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Inventor(s)	MILLER; Robert E. et al.

SYSTEMS AND METHODS FOR FRESHWATER PRODUCTION AND BRINE WASTE RECOVERY

Abstract

A liquid treatment loop system for dissociating and removing brine compositions found in wastewater and producing clean water for freshwater and potable water applications. The system includes an acoustic source process cell stage (SPCS) operatively in communication with a continuous stream from a fluid source. The SPCS is configured to eviscerate contaminants in the continuous fluid stream in at least one treatment process. The SPCS is also configured to separate the eviscerated contaminants from the continuous fluid stream to provide permeated water in the at least one treatment process. The system includes at least one mining process cell stage (MPCS) operatively in communication with SPCS. The at least one MPCS is adapted to receive the eviscerated contaminants from the SPCS. The system includes at least one permeate outlet operatively in communication with SPCS, wherein the at least one permeate outlet is adapted to receive the permeated water from the SPCS.

Inventors: **MILLER; Robert E. (North Canton, OH), MILLER; Scott E. (North Canton, OH), KOONTZ; Franklin N. (Hampstead, MD)**

Applicant: **Mage LLC** (North Canton, OH)

Family ID: **1000008589669**

Assignee: **Mage LLC (North Canton, OH)**

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application is divisional patent application of co-pending U.S. patent application Ser. No. 17/699,409, filed on Mar. 21, 2022, which is a continuation-in-part application of U.S. Pat. No. 11,986,835, filed on Feb. 15, 2022 and issued on May 21, 2024, which claims the benefit of U.S. Provisional Application Ser. No. 63/288,010, filed on Dec. 10, 2021; the disclosures of which are incorporated herein by reference.

TECHNICAL FIELD
[0002] This disclosure is directed to system for treating a continuous flow of fluid-based medium. More particularly, this disclosure is directed to a system applying sonic energy to a continuous flow of fluid-based medium for treating said continuous flow of fluid-based medium. Specifically, this disclosure is directed to a system using sonic energy for dissociating complex substances in a continuous flow of fluid-based medium and separating the dissociated complex substances from continuous flow of fluid-based medium.
BACKGROUND
[0003] Fluid and fluid streams provided from various sources may include contaminants or solids that are entrained, suspended, or dissolved in these fluid and fluid streams. The removal of these contaminates or solids are frequently of considerable interest since the streams containing these solids may otherwise be useable once cleaned. For example, in the case of fluids, cleaning may render the fluids useful for process applications, human consumption or the like.
[0004] Generally, treatment and purification of fluid streams including contaminants or solids therein requires a vast amount of systems and assemblies to make such streams usable. In one example, treatment and purification of waste water streams from water sources (e.g., rivers, lakes, oceans, etc.) requires the act of removing and/or neutralizing vast amounts of microorganisms and various types of chemical compounds found in these waste water streams. Current practices and methods generally treat these waste water stream issues by applying or using chemical additives to disintegrate or neutralize specific contaminants or solids found in these waste water streams. Even though these systems are in place, the continuous application of chemical additives to these waste water streams is costly, time consuming, and marginally effective given the state of the waste water streams.
[0005] Moreover, separation or removal of these contaminants or solids provided in these fluid streams is another issue in various parts of the world. For example, the separation of salt from seawater or separation of dissolved, suspended, and entrained solids (such as microorganisms and chemical compounds) in waste water streams requires vast systems to produce useable and clean fluids like clean drinking water for human consumption. In these fields, current separation processes to produce freshwater are mainly thermal based or micro-filtration systems based on

multiple stages using numerous amounts of standard and membrane filters, particularly reverse osmosis desalination for removal of salt from seawater. Even though these systems are in place, the continuous application of thermal and use of standard and membrane filters to clean fluid streams is also costly, time consuming, and marginally effective given the state of the waste water streams.

SUMMARY

[0006] In one aspect, an exemplary embodiment of the present disclosure may provide a solids dissociation apparatus. The solids dissociation apparatus may comprise a housing; at least one insert operably engaged with the housing, wherein the at least one insert is adapted to receive a continuous fluid stream; and a transducer operably engaged with the housing and disposed about the at least one insert at a distance away from said at least one insert inside of the housing, wherein the transducer is configured to create cavitation inside of the housing, via sonic waves, to eviscerate contaminants in the continuous fluid stream flowing through the at least one insert.

[0007] This exemplary embodiment or another exemplary embodiment may further provide the distance measured between the at least one insert and the transducer is about at least one-half wavelength of a frequency of the sonic waves transmitted by said transducer. This exemplary embodiment or another exemplary embodiment may further provide a pressurized chamber defined by the housing, wherein the pressurized chamber is configured to hold a continuous sonic optimization fluid to allow the transducer to generate cavitation in the continuous sonic optimization fluid stream. This exemplary embodiment or another exemplary embodiment may further provide at least one fluid passage defined by the at least one insert, wherein the at least one fluid passage is adapted to eviscerating contaminants in the continuous fluid stream inside of the at least one insert isolated from the pressurized chamber and remote from the transducer. This exemplary embodiment or another exemplary embodiment may further provide that the transducer further comprises a first end; an opposing second end; and a passageway defined therebetween, wherein the passageway is adapted to house a portion of the at least one insert inside of the passageway, and wherein the at least one insert is free from contacting the transducer. This exemplary embodiment or another exemplary embodiment may further provide a first longitudinal axis defined by the at least one insert; and a second longitudinal axis defined by the transducer; wherein the at least one insert and the transducer are coaxial with one another. This exemplary embodiment or another exemplary embodiment may further provide at least one inlet connection operably engaged with the housing and the at least one insert, wherein the at least one inlet connection is adapted to allow the continuous fluid stream with contaminants to flow into the at least one insert; and at least one outlet connection operably engaged with the housing and the at least one insert, wherein the at least one outlet connection is adapted to allow a continuous fluid stream with eviscerated contaminants to flow out from the at least one insert to at least one output device. This exemplary embodiment or another exemplary embodiment may further provide a second inlet connection operably engaged with the housing, wherein the second inlet connection is adapted to allow a continuous sonic optimization fluid to flow into the pressurized chamber; and a second outlet connection operably engaged with the housing for allowing, wherein the second outlet connection is adapted to allow the continuous sonic optimization fluid stream to flow out from the pressurized chamber. This exemplary embodiment or another exemplary embodiment may further provide that the at least one insert is made of a flexible material to allow the sonic waves generated by the transducer to transfer into the at least one insert to create cavitation inside of the at least one insert. This exemplary embodiment or another exemplary embodiment may further provide at least one director operably engaged with the at least one insert; wherein the director is configured to direct the continuous fluid stream with contaminants in a non-laminar flow inside of the at least one insert. This exemplary embodiment or another exemplary embodiment may further provide a first director operably engaged with a first wall of the at least one insert; and a second director operably engaged with an opposing second wall of the at least one insert; wherein the first director and the second director is configured to direct the continuous fluid stream with contaminants in a laminar flow inside of the at least one insert. This exemplary embodiment or another exemplary embodiment may further provide a third outlet connection operably engaged with the housing and the at least one insert, wherein the third outlet connection is adapted to allow a continuous fluid stream with eviscerated contaminants to flow out from the at least one insert to a second output device. This exemplary embodiment or another exemplary embodiment may further provide that the at least one insert further comprises an outer wall extending between a first wall and an opposing second wall of the at least one insert; and an inner wall extending between the first wall and the second wall of the at least one insert; wherein the at least one fluid passage is defined between the outer wall and the inner wall; and wherein the at least one fluid passage is adapted to isolate cavitation of the continuous fluid stream with contaminants inside of the at least one insert remote from the transducer. This exemplary embodiment or another exemplary embodiment may further provide a second fluid passage defined by the inner wall of the at least one insert, wherein the second fluid passage is adapted to isolate cavitation of a second continuous fluid stream inside of the inner wall remote from the transducer and remote from the at least one fluid passage. This exemplary embodiment or another exemplary embodiment may further provide that the second continuous fluid stream contains one of contaminants and eviscerated containments. This exemplary embodiment or another exemplary embodiment may further provide a first flow director operably engaged with the at least one insert inside of the at least one fluid passage; and second flow director operably engaged with the at least one insert inside of the second fluid passage; wherein the first flow director and the second flow director are configured to direct the continuous fluid stream and the second continuous fluid stream with contaminants in a non-laminar flow inside of the at least one insert. This exemplary embodiment or another exemplary embodiment may further provide that the frequency of the sonic waves generated by the transducer is between about 3 kHz up to about 200 kHz.

[0008] In another aspect, an exemplary embodiment of the present disclosure may provide a method of eviscerating contaminants in a continuous fluid stream. The method further comprises steps of pumping at least one continuous fluid stream into a solids dissociation apparatus, wherein the at least one continuous fluid stream includes contaminants; guiding the at least one continuous fluid stream, via at least one inlet connection, into at least one insert of the solids dissociation apparatus; transmitting sonic waves, via a transducer of the solids dissociation apparatus, inside of a housing of the solids dissociation apparatus, wherein the transducer is positioned at a distance away from the at least one insert; cavitating a continuous sonic stream inside of the housing; cavitating the at least one continuous fluid stream inside of the at least one insert, wherein the at least one continuous fluid stream is isolated from the continuous sonic stream; and eviscerating the contaminants in the at least one continuous fluid stream.

[0009] This exemplary embodiment or another exemplary embodiment may further provide a step of directing the at least one continuous fluid stream with eviscerated contaminants, via at least one outlet connection of the solids dissociation apparatus, to at least one output device. This exemplary embodiment or another exemplary embodiment may further provide a step of directing the at least one continuous fluid stream with eviscerated contaminants, via a second outlet connection of the solids dissociation apparatus, to a second output device. This exemplary embodiment or another exemplary embodiment may further provide steps of pumping a second continuous fluid stream into the fluid treatment apparatus, wherein the second continuous fluid stream includes one of contaminants and eviscerated contaminants; guiding the second continuous fluid stream, via a second inlet connection of the solids dissociation apparatus, into a second insert of the fluid treatment apparatus; cavitating the second continuous fluid stream inside of the at least one insert, wherein the at least one continuous fluid stream is isolated from the continuous sonic stream; eviscerating one of the contaminants and the eviscerated contaminants in the second continuous fluid stream; and directing the second fluid stream with eviscerated contaminants, via a second outlet connection of the solids dissociation apparatus, to a second output device. This exemplary embodiment or another exemplary embodiment may further provide a step of directing the at least one continuous fluid stream, via at least one director, in one of a non-laminar flow and a laminar flow.

[0010] In another aspect, an exemplary embodiment of the present disclosure may provide a solids separation apparatus. The solids separation apparatus may comprise a tower; a transducer operably engaged with a first end of the tower, wherein the transducer is configured to generate a standing sonic wave inside of the tower; a reflector operably engaged with an opposing second end of the tower, wherein the reflector is configured to reflect the standing sonic wave towards the transducer; and at least one set of ports defined in an interior wall of at least one solids removal stage of the tower, wherein the at least one set of ports is positioned at anti-nodes of the standing sonic wave to recover solids concentrate from a fluid stream flowing through the tower; wherein the transducer and the reflector are linearly moveable relative to the tower to linearly move the standing sonic wave.

[0011] This exemplary embodiment or another exemplary embodiment may further provide that the transducer and the reflector are independently moveable relative to one another along a longitudinal axis defined between the first end and the second end of the tower. This exemplary embodiment or another exemplary embodiment may further provide that each port of the at least one set of ports defines a V-shaped configuration. This exemplary embodiment or another exemplary embodiment may further provide at least one set of shutters operably engaged with the interior wall of the tower, wherein each shutter of the at least one set of shutters is moveable relative to the tower to control the flow rate of the fluid stream in the tower. This exemplary embodiment or another exemplary embodiment may further provide that the tower further comprises an effluent outlet defined by the tower, wherein the effluent outlet is in fluid communication with each port of the at least one set of ports, and wherein the effluent outlet is configured to direct recovered solids concentrate from the fluid stream to at least one effluent output. This exemplary embodiment or another exemplary embodiment may further provide at least one set of passageways defined in the interior wall, wherein each passageway of the at least one set of passageways provides fluid communication between a port of the at least one set of ports and the effluent outlet, and wherein each passage of the at least one set of passages is configured to accept solids concentrate with a first configuration. This exemplary embodiment or another exemplary embodiment may further provide that each shutter of the at least one set of shutters is independently moveable relative to one another. This exemplary embodiment or another exemplary embodiment may further provide that the at least one set of shutters is one of longitudinally moveable, laterally moveable, radially moveable, and circumferentially moveable relative to the tower. This exemplary embodiment or another exemplary embodiment may further provide a diaphragm operably engaged with the tower between the first end and the second end of the tower; wherein the diaphragm is configured to prevent solids concentrate with the first configuration from traveling into a second solids removal stage of the tower. This exemplary embodiment or another exemplary embodiment may further provide that the diaphragm is independently moveable relative to the tower along a longitudinal axis defined between the first end and the second end of the tower. This exemplary embodiment or another exemplary embodiment may further provide at least one transfer connection operably engaged with the tower; wherein the at least one transfer connection provides fluid communication for the fluid stream between the at least one solids removal stage of the tower and a second solids removal stage of the tower. This exemplary embodiment or another exemplary embodiment may further provide a second set of ports defined in an interior wall of the second solids removal stage of the tower, wherein the second set of ports is positioned at anti-nodes of the standing sonic wave to recover solids concentrate with a second configuration from the fluid stream flowing through the tower. This exemplary embodiment or another exemplary embodiment may further provide that each port of the second set of ports defines a V-shaped configuration. This exemplary embodiment or another exemplary embodiment may further provide a second set of shutters operably engaged with the interior wall of the tower; wherein each shutter of the second set of shutters is moveable relative to the tower to control the flow rate of the fluid stream in the tower. This exemplary embodiment or another exemplary embodiment may further provide that each shutter of the second set of shutters is independently moveable relative to one another. This exemplary embodiment or another exemplary embodiment may further provide that the second set of shutters is one of longitudinally moveable, laterally moveable, radially moveable, and circumferentially moveable relative to the tower. This exemplary embodiment or another exemplary embodiment may further provide that a second effluent outlet defined by the tower, wherein the second effluent outlet is in fluid communication with each port of the second set of ports, and wherein the second effluent outlet is configured to direct recovered solids concentrate from the fluid stream to a second effluent output. This exemplary embodiment or another exemplary embodiment may further provide a second set of passageways defined in the interior wall, wherein each passageway of the second set of passageways provides fluid communication between a port of the second set of ports and the second effluent outlet, and wherein each passageway of the second set of passageways is configured to accept solids concentrate with a second configuration smaller than the solids concentrate with a first configuration.

[0012] In another aspect, an exemplary embodiment of the present disclosure may provide a method of removing solid concentrates from a fluid stream. The method may comprise the steps of pumping the fluid stream into a tower of a solids separation apparatus, wherein the fluid stream includes solid concentrates of at least one configuration; transmitting a standing sonic wave, via a transducer of the solids separation apparatus, inside of the tower; reflecting the standing sonic wave, via a reflector of the solids separation apparatus, back to the transducer; adjusting one or both of the transducer and the reflector until the anti-nodes of the standing sonic wave are aligned with at least one set of ports defined in the tower; forcing the solid concentrates of the at least one configuration in the fluid stream, via the standing sonic wave, into the at least one set of ports of at least one solids removal stage of the tower; and removing the solid concentrates of the at least one configuration from the fluid stream into the at least one set of ports.

[0013] This exemplary embodiment or another exemplary embodiment may further provide a step of directing the solid concentrates of the at least one configuration, via an effluent outlet, from the tower to at least one effluent output. This exemplary embodiment or another exemplary embodiment may further provide a step of transferring the standing sonic wave, via a diaphragm, from the at least one solids removal stage to a second solids removal stage of the tower. This exemplary embodiment or another exemplary embodiment may further provide a step of directing the fluid stream, via at least one transfer connection, from the at least one solids removal stage of the tower to at least one additional solids removal stage of the tower. This exemplary embodiment or another exemplary embodiment may further provide a step of moving at least one set of shutters along an interior wall of the tower to control the flow rate of the fluid stream in the tower. This exemplary embodiment or another exemplary embodiment may further provide steps of forcing solid concentrates of a second configuration in the fluid stream, via the standing sonic wave, into a second set of ports of the second stage of the tower, wherein the solid concentrates of a second configuration are smaller than the solid concentrates of the at least one configuration; and removing the solid concentrates of the second configuration from the fluid stream into second set of ports. This exemplary embodiment or another exemplary embodiment may further provide a step of directing the solid concentrates of the second configuration, via a second effluent outlet, from the tower to a second effluent output.

[0014] In another aspect, an exemplary embodiment of the present disclosure may provide fluid cleaning system. The fluid cleaning system may comprise at least one solids dissociation apparatus adapted to receive a continuous fluid stream from a fluid source; wherein the at least one solids dissociation apparatus further comprises: a housing; at least one insert operably engaged with the housing, wherein the at least one insert is adapted to receive the continuous fluid stream; a transducer operably engaged with the housing and disposed about the at least one insert at a distance away from the said at least one insert inside of the housing, wherein the transducer is configured to create cavitation inside of the housing, via sonic waves, to eviscerate contaminants in the continuous fluid stream flowing through the at least one insert; and at least one solids separation apparatus operably connected with the at least one fluid treatment apparatus for receiving the eviscerated contaminants provided in the fluid stream, wherein the at least one solids separation apparatus is adapted to separate the eviscerate contaminants from the fluid stream for at least one separation process.

[0015] This exemplary embodiment or another exemplary embodiment may further provide that a portion of the solids separation apparatus is provided inside of the at least one solids dissociation apparatus. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids dissociation apparatus further comprises a distance measured between the at least one insert and the transducer, wherein the distance is about at least one-half wavelength of a frequency of the sonic waves generated by said transducer. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids dissociation apparatus further comprises a pressurized chamber defined by the housing, wherein the pressurized chamber is configured to hold a continuous sonic optimization fluid to allow the transducer to generate cavitation in the continuous sonic optimization fluid. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids dissociation apparatus further comprises at least one fluid passage defined by the at least one insert, wherein the at least one fluid passage is adapted to isolated the continuous fluid stream inside of the at least one insert from the pressurized chamber and remote from the transducer to allow for cavitation inside of the at least one fluid passage via the traveling sonic wave. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids dissociation apparatus further comprises at least one inlet connection operably engaged with the housing and the at least one insert, wherein the at least one inlet connection is adapted to allow the continuous fluid stream with contaminants to flow into the at least one insert; and at least outlet connection operably engaged with the housing and the at least one insert, wherein the at least one outlet connection is adapted to allow a continuous fluid stream with eviscerated contaminants to flow out from the at least one insert to at least one output device. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids dissociation apparatus further comprises a second inlet connection operably engaged with the housing, wherein the second inlet connection is adapted to allow a continuous sonic optimization fluid to flow into the pressurized chamber; and a second outlet connection operably engaged with the housing for allowing, wherein the second outlet connection is adapted to allow the continuous sonic optimization fluid to flow out from the pressurized chamber. This exemplary embodiment or another exemplary embodiment may further provide that the at least one insert is made of a rigid or flexible material to allow the sonic waves generated by the transducer to transfer into the at least one insert to create cavitation inside of the at least one insert. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids dissociation apparatus further comprises at least one director operably engaged with at least one insert; wherein the director is configured to direct the continuous fluid stream with contaminants in a non-laminar flow inside of the at least one insert. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids separation apparatus further comprises a tower; a second transducer operably engaged with a first end of the tower, wherein the transducer is configured to generate a standing sonic wave inside of the tower; a reflector operably engaged with an opposing second end of the tower, wherein the reflector is configured to reflect the standing sonic wave towards the transducer; and at least one set of ports defined in an interior wall of at least one solids separation stage of the tower, wherein the at least one set of ports is positioned at anti-nodes of the standing sonic wave to recover solids concentrate from a fluid stream flowing through the tower; wherein the transducer and the reflector are linearly moveable relative to the tower to linearly move the standing sonic wave. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids separation apparatus further comprises at least one set of shutters operably engaged with the interior wall of the tower inside of the effluent outlet; wherein each shutter of the at least one set of shutters is moveable relative to the tower to control the flow rate of the fluid stream in the tower. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids separation apparatus further comprises an effluent outlet defined by the tower, wherein the effluent outlet is in fluid communication with each port of the at least one set of ports, and wherein the effluent outlet is configured to direct recovered solids concentrate from the fluid stream to at least one effluent output. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids separation apparatus further comprises at least one set of passageways defined in the interior wall, wherein each passageway of the at least one set of passageways provides fluid communication between a port of the at least one set of ports and the effluent outlet, and wherein each passage of the at least one set of passages is configured to accept solids concentrate with a first configuration. This exemplary embodiment or another exemplary embodiment may further provide a second solids dissociation apparatus operably connected with the at least one solids separation apparatus, wherein the second fluid treatment apparatus is configured to eviscerate contaminants provided in the fluid stream for a second evisceration process. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids separation apparatus further comprises a second separation process operably connected with the second fluid treatment apparatus, wherein the at least one solids separation apparatus is adapted to separate the eviscerated contaminants from the fluid stream for a second separation process.

[0016] In another aspect, an exemplary embodiment of the present disclosure may provide a method of separating contaminants from continuous fluid. The method may comprise the steps of pumping at least one continuous fluid stream into a fluid treatment apparatus, wherein the at least one continuous fluid stream includes contaminants; generating a traveling sonic wave, via a transducer of the apparatus, inside of a housing of the fluid treatment apparatus; cavitating the at least one continuous fluid stream inside of the at least one insert, wherein the at least one continuous fluid stream is isolated from the continuous sonic stream; eviscerating the contaminants in the at least one continuous fluid stream; pumping the at least one continuous fluid stream into a tower of a solids separation apparatus, wherein the fluid stream includes eviscerated contaminants of at least one configuration; generating a standing sonic wave, via a transducer of the solids separation apparatus, inside of the tower; adjusting one or both of the transducer and the reflector until the anti-nodes of the standing sonic wave are aligned with at least one set of ports defined in the tower; forcing the eviscerated contaminants of the at least one configuration, via the standing sonic wave, into the at least one set of ports of at least one removal stage of the tower; and removing the eviscerated contaminants of the at least one configuration from the fluid stream into the at least one set of ports.

[0017] This exemplary embodiment or another exemplary embodiment may further provide steps of pumping the at least one continuous fluid stream into a second fluid treatment apparatus; generating a second traveling sonic wave, via a second transducer of the second fluid treatment apparatus, inside of a second housing of the second fluid treatment apparatus; cavitating the at least one continuous fluid stream inside of a second insert, wherein the at least one continuous fluid stream is isolated from a second continuous sonic stream; and eviscerating the contaminants in the at least one continuous fluid stream. This exemplary embodiment or another exemplary embodiment may further provide a step of transferring the standing sonic wave, via a diaphragm, from the at least one solids removal stage to a second solids removal stage of the tower. This exemplary embodiment or another exemplary embodiment may further provide a step of directing the fluid stream, via at least one plumbing member, from the first solids separation stage of the tower to at least one additional solids separation stage of the tower. This exemplary embodiment or another exemplary embodiment may further provide steps of forcing eviscerated contaminants of a second configuration in the fluid stream, via the standing sonic wave, into a second set of ports of the second stage of the tower, wherein the eviscerated contaminants of a second configuration are smaller than the eviscerated contaminants of the at least one configuration; and removing the eviscerated contaminants of the second configuration from the fluid stream into second set of ports.

[0018] In another aspect, an exemplary embodiment of the present disclosure may provide a fluid cleaning system. The fluid cleaning system may comprise at least one solids dissociation apparatus adapted to receive a continuous fluid stream from a fluid source, wherein the at least one solids dissociation apparatus is configured to eviscerate contaminants provided in the fluid stream for at least one evisceration process; and at least one solids separation apparatus operably connected with the at least one fluid treatment apparatus for receiving the eviscerated contaminants provided in the fluid stream, the at least one solids separation apparatus comprising housing (tower); a transducer operably engaged with a first end of the tower, wherein the transducer is configured to generate a standing sonic wave inside of the tower; a reflector operably engaged with an opposing second end of the tower, wherein the reflector is configured to reflect the standing sonic wave towards the transducer; and at least one set of ports defined in an interior wall of at least one solids removal stage of the tower, wherein the at least one set of ports is positioned at anti-nodes of the standing sonic wave to recover solids concentrate from a fluid stream flowing through the tower; wherein the transducer and the reflector are linearly moveable relative to the tower to linearly move the standing sonic wave.

[0019] This exemplary embodiment or another exemplary embodiment may further provide that a portion of the solids separation apparatus is provided inside of the at least one solids dissociation apparatus. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids separation apparatus further comprises at least one set of shutters operably engaged with the interior wall of the tower inside of the effluent outlet; wherein each shutter of the at least one set of shutters is moveable relative to the tower to control the flow rate of the fluid stream in the tower. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids separation apparatus further comprises an effluent outlet defined by the tower, wherein the effluent outlet is in fluid communication with each port of the at least one set of ports, and wherein the effluent outlet is configured to direct recovered solids concentrate from the fluid stream to at least one effluent output. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids separation apparatus further comprises at least one set of passageways defined in the interior wall, wherein each passageway of the at least one set of passageways provides fluid communication between a port of the at least one set of ports and the effluent outlet, and wherein each passage of the at least one set of passages is configured to accept solids concentrate with a first configuration. This exemplary embodiment or another exemplary embodiment may further provide that the at least one solids dissociation apparatus further comprises a housing; at least one insert operably engaged with the housing, wherein the at least one insert is adapted to receive the continuous fluid stream; and transducer operably engaged with the housing and disposed about the at least one insert at a distance away from the said at least one insert inside of the housing, wherein the transducer is configured to create cavitation inside of the housing, via sonic waves, to eviscerate contaminants in the continuous fluid stream flowing through the at least one insert.

[0020] In another aspect, an exemplary embodiment of the present disclosure may provide a fluid treatment loop system. The fluid treatment loop system comprises an acoustic source process cell stage (SPCS), wherein the SPCS comprises: at least one solids dissociation apparatus (SDA) operatively in communication with a continuous fluid stream from a fluid source, wherein the at least one SDA comprises: a housing; at least one insert operably engaged with the housing, wherein the at least one insert is adapted to receive the continuous fluid stream; and a transducer operably engaged with the housing and disposed about the at least one insert at a distance away from said at least one insert inside of the housing, wherein the transducer is configured to create cavitation inside of the housing, via sonic waves, to dissociate contaminants in the continuous fluid stream flowing through the at least one insert; and at least one solids separation apparatus (SSA) operably connected with the at least one fluid treatment apparatus for receiving the dissociated contaminants provided in the continuous fluid stream, wherein the at least one SSA is adapted to separate the dissociated contaminants from the fluid stream for at least one separation process; at least one mining process cell stage (MPCS) operatively in communication with SPCS, wherein the at least one MPCS is adapted to receive the dissociated contaminants from the SPCS; and at least one permeate outlet operatively in communication with SPCS, wherein the at least one permeate outlet is adapted to receive the permeated water from the SPCS.

[0021] This exemplary embodiment or another exemplary embodiment may further include that the at least one SSA of the SPCS comprises: a tower; a second transducer operably engaged with a first end of the tower, wherein the transducer is configured to generate a standing sonic wave inside of the tower; a reflector operably engaged with an opposing second of the tower, wherein the reflector is configured to reflect the standing sonic wave towards the transducer; and at least one set of ports defined in an interior wall of at least one solids separation stage of the tower, wherein the at least one set of ports is positioned at anti-nodes of the standing sonic wave to recover dissociated contaminants from the continuous fluid stream flowing through the tower; wherein the transducer and the reflector are linearly moveable relative to the tower to linearly move the standing sonic wave. This exemplary embodiment or another exemplary embodiment may further include at least one effluent connection operably connected with the at least one SSA and the at least one MPCS; wherein the at least one effluent connection transports the dissociated contaminants of the at least one treatment process from the at least one SSA to the at least one MPCS. This exemplary embodiment or another exemplary embodiment may further include that the SPCS comprises: at second SDA operably connected with the at least one SSA, wherein the at least one SDA is configured to eviscerate the contaminants in the continuous fluid stream in a second treatment process; and a second SSA operably connected with the second SDA for receiving the dissociated contaminants provided in the fluid stream, wherein the at least one SSA is configured to separate the dissociated contaminants from the continuous fluid stream and provide permeated water in the second treatment process. This exemplary embodiment or another exemplary embodiment may further include a second effluent connection operably connected with the second SSA and the at least one MPCS; wherein the second effluent connection transports the dissociated contaminants of the second treatment process from the second SSA to the at least one MPCS. This exemplary embodiment or another exemplary embodiment may further include at least one permeate connection operably connected with the at least one SSA and the at least one permeate outlet; wherein the at least one permeate outlet is adapted to transport the permeated water from the at least one SSA to the at least one permeate outlet. This exemplary embodiment or another exemplary embodiment may further include at least one freshwater channel; and at least one freshwater connection operably connected with the at least one permeate outlet and the at least one freshwater channel; wherein the at least one freshwater connection is adapted to transport the permeated water from the at least one permeate outlet to the at least one freshwater channel. This exemplary embodiment or another exemplary embodiment may further include at least one potable water channel; and at least one potable water connection operably connected with the at least one permeate outlet and the at least one potable water channel; wherein the at least one potable water connection is adapted to transport the permeated water from the at least one permeate outlet to the at least one potable water channel. This exemplary embodiment or another exemplary embodiment may further include at least one battery process cell stage (BPCS); at least one battery process connection operably connected with the at least one MPCS and the BPCS; and a first mined stream collected by the at least one MPCS; wherein the at least one battery process connection is adapted to transport the first mined stream from the at least one MPCS to the at least one BPCS. This exemplary embodiment or another exemplary embodiment may further include that the first mined stream includes a mixture of brine and sodium hydroxide. This exemplary embodiment or another exemplary embodiment may further include at least one hydrogen fuel cell generator process cell stage (GPCS); at least one battery fluid stream collected by the at least one GPCS; and at least one generator process connection operably connected with the at least one BPCS and the at least one GPCS; wherein the at least one generator process connection is adapted to transport the at least one battery fluid stream from the at least one GPCS to the at least one BPCS. This exemplary embodiment or another exemplary embodiment may further include that wherein the at least one battery fluid stream transported from the at least one BPCS to the at least one GPCS includes one of hydrogen solution and sodium hydroxide solution. This exemplary embodiment or another exemplary embodiment may further include a first battery fluid stream collected by the at least one GPCS comprising of hydrogen; a second battery fluid stream collected by the at least one GPCS comprising of sodium hydroxide; a first generator process connection operably connected with the at least one BPCS and the at least one GPCS, wherein the first generator process connection is adapted to transport the first battery fluid stream from the at least one BPCS to the at least one GPCS; and a second generator process connection operably connected with the at least one BPCS and the at least one GPCS, wherein the second generator process connection is adapted to transport the second battery fluid stream from the at least one BPCS to the at least one GPCS. This exemplary embodiment or another exemplary embodiment may further include at least one hydrogen process cell stage (HPCS); a second mined stream collected by the at least one MPCS having a mixture of brine and sodium chloride; and at least one hydrogen process connection operably connected with the at least one HPCS and the at least one MPCS; wherein the at least one hydrogen production connection is adapted to transport the second mined stream from the at least one GPCS to the at least one MPCS. This exemplary embodiment or another exemplary embodiment may further include a liquid discharge process cell stage (LPCS) operably connected with the at least one BPCS, the at least one GPCS, and the at least one HPCS; wherein the LPCS is configured to receive to at least one brine stream from each of the at least one BPCS, the at least one GPCS, and the at least one HPCS; wherein the LPCS is configured to remove brine in the at least one brine stream from each of the at least one BPCS, the at least one GPCS, and the at least one HPCS. This exemplary embodiment or another exemplary embodiment may further include a concentrate connection operably connecting the at least one SPCS with each of the at least one BPCS, the at least one GPCS, the at least one HPCS, and the LPCS; wherein the concentrate connection is configured to transport concentrate brine removed in the at least one brine stream from each of the at least one BPCS, the at least one GPCS, and the at least one HPCS to the at least one SPCS. This exemplary embodiment or another exemplary embodiment may further include that wherein the fluid treatment loop system is adapted to be operatively connected with a preexisting desalination process.

[0022] In another aspect, an exemplary embodiment of the present disclosure may provide a method. The method comprises steps of pumping a continuous fluid stream, via a fluid source, into a solids dissociation apparatus (SDA) of an acoustic source process cell stage (SPCS); generating a traveling sonic wave, via a transducer of the SDA, inside of a housing of the fluid treatment apparatus; cavitating the continuous fluid stream inside of at least one insert of the SDA, wherein the at least one continuous fluid stream is isolated from the continuous sonic stream; dissociating contaminants, via the transducer of the SDA, from the continuous fluid stream; pumping the continuous fluid stream into a tower of a solids separation apparatus (SSA) of the SPCS, wherein the fluid stream includes the dissociated contaminants; removing the dissociated contaminants, via the SSA of the SPCS, from the continuous fluid stream; outputting the dissociated contaminants, via an effluent connection, to at least one mining process cell stage (MPCS); and outputting permeate water, via a permeate connection, to one of at least one permeate output and at least one

freshwater output.
[0023] This exemplary embodiment or another exemplary embodiment may further include steps of generating a standing sonic wave, via a transducer of the SSA, inside of the tower; adjusting one or both of the transducer and the reflector until the anti-nodes of the standing sonic wave are aligned with at least one set of ports defined in the tower; and forcing the dissociated contaminants, via the standing sonic wave, into the at least one set of ports of at least one removal stage of the tower of the SSA. This exemplary embodiment or another exemplary embodiment may further include steps of mining at least one mineral, via the at least one MPCS, from the dissociated contaminants, wherein the at least one mineral is a mixture of brine and sodium chloride; and outputting the at least one mineral, via at least one battery process connection, to at least one battery process cell stage (BPCS). This exemplary embodiment or another exemplary embodiment may further include steps of mining at least another mineral, via the at least one MPCS, from the dissociated contaminants, wherein the at least another mineral is a mixture of brine and sodium chloride; and outputting the at least another mineral, via at least one generator process connection, to at least one hydrogen production stage (HPCS). This exemplary embodiment or another exemplary embodiment may further include steps of outputting a first battery fluid stream, via a first generator process connection, from the at least one GPCS to the at least one BPCS, wherein the first battery fluid includes hydrogen; and outputting a second battery fluid stream, via a second generator process connection, from the at least one GPCS to the at least one BPCS, wherein the second battery fluid includes sodium hydroxide. This exemplary embodiment or another exemplary embodiment may further include a step of outputting at least one hydrogen stream, via at least one hydrogen production connection, from the at least one HPCS to the at least one GPCS. This exemplary embodiment or another exemplary embodiment may further include a step of outputting at least one brine stream, via at least one brine stream connection, from at least one of the at least one BPCS, the at least one GPCS, and the at least one HPCS to a liquid discharge process cell stage (LPCS). This exemplary embodiment or another exemplary embodiment may further include a step of outputting at least one freshwater stream from the LPCS to the at least one freshwater output. This exemplary embodiment or another exemplary embodiment may further include a step of outputting concentrate brine, via at least one concentrate brine connection, from the LPCS to the at least one SPCS. This exemplary embodiment or another exemplary embodiment may further include a step of powering at least one of the at least one SPCS, the at least one BPCS, the at least one GPCS, and the at least one HPCS, via at least one electrical connection, from an electrical controller.

Description

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS
[0024] Sample embodiments of the present disclosure are set forth in the following description, are shown in the drawings and are particularly and distinctly pointed out and set forth in the appended claims.
[0025] FIG. **1**A is diagrammatic sectional view of a fluid cleaning system having a solids dissociation apparatus (SDA) and a solids separation apparatus (SSA).
[0026] FIG. **1**B is a diagrammatic sectional view of the fluid cleaning system similar to FIG. **1**A, with the fluid cleaning system performing a fluid cleaning operation for a continuous fluid stream.
[0027] FIG. **2** is a diagrammatic sectional view of the SDA of the fluid cleaning system shown in FIG. **1**A.
[0028] FIG. **3** is a diagrammatic sectional view of the SSA of the fluid cleaning system shown in FIG. **1**B.
[0029] FIG. **3**A is a partial diagrammatic sectional view of an alternative adjustment assembly for a

diaphragm of the SSA of the fluid cleaning system shown in FIG. **1**B.
[0030] FIG. **4**A is an enlargement view of the highlighted region shown in FIG. **3**.
[0031] FIG. **4**B is an enlargement view of the highlighted region shown in FIG. **3**.
[0032] FIG. **5**A is a diagrammatic sectional view of an alternative SDA of another fluid cleaning system.
[0033] FIG. **5**B is a diagrammatic sectional view of an alternative SDA of another fluid cleaning system.
[0034] FIG. **5**C is a diagrammatic sectional view of an alternative SDA of another fluid cleaning system.
[0035] FIG. **5**D is a diagrammatic sectional view of an alternative SDA of another fluid cleaning system.
[0036] FIG. **5**E is a diagrammatic cross-section view of the alternative SDA shown in FIG. **5**D taken in the direction of line **5**E-**5**E in FIG. **5**D.
[0037] FIG. **5**F is a diagrammatic sectional view of an alternative SDA of another fluid cleaning system.
[0038] FIG. **6** is a diagrammatic sectional view of another fluid cleaning system having first and second SDAs operably engaged with a SSA.
[0039] FIG. **7** is a diagrammatic sectional view of another fluid cleaning system having a SDA operably engaged with a SSA, wherein a portion of the SSA is provided inside of the SDA.
[0040] FIG. **8** is a method flowchart of eviscerating contaminants in a continuous fluid stream.
[0041] FIG. **9** is a method flowchart of removing solid concentrates from a fluid stream.
[0042] FIG. **10** is a method flowchart of separating contaminants from a continuous fluid.
[0043] FIG. **11** is a partial diagrammatic flowchart of a fluid treatment loop system.
[0044] FIG. **12** is a partial diagrammatic flowchart of the fluid treatment loop system shown in FIG. **11**.
[0045] Similar numbers refer to similar parts throughout the drawings.

DETAILED DESCRIPTION

[0046] FIGS. **1**A-**1**B, **2**, **3**, and **4**A-**4**B illustrate a fluid treatment system generally referred to as **1**. The fluid treatment system **1** may include at least one solids dissociation apparatus (or "SDA" hereinafter) which is generally referred to as **10**. The at least one solids dissociation apparatus **10** is configured to dissociate and/or disintegrate complex substances or solids into simpler constituents and/or elements. In other words, the at least one solids dissociation apparatus **10** is configured to eviscerate and/or break up complex substances found in a fluid source for cleaning and decontaminating said fluid source. Such dissociation of complex substances and solids via the at least one solids dissociation apparatus **10** is described in more detail below.
[0047] The fluid treatment system **1** may also include at least one solids separation apparatus (or hereinafter "SSA") which is generally referred to as **12**. The at least one solids separation apparatus **12** is operably engaged with the at least one solids dissociation apparatus **10** where the at least one SDA **10** and the at least one SSA **12** are in fluid communication with one another. Due to this fluid communication, the at least one SSA **12** is configured to separate simple constituents (i.e., dissociated complex substances) from the fluid stream subsequent to the dissociation operation caused by the at least one SDA **10**. Such separation of simple constituents from the fluid stream via the at least one solids separation apparatus **12** is described in more detail below.
[0048] The complex substances, contaminants, or solids referenced herein that are dissociated and/or disintegrated into simple constituents by the at least one SDA **10** and separated from a fluid stream (e.g., a water source or other types of fluid of the like) by the at least SSA **12** may be any complex substances or solids found in said fluid source. The constituents may be totally dissolved solids (e.g., totally dissolved minerals and salts in the fluid) and may be totally suspended solids (e.g., solids that float or suspend in water and affect the turbidity and/or transparency of the water). Examples of complex substances or solids that may be dissociate and/or disintegrated by at least

one SDA include microorganisms (e.g., Dinoflagellates (*ceratium*), Rotifers, Copepod Adults, Copepodites, Copepod Nauplii, Bivalve Larve, Cladocerans, Polychaete Larve, Ostracods, Protozoan, Decapod Larve, *Staphylococcus, E. coli*, substantially all bacteria, molds, and/or viruses), chemical compounds (e.g., nitrate compounds to manufacture fertilizer, oil compounds, and other of the like), and solids provided in seawater (e.g., salt solids, sediment, clay, sand, minerals, metals, and other solids of the like found in seawater). Moreover, the at least one SDA **10** may be configured to neutralize basic and acidic compounds through its dissociation and disintegration capabilities.

[0049] As described herein, the term "fluid" herein is a substance, as a fluid or a gas, that is capable of flowing and capable of changing its shape at a steady rate when acted upon by a force tending to changes its shape. As such, any fluid known may be used herein when experiencing the at least one SDS **10** and the at least one SSA **12**.

[0050] It should be understood that FIGS. **1**A-**1**B, **2**, **3**, and **4**A-**4**B are diagrammatic only for the fluid treatment system **1** and do not illustrate exact and precise dimensions of any component, assembly, or apparatus provided herein. Such diagrammatic illustrations of the at least one SDA **10** and the at least one SSA **12** of the fluid treatment system **1** shown in FIGS. **1**A-**1**B, **2**, **3**, and **4**A-**4**B should not limit the exact positioning, orientation, or location of the at least one SDA **10** and the at least one SSA **12** relative to one another.

[0051] As illustrated in FIGS. **1**A-**1**B and **4**A-**4**B, the fluid treatment system **1** includes a single SDA **10** operably engaged with a single SSA **12** for treating a continuous fluid stream. The continuous fluid stream is denoted by arrows labeled "LS" in FIGS. **1**B, **2** and **3**. In other exemplary embodiments, any suitable number of SDAs and SSAs may be used in a fluid treatment system, which is described in more detail below.

[0052] While the SDA **10** and the SSA **12** are oriented in upright, vertical positions as illustrated in FIGS. **1**A-**1**B, **2**, **3**, and **4**A-**4**B, the SDA **10** and the SSA **12** may be oriented in any suitable position. In one exemplary embodiment, at least one SDA and at least one SSA of a fluid treatment system may be oriented in lateral, horizontal position. In another exemplary embodiment, at least one SDA of a fluid treatment system may be oriented in a first position (upright, vertical position) and at least one SSA of the fluid treatment system may be oriented in a second position (lateral, horizontal position). In another exemplary embodiment, at least one SDA and at least one SSA of a fluid treatment system may be oriented in any suitable position based on the particular application of said fluid treatment system.

[0053] As illustrated in FIGS. **1**A-**2**, the SDA **10** includes a housing **20**. The housing **20** has a first or top wall **20**A, an opposing second or bottom wall **20**B, and a longitudinal axis "X**1**" defined therebetween. The housing **20** also includes a circumferential wall **20**C that extends between the top wall **20**A and the bottom wall **20**B along an axis parallel with the longitudinal axis "X**1**" of the housing **20**. The circumferential wall **20**C also defines diameter or width "D**1**" that is continuous between the top and bottom walls **20**A, **20**B as shown in FIG. **2**. In the illustrated embodiment, the housing **20** is tubular and/or cylindrically-shaped. In other exemplary embodiments, a housing may have any shape or configuration based on various considerations. Examples of suitable shapes or configuration for a housing include spherical, cubical, cuboidal, conical, triangular, torus-shaped, pyramidal, polyhedron-shaped, and other suitable shapes or configuration for a housing of a SDA.

[0054] Referring to FIG. **2**, the housing **20** also defines a pressurized reservoir **22** that is collectively defined by the top wall **20**A, the bottom walls **20**B, and the circumferential wall **20**C. In one exemplary embodiment, the pressurized reservoir **22** may be held at a pressure that is greater than the surrounding atmospheric pressure for various process reasons, which are described in more detail below. In another exemplary embodiment, the pressurized reservoir **22** may be held at a pressure that is less than the surrounding atmospheric pressure. In another exemplary embodiment, the pressurized reservoir **22** may be held at a pressure that is substantially equal to the surrounding atmospheric pressure. The housing **20** also defines at least one inlet **24** that allows fluid

communication between the pressurized reservoir **22** and the external environment without depressurizing the pressurized reservoir **22**. In the illustrated embodiment, the housing **20** defines a first inlet **24**A at a first position in the circumferential wall **20**C between the top and bottom ends **20**A, **20**B. The housing **20** also defines a second inlet **24**B at a second position in the circumferential wall **20**C between the top and bottom ends **20**A, **20**B. In the illustrated embodiment, the first and second inlets **24**A, **24**B are defined proximate to the bottom end **20**B. Such uses of the first and second inlets **24**A, **24**B defined in the housing **20** are described in more detail below.
[0055] While the first and second inlets **24**A, **24**B of the housing **20** are defined at first and second positions in the circumferential wall **20**C, first and second inlets of a housing may be defined along any portion of the housing. In one exemplary embodiment, first and second inlets of a housing may be defined in a bottom wall of the housing. In another exemplary embodiment, first and second inlets of a housing may be defined in a top wall of the housing. In another exemplary embodiment, a first inlet of a housing may be defined in a first wall of the housing and the second inlet of a housing may be defined a second different wall of the housing.
[0056] Still referring to FIG. **2**, the housing **20** also defines at least one outlet **26** that allows fluid communication between the pressurized reservoir **22** and the external environment without depressurizing the pressurized reservoir **22**. In the illustrated embodiment, the housing **20** defines a first outlet **26**A in the top wall **20**A to provide fluid communication between the pressurized reservoir **22** and the external environment without depressurizing the pressurized reservoir **22**. The housing **20** also defines a second outlet **26**B at a third positioning the circumferential wall **20**C opposite to the second position of the second inlet **24**B between the pressurized reservoir **22** and the external environment without depressurizing the pressurized reservoir **22**. Such uses of the first and second outlets **26**A, **26**B defined in the housing **20** are described in more detail below.
[0057] While the first outlet **26**A is defined in the top wall **20**A and the second outlet **26**B is the circumferential wall **20**C, first and second outlets of a housing may be defined in any portion of the housing. In one exemplary embodiment, first and second outlets of a housing may be defined in a bottom wall of the housing. In another exemplary embodiment, first and second outlets of a housing may be defined in a top wall of the housing. In another exemplary embodiment, first and second outlets of a housing may be defined in a circumferential wall of the housing. In another exemplary embodiment, a first outlet of a housing may be defined a first wall of the housing and the second outlet of a housing may be defined a second different wall of the housing.
[0058] Still referring to FIG. **2**, the SDA **10** also includes at least one insert **40**. The at least one insert **40** is operably engaged with the housing **20** inside of the pressure reservoir **22**. In the illustrated embodiment, the at least one insert **40** is operably engaged with an interior surface of the top wall **20**A of the housing **20**. In other exemplary embodiments, at least one insert may be operably engaged with any portion of the housing, more particularly an interior surface of any portion of the housing. In addition, the at least one insert **40** is configured to receive a continuous fluid stream “LS” from an external fluid source to help isolate dissociation and disintegration of complex substances and solids. Such dissociation and disintegration of complex substances and solids inside of the at least one insert **40** is described in more detail below.
[0059] In the illustrated embodiment, the insert **40** is a made and/or formed of a flexible, resilient material that is able to deform when pressure is applied to the insert **40**, which is described in more detail below. In other exemplary embodiments, an insert described and illustrated herein may be made and/or formed of a rigid, resilient material.
[0060] As illustrated in FIG. **2**, the SDA **10** includes a single insert to help isolate dissociation and disintegration of complex substances and solids. In other exemplary embodiments, any suitable number of inserts may be used in a SDA to help isolate dissociation and disintegration of complex substances and solids, which is described in more detail below.
[0061] Referring to FIG. **2**, the insert **40** includes a first or upper wall **40**A, an opposing second or

bottom wall **40**B, and a longitudinal axis “X**2**” defined therebetween. As shown in FIG. **2**, the longitudinal axis “X**2**” of the insert **40** is parallel with the longitudinal axis “X**1**” of the housing **20**. The insert **40** also includes a peripheral wall **40**C that extends between the upper wall **40**A and the lower wall **40**B along an axis parallel with the longitudinal axis “X**2**” of insert **40**. The peripheral wall **40**C also defines a diameter or width “W**1**” as shown in FIG. **2**. In the illustrated embodiment, the insert **40** is tubular and/or cylindrically-shaped. In other exemplary embodiments, an insert may have any shape or configuration based on various considerations. Examples of suitable shapes or configuration for an insert include spherical, cubical, cuboidal, conical, triangular, torus-shaped, pyramidal, polyhedron-shaped, and other suitable shapes or configuration for an insert of a SDA.

[0062] Still referring to FIG. **2**, a fluid passage **42** is collectively defined by the upper wall **40**A, the lower wall **40**B, and the peripheral wall **40**C of the insert **40**. The fluid passage **42** is accessible via at least one inlet opening **44** and at least one outlet opening **46**. In the illustrated embodiment, the fluid passage **42** is accessible via an inlet opening **44**A defined in the lower wall **40**B of the insert **40**. The fluid passage **42** is accessible via an outlet **46**A defined in the upper wall **40**A of the insert **40**. Such uses of the inlet opening **44**A and the outlet opening **46**A are described in more detail below.

[0063] While the first inlet **44**A is defined in the lower wall **40**B of the insert **40** and the first outlet **46**A is defined in the upper wall **40**A, a first inlet and a first outlet of an insert may be defined in any portion of the insert. In one exemplary embodiment, a first inlet and a first outlet of an insert may both be defined in a bottom wall of the insert. In another exemplary embodiment, a first inlet and a first outlet of an insert may both be defined in a top wall of the insert. In another exemplary embodiment, a first inlet and a first outlet of an insert may both be defined in a peripheral wall of the insert. In another exemplary embodiment, a first inlet of an insert may be defined in a first wall of the insert and a first outlet of an insert may be defined in a second different wall of the insert.

[0064] Still referring to FIG. **2**, the insert **40** may also include a flow director or baffle **48**. The flow director **48** is operably engaged with the peripheral wall **40**C of the insert **40** proximate to the lower wall **40**B and the first inlet **44**A of the insert **40**. As described in more detail below, the flow director **48** creates a specific flow to a continuous fluid stream “LS” that is pumped into the insert **40**. In this illustrated embodiment, the flow director **48** creates a non-laminar flow pattern on the continuous fluid stream “LS” shown in FIGS. **1**B and **2**. In other exemplary embodiments, a flow director or baffle may be omitted from an insert. The use of the flow director **48** is considered advantageous at least because the flow pattern caused by the flow direction **48** on the continuous fluid stream “LS” creates a longer dwell time on the continuous fluid stream “LS” to travel through the insert **40**. Such dwell time allows the continuous fluid stream “LS” to experience more cavitation inside of the insert **40** to further dissociate and/or disintegrate complex contaminants in the continuous fluid stream “LS”, which is described in more detail below.

[0065] While a single flow director **48** is provided with the insert **40**, any suitable number of flow directors may be installed in an insert for various considerations, including the desired dwell time of the continuous fluid stream inside of the insert, the intensity and desired turbulence of a continuous fluid stream, and other various considerations. While a flow director **48** is positioned proximate to the first inlet **44**A of the insert **40**, a flow director may be positioned along any suitable position inside of an insert for various considerations, including the desired dwell time of the continuous fluid stream inside of the insert, the intensity and desired turbulence of a continuous fluid stream, and other various considerations.

[0066] Still referring to FIG. **2**, at least one inlet connection **50** may be operably engaged with the housing **20** and/or insert **40** for delivering a continuous fluid stream “LS” or a continuous sonic optimization fluid stream “US” for dissociation operations. In the illustrated embodiment, a first inlet connection **50**A is operably engaged with the housing **20**, via the first inlet **24**A, and operably engaged with the insert **40**, via the first inlet opening **44**A. As shown in FIG. **2**, the first inlet connection **50**A is configured to direct the continuous fluid stream “LS” pumped from a fluid source (i.e., a body of water or fluid) and into the fluid passage **42** of the insert **40** via the fluid communication between the first inlet connection **50**A and the insert **40**. In addition, a second inlet connection **50**B is operably engaged with the housing **20** via the second inlet **26**A. As shown in FIG. **2**, the second inlet connection **50**B is configured to direct the continuous sonic optimization fluid stream "US" pumped from a sonic optimization fluid source and into the pressurized reservoir **22** of the housing **20** via the fluid communication between the second inlet connection **50**B and the housing **20**. As illustrated in FIG. **2**, the first inlet connection **50**A isolates the continuous fluid stream "LS" from the continuous sonic optimization fluid stream "US" pumped into the pressure reservoir **22** to prevent any mixing of or interaction between the continuous fluid stream "LS" and the continuous sonic optimization fluid stream "US" during dissociation processes, which is described in more detail below.

[0067] Still referring to FIG. **2**, at least one outlet connection **52** may be operably engaged with the housing **20** and/or insert **40** for delivering a continuous fluid stream "LS" with dissociated substances and/or solids or delivering a continuous sonic optimization fluid stream "US" from the housing **20** for dissociation purposes. In the illustrated embodiment, a first outlet connection **52**A is operably engaged with the housing **20**, via the first outlet **26**A, and operably engaged with the insert **40** via the first outlet opening **46**A. As shown in FIG. **2**, the second outlet connection **52**A is configured to direct the continuous fluid stream "LS" with dissociated substances and/or solids from the fluid passage **42** of the insert **40** to an output device. In one exemplary embodiment, an output device may be a solids separation apparatus, such as SSA **12**, for separating the dissociated substances and/or solids from the continuous fluid stream for purification/cleaning purpose. In another exemplary embodiment, an output device may be a waste facility for receiving dissociated substances and/or solids. In another exemplary embodiment, an output device may be another solids dissociation apparatus, such as SDA **10**, for providing another process of dissociation.

[0068] Still referring to FIG. **2**, a second outlet connection **52**B is operably engaged with the housing **20** via the second outlet **26**B. The second outlet connection **52**B is configured to direct the continuous sonic optimization fluid stream "US" from the pressurized reservoir **22** of the housing **20** to a sonic optimization fluid output device or to the original sonic inlet device. Such pumping and removing of sonic optimization fluid "US" allows for a continuous flow of sonic optimization fluid into the pressure reservoir **22** for adequate generation of sonic waves during dissociation processes, which is described in more detail below.

[0069] Still referring to FIG. **2**, the SDA **10** also includes at least one transducer **60** operably engaged inside of the housing **20**. In particular, the transducer **60** is operably engaged with the circumferential wall **20**C of the housing **20** inside of the pressured reservoir **22** of said housing **20**. In the illustrated embodiment, the at least one transducer **60** includes a first or top end **60**A, an opposing second or bottom end **60**B, and a longitudinal axis "X**3**" extending between the top and bottom ends **60**A, **60**B of the transducer **60**. The longitudinal axis "X**3**" of the transducer **60** is parallel with the longitudinal axes "X**1**", "X**2**" of the housing **20** and the inlet **40**.

[0070] Still referring to FIG. **2**, the at least one transducer **60** includes a collar **60**C extending between the top and bottom end **60**A, **60**B of the at least one transducer **60**. The at least one transducer **60** also defines a reflector plate **62** operably engaged with the collar **60**C for allowing the transducer to generate sonic waves inside of the housing **20** via the sonic optimization fluid stream "US", which is described in more detail below. As illustrated in FIG. **2**, the collar **60**C and the reflector plate **62** collectively define a passageway **63** extending between the top and bottom ends **60**A, **60**B of the transducer **60** along an axis parallel with the longitudinal axis "X**3**" of the at least one transducer **60**. The at least one transducer **60** includes a heat exhaust fan **64** to disseminate heat generated by the transducer when generating sonic waves inside of the housing **20**.

[0071] As illustrated in FIG. **2**, a single transducer **60** is provided with the SDA **1** in this embodiment. In other exemplary embodiments, any suitable number of transducers may be provided in a SDA for various considerations, including the size, shape, and configuration of an

SDA.

[0072] As illustrated in FIGS. **1**B and **2**, the transducer **60** may be operatively connected with a generator **66** via an electrical connection or wire **67**. The connection between the transducer **60** and the generator **66** allows the transducer **60** to send a traveling sonic wave **68** inside of the housing **20** and against the insert **40** for creating cavitation and causing dissociation and/or evisceration of the complex substances into simple substances, which is described in more detail below. The generator **66** may be any suitable generator that is capable of generating a range of frequencies to cause a transducer to create cavitation resulting in dissociation and/or evisceration of complex substances into simple substances. In one exemplary embodiment, a suitable range of frequency generated by a generator for creating cavitation and causing dissociation and/or evisceration of complex substances into simple constituents is a frequency range from about 3 kHz up to about 200 KHz.

[0073] Referring to FIG. **2**, the transducer **60** is disposed about a portion of the insert **40** via the passageway **63** defined collectively by the collar **60**C and the reflector plate **62**. In the illustrated embodiment, the transducer **60** is disposed at a distance away from the insert **40**. In one example, the insert **40** and the transducer **60** may be disposed at a distance of about at least one-half wavelength of a frequency of the sonic waves transmitted by the transducer **60**. Such configuration of the insert **40** inside of the transducer **60** allows the transducer **60** to direct and send the traveling sonic wave **68** against the insert **40** to cause cavitation inside of said insert **40** during dissociation operations. Here, the traveling sonic wave **68** generated by the transducer **60**, via power from the generator **66**, creates a first or primary cavitation in the continuous sonic optimization fluid stream “US” inside of the passageway **63** of the transducer **60**. This cavitation remains inside of the passageway **63** of the transducer **60** until the transducer **60** is powered off. Upon this cavitation, the energy on the sonic optimization fluid stream “US” creates micro-mechanical implosions on the sonic fluid stream.

[0074] Upon this cavitation, a second or secondary cavitation occurs inside of the insert **40** upon the continuous fluid stream “LS” via the traveling sonic wave **68** generated by the transducer **60**. As shown in FIG. **2**, traveling sonic wave **68** penetrates against the outer wall of the insert **40** causing the second cavitation to occur on the continuous fluid stream “LS” as said continuous fluid stream “LS” flows through the insert **40**. The second cavitation caused by sonic waves generated by the transducer **60** is denoted by rotating arrows labeled “C” in FIG. **2**. As described in more detail below, the combination of both non-laminar flow and the second cavitation “C” on the continuous fluid stream “LS” allow for dissociation and/or disintegration of the complex substances and solids provided in the continuous fluid stream “LS.” As the complex substances and solids reach the first outlet **46**A of the inlet **40**, substantially all or all of the complex substances and solids are dissociated in that the complex substances are simple constituents that no longer making up a specific substance or solid recognized prior to such dissociation operations.

[0075] The configuration of the SDA **10** is considered advantageous at least because the cavitation's caused by the traveling sonic wave **68**, via the wave frequency generated by the generator **66**, is able to dissociate complex substances of the continuous fluid stream “LS” into simple constituents when being bombarded with the traveling sonic wave **68** of the transducer **60**. The cavitation created by the transducer **60** produces cavitation with pressures of at least 20,000 psi and with temperatures of at least 10,000 degrees Fahrenheit with each cavitation energy implosion occurring every wave cycle (e.g., every second). Moreover, the configuration of the SDA **10** is considered advantageous at least because the cavitation caused by the traveling sonic wave **68**, via the wave frequency generated by the generator **66**, is able to create a uniform cavitation in the continuous fluid stream “LS” for dissociating the complex substances of the continuous fluid stream “LS” into simple constituents.

[0076] In the illustrated embodiment, the traveling sonic wave **68** transmitted by the transducer **60** is provided in a sinusoidal wave form. In other exemplary embodiments, a transducer may transmit a traveling sonic wave having any suitable wave form to create cavitation inside of a housing and inside of an insert of a SDA. Examples of suitable wave forms to create cavitation inside of a housing and inside of an insert of a SDA include square wave form, a triangle wave form, a saw tooth wave form, or other suitable waveforms to create cavitation inside of a housing and inside of an insert of a SDA.

[0077] In the illustrated embodiment, the transducer **60** of the SDA **10** may be constructed of any suitable materials for transmitting a traveling sonic wave (such as traveling sonic wave **68**) inside of the housing **20**. In one exemplary embodiment, a transducer of a SDA may be constructed of magnetostrictive-type construction with magnetostrictive materials. In another exemplary embodiment, a transducer of a SDA may be constructed of a electrostrictive-type construction with piezoelectric or electrostrictive materials. In another exemplary embodiment, a transducer of a SDA may be constructed of smart materials. In another exemplary embodiment, a transducer of a SDA may be constructed of ferromagnetic materials.

[0078] Referring to FIGS. **1**A-**1**B and **3**, the SSA **12** may include a column or tower **70** operably connected with the SDA **10**. The tower **70** includes at least one stage **72** for separating or removing the simple constituents dissociated by the SDA **10**. In the illustrated embodiment, the tower **70** includes a first stage **72**A for removing a first set of simple constituents from the fluid stream “LS” and a second stage **72**B for removing a second set of simple constituents from the fluid stream “LS” where the second set of simple constituents have a smaller configuration than the first set of simple constituents. Such removal of first and second sets of constituents from the fluid stream is described in more detail below. The first and second stages **72**A, **72**B of the tower **70** are similar to one another, except as detailed below. Inasmuch as the first and second stages **72**A, **72**B are similar, the following description will relate to the first stage **72**A. It should be understood, however, that the description of the first stage **72**A applies substantially equally to the second stage **72**B, except as detailed below.

[0079] Referring to FIGS. **1**A-**1**B and **3**, the tower **70** includes a top or first wall **74**A, an opposing bottom or second wall **74**B, and a longitudinal axis defined therebetween. The tower **70** also includes a first or exterior circumferential wall **74**C extending along the longitudinal axis of the tower **70** between the top wall **74**A and the bottom wall **74**B. The tower **70** also includes a second or interior circumferential wall **74**D extending along the longitudinal axis of the tower **70** between the top wall **74**A and the bottom wall **74**B. The tower **70** also includes a third or medial circumferential wall **74**E extending along the longitudinal axis of the tower between the top wall **74**A and the bottom wall **74**B. The medial circumferential wall **74**E is positioned between the exterior circumferential wall **74**C and the interior circumferential wall **74**D. The top wall **74**A, the bottom wall **74**B, and the interior circumferential wall **74**D collectively define a pressurized chamber **75** that extends along the longitudinal axis of the tower **70**. In one exemplary embodiment, the pressurized chamber **75** may be held at a pressure that is greater than the surrounding atmospheric pressure for various process reasons, which are described in more detail below. In another exemplary embodiment, the pressurized chamber **75** may be held at a pressure that is less than the surrounding atmospheric pressure. In another exemplary embodiment, the pressurized chamber **75** may be held at a pressure that is substantially equal to the surrounding atmospheric pressure.

[0080] Referring to FIG. **1**A, the tower **70** may include a peripheral engagement wall **76** that operably engages with each of the exterior circumferential wall **74**A, the interior circumferential wall **74**B, and the medial circumferential wall **74**C via attachment mechanisms **77** (e.g., a connector and a nut). Such use of the peripheral engagement wall **76** with attachment mechanisms **77** provides a structural configuration to hold each of the exterior circumferential wall **74**A, the interior circumferential wall **74**B, and the medial circumferential wall **74**C together. In one exemplary embodiment, any suitable number of peripheral engagement walls may be used to provide additional support between an exterior circumferential wall, an interior circumferential wall, and a medial circumferential wall.

[0081] Still referring to FIGS. **1**A-**1**B through **3**, the tower **70** may define at least one fluid stream inlet **78** defined in the bottom wall **74**B of the tower **70**. The at least one fluid stream inlet **78** may be configured to allow at least one inlet connection **80** to be operably engaged with the tower **80** to allow the continuous fluid stream "LS" to be directed from the SDA **10** to the SSA **12** for separating the simple constituents from said fluid stream "LS." In the illustrated embodiment, a first fluid stream inlet **78**A is defined in the bottom wall **74**B of the tower **70**. The first fluid stream inlet **78**A is configured to allow a first inlet connection **80**A to be operably connected with the tower **70** to allow the fluid stream "LS" to flow from the SDA **10** into the SSA **12** (see FIG. **1**B). Additionally, a second fluid stream inlet **78**B is defined in the bottom wall **74**B of the tower **70** where the second fluid stream inlet **78**B is coaxial with the first fluid stream inlet **78**A. The second fluid stream inlet **78**B is configured to allow a second inlet connection **80**B to be operably connected with the tower **70** to allow the fluid stream "LS" to flow from the SDA **10** into the SSA **12** (see FIG. **1**B).

[0082] As illustrated herein, the first outlet connection **52**A of the SDA **10** may be continuous with the first and second inlet connections **80**A, **80**B of the SSA **12** such that the connections **52**A, **80**A, **80**B are a single unitary connection. In other exemplary embodiments, a first outlet connection of a SDA may be coupled with first and second inlet connections of a SSA via various coupling devices and/or connectors (e.g., pipe couplers, flanges, valves, etc.)

[0083] Referring to FIG. **3**, the tower **70** may define at least one set of ports **82** in the interior circumferential wall **74**D of at least one stage **72** of said tower **70**. In the illustrated embodiment, the tower **70** defines a first set of ports **82**A in the interior circumferential wall **74**D of the first stage **72**A of said tower **70**. As illustrated in FIG. **4**A, each port of the first set of ports **82**A includes a first diameter **84**A defined in the interior circumferential wall **74**D along the inner surface of the interior circumferential wall **74**D proximate to the pressurized chamber **75**. Still referring to FIG. **4**A, each port of the first set of ports **82**A also includes a second diameter **84**AA defined in the interior circumferential wall **74**A inside of the interior circumferential wall **74**D remote from the pressurized chamber **75**; the second diameter **84**AA is less than the first diameter **84**A. As such, the first set of ports **82**A defined by the interior circumferential wall **74**D are V-shaped or funnel-shaped in which the first diameter **84**A of each port **82**A tapers to the second diameter **84**AA.

[0084] Referring to FIG. **4**B, the tower **70** defines a second set of ports **82**B in the interior circumferential wall **74**D of the second stage **72**B of said tower **70**. As illustrated in FIG. **4**B, each port of the second set of ports **82**B includes a first diameter **84**B defined in the interior circumferential wall **74**D along the inner surface of the interior circumferential wall **74**D proximate to the pressurized chamber **75**. Still referring to FIG. **4**B, each port of the second set of ports **82**B also includes a second diameter **84**BB defined in the interior circumferential wall **74**A inside of the interior circumferential wall **74**D remote from the pressurized chamber **75**; the second diameter **84**BB is less than the first diameter **84**B. Additionally, the second diameter **84**BB of each port of the second set of ports **84**B is less than the second diameter **84**AA of each port of the first set of ports **84**A for receiving constituents of a smaller size than the first set of ports **82**A, which is described in more detail below. As such, the second set of ports **82**B defined by the interior circumferential wall **74**D are also V-shaped or funnel-shaped in which the first diameter **84**B of each port **82**B tapers to the second diameter **84**BB.

[0085] Still referring to FIG. **4**A, the interior circumferential wall **74**D also defines at least one set of passageways **85** that is in fluid communication with the at least one set of ports **82**. In the illustrated embodiment, the interior circumferential wall **74**D defines a first set of passageways **85**A that is in fluid communication with the first set of ports **82**A in the first stage **72**A of the tower **70**. Each passageway of the first set of passageways **85**A defines a third diameter **85**C that extends along the entire length of each passageway of the first set of passageways **85**A. In the illustrated embodiment, the third diameter **85**C of each passageway of the first set of passageways **85**A is equal to the second diameter **84**AA of each port of the first set of ports **82**A. The configuration between the first set of ports **82**A and the first set of passageways **85**A allows the first set of ports **82**A to capture and recover first simple constituents "S**1**" from the fluid stream "LS" dissociated by the SDA **10** in previous operations. Such operations of capturing and recovering the first simple constituents "S**1**" from the fluid stream "LS" dissociated by the SDA **10** is described in more detail below.

[0086] Referring to FIG. **4**B, the interior circumferential wall **74**D defines a second set of passageways **85**B that is in fluid communication with the second set of ports **82**B in the second stage **72**B of the tower **70**. Each passageway of the second set of passageways **85**B defines a third diameter **85**CC that extends along the entire length of each passageway of the second set of passageway **85**B. In the illustrated embodiment, the third diameter **85**CC of each passageway of the second set of passageways **85**B is equal to the second diameter **84**BB of each port of the second set of ports **82**B. The configuration between the second set of ports **82**B and the second set of passageways **85**B allows the second set of ports **82**B to capture and recover second simple constituents "S**2**" from the fluid stream "LS" dissociated by the SDA **10** in previous operations where the second simple constituents are smaller in size than the first simple constituents "S**1**." Such operations of capturing and recovering the second simple constituents "S**2**" from the fluid stream "LS" dissociated by the SDA **10** is described in more detail below.

[0087] Referring to FIGS. **3** and **4**A, the tower **70** also includes at least one effluent and/or concentrated waste stream outlet **86** defined by the exterior circumferential wall **74**C and the medial circumferential wall **74**E for at least one stage **72** of the tower **70**. The at least one effluent outlet **86** is in fluid communication with the pressurized chamber **75** of the tower **70** for disposing of simple constituents recovered by the at least one set of ports **82**. Additionally, the at least one effluent outlet **86** may be configured to allow at least one effluent outlet connection **88** to operably engage with the tower **70** for dispensing simple constituents to an output location (e.g., waste facility, another SDA such as SDA **10**, etc.).

[0088] Referring to FIGS. **3** and **4**A, the tower **70** includes a first effluent outlet **86**A defined between the exterior circumferential wall **74**C and the medial circumferential wall **74**E for the first stage **72**A of the tower **70**. The first effluent outlet **86**A is in fluid communication with the pressurized chamber **75** of the tower **70** via the first set of ports **82**A and the first set of passageways **85**A. Such communication with the pressurized chamber **75**, the first set of ports **82**A, and the first set of passageways **85**A allows the first effluent outlet **86**A to dispose of the first simple constituents "S**1**" recovered by the first set of ports **82**A. The first effluent outlet **86**A may also be configured to allow the tower **70** to operably engage with a first effluent outlet connection **88**A for dispensing the first simple constituents "S**1**" in an output location.

[0089] Referring to FIGS. **3** and **4**B, the tower **70** also includes a second effluent outlet **86**B defined between the exterior circumferential wall **74**C and the medial circumferential wall **74**E for the second stage **72**B of the tower **70**. The second effluent outlet **86**B is in fluid communication with the pressurized chamber **75** of the tower **70** via the second set of ports **82**B and the second set of passageways **85**B. Such communication with the pressurized chamber **75**, the second set of ports **82**B, and the second set of passageways **85**B allows the second effluent outlet **86**B to dispose of the second simple constituents "S**2**" recovered by the second set of ports **82**B. The second effluent outlet **86**B may also be configured to allow the tower **70** to operably engage with a second effluent outlet connection **88**B for dispensing the second simple constituents "S**2**" in an output location.

[0090] As illustrated in FIGS. **1**A-**1**B and **3**-**4**B, the SSA **12** includes at least one set of shutters **90** operably engaged with the tower **70** in the at least one stage **72**. Each shutter of the at least one set of shutters **90** is moveable relative to the tower **70** for controlling the flow rate of the fluid stream "LS" depending on the position of each shutter of the at least one set of shutters **90** relative to a respective passageway of the at least one set of passageways **85**.

[0091] As illustrated in FIGS. **3** and **4**A, the SSA **12** includes a first set of shutters **90**A operably engaged with the tower **70** in the first stage **72**A. As illustrated in FIG. **4**A, each shutter of the first set of shutters **90**A is operably engaged with the interior circumferential wall **74**D of the tower **70** inside of the first effluent outlet **86**A. As illustrated herein, each shutter of the first set of shutters **90**A is linearly moveable between a covered position and an uncovered position relative to first set of ports **82**A and the first set of passageways **85**A defined in the interior circumferential wall **74**D of the tower **70**. Such linear movement of the first set of shutters **90**A is denoted by arrows labeled "LM**1**" in FIG. **4**A. Prior to operation, each shutter of the first set of shutters **90**A may be provided in the covered position to fully cover a respective passageway of the first set of passageways **85**A for preventing any first simple constituents "S**1**" and fluid stream "LS" from entering into the first effluent outlet **86**A (see FIG. **1**A). During a separation operation, each shutter of the first set of shutter **90**A may be provided in the uncovered position to uncover (see FIG. **4**A) a respective passageway of the first set of passageways **85**A for allowing first simple constituents "S**1**" and fluid stream "LS" to enter into the first effluent outlet **86**A. While not illustrated herein, the shutters of first sets of shutters **90**A may be configured to partially cover and/or uncover a respective passageway of the first set of passageways **85**A for controlling a desired flow rate through the first set of ports **82**A and the first set of passageways **85**A. While not illustrated herein, each shutter of the second sets of shutters **90**B may also be configured to move independently of one another.

[0092] As illustrated in FIGS. **3** and **4**B, the SSA **12** includes a second set of shutters **90**B operably engaged with the tower **70** in the second stage **72**B. As illustrated in FIG. **4**B, each shutter of the second set of shutters **90**B is operably engaged with the interior circumferential wall **74**D of the tower **70** inside of the second effluent outlet **86**B. As illustrated herein, each shutter of the second set of shutters **90**B is linearly moveable between a covered position and an uncovered position relative to second set of ports **82**B and the second set of passageways **85**B defined in to the interior circumferential wall **74**D of the tower **70**. Such linear movement of the second set of shutters **90**B is denoted by arrows labeled "LM**2**" in FIG. **4**B. Prior to operation, each shutter of the second set of shutters **90**B may be provided in the covered position to fully cover a respective passageway of the second set of passageways **85**B for preventing any second simple constituents "S**2**" and fluid stream "LS" from entering into the second effluent outlet **86**B (see FIG. **1**A). During a separation operation, each shutter of the second set of shutter **90**B may be provided in the uncovered position to uncover (see FIG. **4**B) a respective passageway of the second set of passageways **85**B for allowing second simple constituents "S**2**" and fluid stream "LS" to enter into the second effluent outlet **86**B. While not illustrated herein, the shutters of second sets of shutters **90**B may be also configured to partially cover and/or uncover a respective passageway of the second set of passageways **85**B for controlling a desired flow rate through the second set of ports **82**B and the second set of passageways **85**B. While not illustrated herein, each shutter of the second sets of shutters **90**B may also be configured to move independently of one another.

[0093] While the shutters in the first and second sets of shutters **90**A, **90**B are longitudinally moveable along the interior circumferential wall **74**D of the tower **70** relative to the longitudinal axis of said tower **70**, shutters of first and second sets of shutters may be moveable along an interior circumferential wall of a tower relative to any suitable axis of said tower. In one exemplary embodiment, shutters of one or both of first and second sets of shutters may be radially or transversally moveable along an interior circumferential wall of a tower relative to a horizontal or transverse of said tower. In another exemplary embodiment, shutters of one or both of first and second sets of shutters may be circumferentially moveable about an interior circumferential wall of a tower relative to a longitudinal axis of said tower. In another exemplary embodiment, shutters of one of both of first and second sets of shutters may be rotatably moveable on an interior circumferential wall of a tower relative to a longitudinal axis of said tower. In another exemplary embodiment, shutters of one or both of first and second sets of shutters may be laterally moveably on an interior circumferential wall of a tower relative to a longitudinal axis of said tower.

[0094] While the shutters in the first and second sets of shutters **90**A, **90**B are longitudinally moveable along the interior circumferential wall **74**D of the tower **70**, any suitable mechanism and/or drive systems may be used to move shutters in first and second sets of shutters. Examples of suitable mechanisms and/or drive systems for moving shutters in first and second sets of shutters include linkage mechanisms, slider-crank mechanisms, cam mechanisms, gear mechanisms, and other suitable mechanism and/or drive systems for moving shutters in first and second sets of shutters. Additionally, any suitable device or machine may be used to move shutters in first and second sets of shutters for controlling flow rate in a tower. In one exemplary embodiment, devices or machines operably engaged with first and second sets of shutters may be manually operated for moving shutters of the first and second sets of shutters to control flow rate in a tower. In another exemplary embodiment, devices or machines operably engaged with first and second sets of shutters may be automated and/or autonomously controlled for moving shutters of the first and second sets of shutters to control flow rate in a tower.

[0095] As illustrated in FIGS. **1**A-**1**B and **3**, the SSA **12** includes at least one transfer inlet **92** defined in the interior circumferential wall **74**D of the first stage **72**A of the tower **70**. The SSA **12** also includes at least one transfer outlet **93** defined in the interior circumferential wall **74**D of the second stage **72**B of said tower **70**. The at least one transfer inlet **92** and the least one transfer outlet **93** are configured to allow at least one transfer connection **94** to be operably engaged with the interior circumferential wall **74**D of the tower **70**. Due to this configuration between the at least one transfer connection **94** and the tower **70**, the at least one transfer connection **94** is able to transfer and/or direct the fluid stream “LS” having second simple constituents “S**2**” from the first stage **72**A of the tower to the second stage **72**B of the tower **70** via the at least one transfer inlet **92** and the at least one transfer outlet **93**.

[0096] In the illustrated embodiment, the SSA **12** has a first transfer inlet **92**A that is defined in the interior circumferential wall **74**D of first stage **72**A of the tower **70**. The SSA **12** also has a first transfer outlet **93**A that is defined in the interior circumferential wall **74**D of the second stage **72**B of the tower **70**. As illustrated in FIG. **3**, the first transfer inlet **92**A and the first transfer outlet **93**A are configured to allow a first transfer connection **94**A to be operably engaged with the interior circumferential wall **74**D of the tower **70**. Due to this configuration between the first transfer connection **94**A and the tower **70**, the first transfer connection **94**A is able to transfer and/or direct the fluid stream “LS” having second simple constituents “S**2**” from the first stage **72**A of the tower to the second stage **72**B of the tower **70** via the first transfer inlet **92**A and the first transfer outlet **93**A.

[0097] Similarly, the SSA **12** may also have a second transfer inlet **92**B that is defined in the interior circumferential wall **74**D of first stage **72**A of the tower **70**. The SSA **12** also has a second transfer outlet **93**B that is defined in the interior circumferential wall **74**D of the second stage **72**B of the tower **70**. As illustrated in FIG. **3**, the second transfer inlet **92**B and the second transfer outlet **93**B are configured to allow a second transfer connection **94**B to be operably engaged with the interior circumferential wall **74**D of the tower **70**. Due to this configuration between the second transfer connection **94**B and the tower **70**, the second transfer connection **94**A is able to transfer and/or direct the fluid stream “LS” having second simple constituents “S**2**” from the first stage **72**A of the tower to the second stage **72**B of the tower **70** via the second transfer inlet **92**B and the second transfer outlet **93**B. Such inclusion of the second transfer connection **94**B allows for a greater volume of the fluid stream “LS” having second simple constituents “S**2**” to be directed from the first stage **72**A of the tower into the second stage **72**B of the tower **70**.

[0098] Referring to FIGS. **1**A-**1**B and **3**, the SSA **12** may include at least one cleaned fluid outlet **96** defined in the interior circumferential wall **74**D of the tower **70**. The at least one cleaned fluid outlet **96** may be configured to allow at least one cleaned fluid outlet connection **98** to operably engage with the tower **70**. The configuration between the at least one cleaned fluid outlet connection **98** and the tower **70** allows the at least one fluid outlet connection **98** to be in fluid communication with the pressurized chamber **75** in the second stage **72**B of the tower **70**. The at least one fluid outlet connection **98** is also in fluid communication with an output device or facility for holding the clean or permeate fluid stream "LS" subsequent the separation process performed by the SSA **12**.

[0099] As illustrated in FIGS. **1**A-**1**B, **3**, and **4**A-**4**B, the tower **70** may define at least one air space **100** circumferential disposed about the pressurized chamber **75** of the tower **70**. More particularly, the at least one air space **100** may be defined between the exterior circumferential wall **74**C and the medial circumferential wall **74**E. The at least one air space **100** is considered advantageous at least because the at least one air space **100** separates and isolates sonic waves being used in the SSA **12** from sonic waves being used in the SDA **10**, which is described in more detail below.

[0100] As illustrated in FIGS. **1**A-**1**B and **3**, the SSA **12** may include at least one transducer **110** operably engaged with the tower **70** inside of the pressurized chamber **75**. The at least one transducer **110** is selectively adjustable relative to the tower **70**, which is described in more detail below. In the illustrated embodiment, a single transducer **110** is operably engaged with the tower **70** inside of the pressurized chamber **75**.

[0101] Referring to FIGS. **1**A-**1**B and **3**, the transducer **110** includes a reflector plate **112** operably engaged with a pressurized housing **114** encapsulating the transducer **110**. Such configuration between the reflector plate **112** and the pressurized housing **114** allows the transducer **110** to generate a standing sonic wave **115** along the entire length of the tower **70** inside of the pressurized chamber **75**.

[0102] As shown in FIGS. **1**B and **3**, the standing sonic wave **115** generated by the transducer **110** includes a plurality of nodes **115**A and a plurality of anti-nodes **115**B positioned along the longitudinal axis of the tower **70**. As illustrated in FIGS. **3** and **3**A, the plurality of nodes **115**A signifies a first pressure being exerted against the simple constituents "S**1**", "S**2**" generated by the standing sonic wave **115**. The plurality of nodes **115**A is also positioned between each port of the first and second sets of ports **82**A, **82**B to allow the fluid stream "LS" to flow through the pressurized chamber **75**. As illustrated in FIGS. **3** and **4**A-**4**B, the plurality of anti-nodes **115**B signify a second pressure being exerted against the simple constituents "S**1**", "S**2**" generated by the standing sonic wave **115**; the second pressure of the plurality of anti-nodes **115**B is greater than the first pressure of the plurality of nodes **115**A. Each anti-node of plurality of anti-nodes **115**B is positioned directly over a port of one or both of the first and second sets of ports **82**A, **82**B to direct simple constituents "S**1**", "S**2**" into a respective port **82**A, **82**B in the first or second stages **72**A, **72**B of the tower **70**. In other exemplary embodiments, each anti-node of a plurality of anti-nodes may be positioned outside of a port of one or both of first and second sets of ports due to the size of constituents, the velocity of the fluid, and other similar considerations of the like.

[0103] As illustrated in FIG. **3**, the transducer **110** is also moveable relative to the tower **70**. In the illustrated embodiment, an adjustment mechanism **116** (e.g., a nut threadably engaged with a threaded shaft) is operably engaged with the transducer **110** (more particularly the pressurized housing **114**) for linearly moving the transducer **110** along the longitudinal axis of the tower **70**. Such movement of the transducer **110** is considered advantageous at least because the linear movement of the transducer **110** allows a user to fine-tune or precisely adjust on the standing sonic wave **115** inside of the tower **70**. With this adjustment capability, a user of the SSA **12** may adjust the positioning of the standing sonic wave **115** so that the plurality of nodes **115**A are positioned directly between each port of the first and second sets of ports **82**A, **82**B and the plurality of anti-nodes **115**B are positioned directly inside of each port of the first and second sets of ports **82**A, **82**B. The adjustment capability via the adjustment mechanism **116** is helpful when the transducer **110** becomes misaligned causing the plurality of nodes **115**A and the plurality of anti-nodes **115**B of standing sonic wave **115** to be misaligned with the ports of the first and second sets of ports **82**A, **82**B.

[0104] While the transducer **110** is moveable relative to the tower **70** via the adjustment mechanism **116** described and illustrated herein, any suitable adjustment mechanism may be used to move a transducer relative to a tower. In one exemplary embodiment, a transducer may be moveable relative to a tower via an adjustment mechanism that is manually adjusted for moving the transducer. In another exemplary embodiment, a transducer may be moveable relative to a tower via an adjustment mechanism that is mechanical adjusted via a machine enabled to move the transducer via the adjustment mechanism; examples of suitable machines that are able to move the transducer via the adjustment mechanism include motors, actuators, and other suitable types of machines for moving the transducer.

[0105] As illustrated in FIGS. **1**B and **3**, the transducer **110** may be operatively connected with a generator **118** via an electrical connection or wire **119**. The connection between the transducer **110** and the generator **118** allows the transducer **110** to transmit the standing sonic wave **115** inside of the tower **70** for separating and removing simple constituents “S**1**”, “S**2**” from the fluid stream “LS” flowing in the pressurized chamber **75** of the tower **70**. The generator **118** may be any suitable generator that is capable of generating a range of frequencies to cause the separation of simple constituents from a continuous fluid stream inside of a tower. In one exemplary embodiment, a suitable range of frequency generated by a generator for separating simple substances from a continuous fluid stream is a frequency range from about 3 kHz up to about 200 kHz. More particularly, a suitable range of frequency generated by a generator for separating simple substances from a continuous fluid stream is a frequency range from about 10 kHz up to about 40 KHz. Specifically, a suitable range of frequency generated by a generator for separating simple substances from a continuous fluid stream is a frequency range from about 19 kHz up to about 25 kHz.

[0106] In the illustrated embodiment, the transducer **110** of the SSA **12** may be constructed of any suitable materials for transmitting a standing sonic wave (such as standing sonic wave **115**) inside of the tower **70**. In one exemplary embodiment, a transducer of a SSA may be constructed of magnetostrictive-type construction with magnetostrictive materials. In another exemplary embodiment, a transducer of a SSA may be constructed of a electrostrictive-type construction with piezoelectric or electrostrictive materials. In another exemplary embodiment, a transducer of a SSA may be constructed of smart materials. In another exemplary embodiment, a transducer of a SSA may be constructed of ferromagnetic materials.

[0107] While the generator **118** is shown being a separate component from the tower **70** and the transducer **110**, any suitable configuration may be used between a generator and a tower and a transducer. In one exemplary embodiment, a generator may be operably engaged with a tower of a SSA where the generator is positioned inside of or on the tower.

[0108] Referring to FIGS. **1**B-**3**, the SSA **12** also includes a reflector **130**. In the illustrated embodiment, the reflector **130** is operably engaged with a top wall **74**A of the tower **70** directly opposite to the transducer **110** relative to the longitudinal axis of the tower **70**. The reflector **130** is configured to reflect the standing sonic wave **115**, transmitted by the transducer **110**, back to the transducer **110** along the longitudinal axis of the tower **70**. Such reflection creates a mirrored wave inside of the tower **70** in order for the standing sonic wave **115** to be consistent along the entire length of the tower **70** inside of the pressurized chamber **75**.

[0109] Similar to the transducer **110**, the reflector **130** is also moveable relative to the tower **70** via an adjustment mechanism **132** (e.g., a nut threadably engaged with a threaded shaft) operably engaged with the reflector **130**. In the illustrated embodiment, the adjustment mechanism **132** is able to linearly move the reflector **130** along the longitudinal axis of the tower **70** similar to the movement of the transducer **110**. Such movement of the reflector **130** is considered advantageous at least because the linear movement of the reflector **130** allows a user to fine-tune or precisely adjust on the standing sonic wave **115** inside of the tower **70**. With this adjustment capability, a user of the SSA **12** may adjust the positioning of the standing sonic wave **115** so that the plurality of nodes **115**A are positioned directly between each port of the first and second sets of ports **82**A, **82**B and the plurality of anti-nodes **115**B are positioned directly inside of each port of the first and second sets of ports **82**A, **82**B. The adjustment capability via the adjustment mechanism **132** is helpful when the reflector **130** becomes misaligned causing the plurality of nodes **115**A and the plurality of anti-nodes **115**B of standing sonic wave **115** to be misaligned with the ports of the first and second sets of ports **82**A, **82**B. As such, the adjustment capability of both the transducer **110** and the reflector **130** provides a user with two independent options in fine tuning and precisely adjusting the standing sonic wave **115** inside of the pressurized chamber **75** due to the transducer **110** and the reflector **130** being independently moveable relative to one another.

[0110] Referring to FIGS. **1**B through **3**, the SSA **12** may also include at least one diaphragm **140**. In the illustrated embodiment, a single diaphragm **140** is operably engaged with the tower **70** between the transducer **110** and the reflector **130**. The diaphragm **140** is configured to transfer the standing sonic wave **115** between the first stage **72**A and the second stage **72**B. during a separation operation inside of the tower **70**. The use of the diaphragm is considered advantageous at least because a single transducer **110** may only be used in the SSA **12** for generating a standing sonic wave. While the SSA **12** may include at least one diaphragm **140** operably engaged with the tower **70** inside of the pressurized chamber **75** for transferring the standing sonic wave **115** between the first and second stages **72**A, **72**B, any suitable number of diaphragms may be used for transferring a standing sonic wave between any suitable number of stages included in a tower. As such, the number of diaphragms may be dependent upon the number of stages defined in a tower for a separation operation.

[0111] Similar to the transducer **110** and the reflector **130**, the diaphragm **140** is also moveable relative to the tower **70** via an adjustment mechanism **142** operably engaged with the diaphragm **140** (see FIG. **3**A). In the illustrated embodiment, the adjustment mechanism **142** is able to linearly move the diaphragm **140** along the longitudinal axis of the tower **70** similar to the movement of the transducer **110** and the reflector **130**. The adjustment mechanism **142** may allow the diaphragm **140** to be selectively adjustable along the tower **70** for various considerations, including collecting excessive first simple constituents "S**1**" from the fluid stream "LS" that were not forced through the first set of ports **82**A via the standing sonic wave **115**, aligning with the standing sonic wave **115** inside of the tower **70**, and other various considerations for selectively adjusting the diaphragm **170**.

[0112] While the diaphragm **140** is moveable along the tower **70** and is selectively adjustable along the tower **70** via the adjustment mechanism **142**, any suitable adjustment mechanism may be operably engaged with a diaphragm. In one exemplary embodiment, a mechanical assembly or system may be operably engaged with a diaphragm and a tower of a SSA to allow a user to manually adjust the diaphragm relative to the tower. In another exemplary embodiment, a mechanical assembly or system powered by at least one machine or apparatus may be operably engaged with a diaphragm and a tower of a SSA to allow a user to automatically adjust the diaphragm relative to the tower via inputs placed on the at least one machine or apparatus.

[0113] As illustrated in FIG. **3**A, an alternative adjusting mechanism **142**′ may use a first jackscrew assembly **142**A′ and an opposing second jackscrew assembly **142**B′ for selectively adjusting an alternative diaphragm **140**′ substantially similar to the diaphragm **140** described above. In this alternative embodiment, each jackscrew mechanism **143**′ in the first and second jackscrew assemblies **142**A′, **142**B′ is able to incrementally move the diaphragm **140**′ along the tower **70** relative to the longitudinal axis of the tower **70**. Additionally, each jackscrew mechanism **143**′ in the first and second jackscrew assemblies **142**A′, **142**B′ are independently moveable to allow a user to selectively adjust one more of the jackscrew mechanisms **143**′ based on the misalignment scenario.

[0114] Such movement of the diaphragm **140** is considered advantageous at least because the linear movement of the diaphragm **140** allows a user fine-tune or precisely adjust on the standing sonic wave **115** inside of the tower **70**. With this adjustment capability, a user of the SSA **12** may adjust the positioning of the standing sonic wave **115** so that the plurality of nodes **115**A are positioned directly between each port of the first and second sets of ports **82**A, **82**B and the plurality of anti-nodes **115**B are positioned directly inside of each port of the first and second sets of ports **82**A, **82**B. The adjustment capability via the adjustment mechanism **142** is helpful when the diaphragm **140** becomes misaligned causing the plurality of nodes **115**A and the plurality of anti-nodes **115**B of standing sonic wave **115** to be misaligned with the ports of the first and second sets of ports **82**A, **82**B. As such, the adjustment capability of the transducer **110**, the reflector **130**, and the diaphragm **140** provides a user with three independent options in fine tuning and precisely adjusting the standing sonic wave **115** inside of the pressurized chamber **75** due to the transducer **110**, the reflector **130**, and the diaphragm **140** being independently moveable relative to one another.

[0115] Having now described the fluid treatment system **1** having at least one SDA **10** and at least one SSA **12**, a method of use is described in more detail below.

[0116] Upon operation, the continuous fluid stream "LS" is pumped from a contaminated or polluted fluid source (e.g., water stream, pond, lake, ocean, etc.) and into the SDA **10** via the first inlet connection **50**A. At this period, the continuous fluid stream "LS" is of a first fluid stream state "LS**1**" where the first fluid stream state "LS**1**" includes various types of complex substances and solids (examples of such complex substances and solids are provided above).

[0117] Prior to or upon the introduction of the first fluid stream state "LS**1**" into the SDA **10**, the continuous sonic optimization fluid stream "US" is pumped into the pressurized reservoir **22** of the housing **20** via the second inlet connection **50**B. The sonic optimization fluid stream "US" is continuously pumped into and out of the pressurized reservoir **22** during operation of the SDA **10** where the pressurized reservoir **22** remains pressurized.

[0118] Prior to introduction of the first fluid stream state "LS**1**" into the SDA **10**, the transducer **60** and the generator **66** are activated from an OFF state to an ON state for generating the traveling sonic wave **68** and causing cavitation inside of the housing **20** and the insert **40** subsequent to the introducing of the continuous sonic optimization fluid "US". Upon activation from the OFF state to the ON state, the generator **66** is able to generate and transmit the desired traveling sonic wave **68** frequency to the transducer **60** via the electrical connection **67**. Once received, the transducer **60** transmits the traveling sonic wave **68** into the pressurized reservoir **22** of the housing **20** causing the primary cavitation "C**1**" on the continuous sonic optimization fluid stream "US" shown in FIG. **2**. With the assistance of the primary cavitation "C**1**" in the pressurized reservoir **22**, the transducer **60** is able transmit the secondary cavitation "C**2**" inside of the insert **40** to dissociate various types of complex substances and solids included in the first fluid stream state "LS**1**", which is described in more detail below.

[0119] Once pumped through the first inlet connection **50**A, the fluid stream "LS**1**" passes through the first inlet **44**A of the insert **40** and contacts the flow director **48**. Upon this contact, the flow director **48** directs the fluid stream "LS**1**" into a non-laminar flow state when traveling through the fluid passage **42** of the insert **40**. As stated previously, the non-laminar flow state caused by the flow director **48** on the fluid stream "LS**1**" creates a longer dwell time on the fluid stream "LS**1**" when traveling through fluid passage **42**. Such excessive dwell times allows the secondary cavitation "C**2**" generated by the traveling sonic wave **68** on the fluid stream "LS**1**" to dissociate and disintegrate the complex substances and solids provided in the fluid stream "LS**1**". As the fluid stream "LS**1**" reaches the first outlet **46**A of the insert **40**, the continuous fluid stream "LS" transitions from the first fluid stream state "LS**1**" to a second fluid stream state "LS**2**" including dissociated and disintegrated complex substances and solids. In other words, the fluid stream "LS" in the second fluid stream state "LS**2**" includes simple constituents from the secondary cavitation "C**2**" caused on the continuous fluid stream "LS" when passing through the insert **40** and the transducer **60**.

[0120] Prior to introducing the fluid stream "LS**2**" into the SSA **12** from the SDA **10**, the transducer **110** and the generator **120** are actuated from an OFF state to an ON state for generating the standing sonic wave **115** inside of the pressurized chamber **75** of the housing **70**. Upon being actuated from the OFF state to the ON state, the generator **120** is able to generate and transmit the desired standing sonic wave **115** frequency to the transducer **110** via the electrical connection **118**. Once received, the transducer **110** transmits the standing sonic wave **115** into the pressurized chamber **75** of the tower **70** along the longitudinal axis of the tower **70**. As the standing sonic wave **115** is transmitted from the transducer **110**, the standing sonic wave **115** travels through the diaphragm **140** and towards the reflector **130**. As the standing sonic wave **115** contacts the reflector **130**, the reflector **130** reflects the standing sonic wave **115** back through the diaphragm **140** and to the transducer **110**. Such configuration between the transducer **110**, the reflector **130**, and the diaphragm **140** allows for a uniform standing sonic wave **1116** to continuously transmit through the tower **70** for separating simple substances and solids from the fluid stream "LS**2**".

[0121] Optionally, a user of the SSA **12** may selectively adjust the transducer **110**, the reflector **130**, and the diaphragm **140** in order for the plurality of anti-nodes **115**B of the standing sonic wave **115** to be directly aligned with the first and second sets of ports **82**A, **82**B of the tower **70**. As illustrated in FIGS. **3** and **4**A-**4**B, at least one of the transducer **110**, the reflector **130**, and the diaphragm **140** may be selectively adjusted by the user so that the plurality of anti-nodes **115**B are aligned with the first set of ports **82**A in the first stage **72**A of the tower **70** and/or aligned with the second set of ports **82**A in the second stage **72**B of the tower **70**. As such, a user may cause at least one of the transducer **110**, the reflector **130**, and the diaphragm **140** to be linearly moved along the tower **70** relative to the longitudinal axis of the tower **70** until the plurality of anti-nodes **115**B of the standing sonic wave **115** is directly aligned with the first and second sets of ports **82**A, **82**B of the tower **70**.

[0122] Once the standing sonic wave **115** is generated inside of the tower **70**, the fluid stream "LS**2**" may be pumped from the fluid passage **42** of the insert **40** of the SDA **10** and into the pressurized chamber **75** of the tower **70** via the first and second inlet connection **80** being in fluid communication with the insert **40** and the tower **70**. As the fluid stream "LS**2**" is pumped into the pressurized chamber **75** of the tower **70**, the fluid stream "LS**2**" flows towards the diaphragm **140** in the first stage **72**A. As the fluid stream "LS**2**" travels through the pressurized chamber **75**, the plurality of anti-nodes **115**B of the standing sonic wave **115** force the first plurality of constituents "S**1**" of the fluid stream "LS**2**" into the first set of ports **82**A.

[0123] As illustrated in FIGS. **1**B, **3**, and **4**A, the first set of shutters **90**A are provided in the uncovered position in which the first set of shutters **90**A are completely removed away from the first set of ports **82**A and the first set of passageways **85**A. In this position, the first set of shutters **90**A creates the greatest amount of flow through the first set of ports **82**A the first set of passageways **85**A in the tower **70** for removing the largest volume of first plurality of constituents "S**1**" and effluent fluid. As discussed above, the first set of shutters **90**A may be positioned at any suitable position between the covered position (see FIG. **1**A) and the uncovered position (FIGS. **1**B, **3**, and **4**A) for a desired flow rate of effluent fluid and the first plurality of constituents "S**1**." Once the first plurality of constituents "S**1**" passes through the first set of ports **82**A, the first plurality of constituents "S**1**" passes through the first set of passageways **85**A and into the first effluent outlet **86**A. The first plurality of constituents "S**1**", along with effluent fluid, is outputted to an output container or facility via the first effluent outlet connection **88**A.

[0124] Upon the separation of the first plurality of constituents "S**1**" from the fluid stream "LS**2**", the fluid stream "LS" transitions from the second fluid stream state "LS**2**" to a third fluid stream state "LS**3**" as the fluid stream "LS" is pumped from the first stage **72**A to the second stage **72**B via one of both of the first and second transfer connections **94**A, **94**B. Once pumped into the second stage **72**B, the fluid stream "LS**3**" flows away from the diaphragm **140** and towards the reflector **130**. As the fluid stream "LS**3**" travels through the pressurized chamber **75** in the second stage **72**B of the tower **70**, the plurality of anti-nodes **115**B of the standing sonic wave **115** force the second plurality of constituents "S**2**" of the fluid stream "LS**3**" into the second set of ports **82**B substantially similar to the first plurality of constituents "S**1**" of the fluid stream "LS**2**" into the first set of ports **82**A.

[0125] As illustrated in FIGS. **1**B, **3**, and **4**B, the second set of shutters **90**B are provided in the uncovered position in which the second set of shutters **90**B are completely removed from the second set of ports **82**B and the second set of passageways **85**B. In this position, the second set of shutters **90**B creates the greatest amount of flow through the second set of ports **82**B in the tower **70** for removing the largest volume of second plurality of constituents "S**2**" and effluent fluid. As discussed above, the second set of shutters **90**B may be positioned at any suitable position between the covered position (see FIG. **1**A) and the uncovered position (FIGS. **1**B, **3**, and **4**B) for a desired flow rate of effluent fluid and the second plurality of constituents "S**2**." Once the second plurality of constituents "S**2**" passes through the second set of ports **82**B, the second plurality of constituents "S**2**" passes through the second set of passageways **85**B and into the second effluent outlet **86**B. The second plurality of constituents "S**2**", along with effluent fluid, is outputted to an output container or facility via the second effluent outlet connection **88**B.

[0126] Once the second plurality of constituents "S**2**" is separated from the third fluid stream state "LS**3**" in the second stage **72**B, the fluid stream "LS" transitions from the third fluid stream state "LS**3**" to a fourth fluid stream state "LS**4**". Here, the fluid stream "LS**4**" is separated from first and second pluralities of constituents "S**1**", "S**2**" where the fluid stream "LS**4**" is substantially free of substances and solids and is considered a cleaned fluid. Upon this separation, the fluid stream "LS**4**" escapes around the reflector **130** and moves towards the at least one cleaned fluid outlet **96**. The fluid stream "LS**4**" is then pumped to a clean fluid output container or facility, via the at least one cleaned fluid outlet connection **98**, from the tower **70**.

[0127] The method of cleaning a fluid stream, such as fluid stream "LS", may be repeated for continuously dissociating complex substances in the fluid stream, via at least one SDA **10**, and separating the dissociated complex substances from the fluid stream, via at least one SSA **12**.

[0128] FIG. **5**A illustrates another fluid treatment system **201** having at least one SDA **210**. The SDA **210** is substantially similar to the SDA **10** of the fluid treatment system **1** described above and illustrated in FIGS. **1**A-**1**B, **2**A, and **3**, expect as detailed hereinafter. The SDA **210** includes a housing **220**, at least one insert **240** operably engaged with the housing **220**, at least one inlet connection **250** operably engaged with the housing **220** and/or insert **240** for delivering a continuous fluid stream "LS" or a continuous sonic optimization fluid stream "US" into the housing **220** and/or insert **240** for dissociation operations, at least one outlet connection **252** operably engaged with the housing **220** and/or insert **240** for delivering a continuous fluid stream "LS" or a continuous sonic optimization fluid stream "US" from the housing **220** and/or insert **240** subsequent dissociation operations, and a transducer **260** operably engaged inside of the housing **220** disposed about the insert **240**.

[0129] It should be understood that FIG. **5**A is diagrammatic only for the SDA **210** and does not illustrate exact and precise dimensions of any component or assembly of the SDA **210** provided herein. Such diagrammatic illustrations of the SDA **210** shown in FIG. **5**A should not limit the exact positioning, orientation, or location of the SDA **210**.

[0130] As illustrated in FIG. **5**A, the housing **220** has a first or top wall **220**A, an opposing second or bottom wall **220**B, and a longitudinal axis "X**1**" defined therebetween. The housing **220** also includes a circumferential wall **220**C that extends between the top wall **220**A and the bottom wall **220**B along an axis parallel with the longitudinal axis "X**1**" of housing **220**. The circumferential wall **220**C also defines a diameter or width "D**2**" as shown in FIG. **5**A. The diameter "D**2**" of the housing **220** is greater than the diameter "D**1**" of the housing **20** of the SDA **10** described above and illustrated in FIG. **2**. The larger diameter "D**2**" of the housing **220** is considered advantageous at least because the large diameter "D**2**" allows for more space for the transducer **260** to generate uniform cavitation inside of the housing **220** for dissociating complex substances and solids found in the continuous contaminated fluid stream "LS".

[0131] FIG. **5**B illustrates another fluid treatment system **301** having at least one SDA **310**. The SDA **310** is substantially similar to the SDAs **10**, **210** of the fluid treatment systems **1**, **201** described above and illustrated in FIGS. **1**A-**1**B, **2**, **3**, and **5**A expect as detailed hereinafter. The SDA **310** includes a housing **320**, at least one insert **340** operably engaged with the housing **320**, at least one inlet connection **350** operably engaged with the housing **310**, at least one outlet connection **352** operably engaged with the housing **310**, and a transducer **360** operably engaged inside of the housing **320** disposed about the insert **340** and operatively connected with a generator **366**, via an electrical connection **367**, to generate a traveling sonic wave **368**.
[0132] It should be understood that FIG. **5**B is diagrammatic only for the SDA **310** and does not illustrate exact and precise dimensions of any component or assembly of the SDA **310** provided herein. Such diagrammatic illustrations of the SDA **310** shown in FIG. **5**B should not limit the exact positioning, orientation, or location of the SDA **310**.
[0133] As illustrated in FIG. **5**B, the SDA **10** includes a single insert **340** to help isolate dissociation and disintegration of complex substances and solids into simple constituents. The insert **340** includes a first or upper wall **340**A, an opposing second or bottom wall **340**B, and a longitudinal axis “X**2**” defined therebetween. As shown in FIG. **5**B, the longitudinal axis “X**2**” of the insert **340** is parallel with a longitudinal axis “X**1**” of the housing **320**. The insert **340** also includes a peripheral wall **340**C that extends between the upper wall **340**A and the lower wall **340**B along an axis parallel with the longitudinal axis “X**2**” of insert **340**. The peripheral wall **340**C also defines a diameter or width “W**2**” as shown in FIG. **5**B. In the illustrated embodiment, the insert **340** is tubular and/or cylindrically-shaped. In other exemplary embodiments, an insert may have any shape or configuration based on various considerations. Examples of suitable shapes or configuration for an insert include spherical, cubical, cuboidal, conical, triangular, torus-shaped, pyramidal, polyhedron-shaped, and other suitable shapes or configuration for an insert of a SDA.
[0134] Still referring to FIG. **5**B, a fluid passage **342** is collectively defined by the upper wall **340**A, the lower wall **340**B, and the peripheral wall **340**C of the insert **340**. The fluid passage **342** is accessible via at least one inlet opening **344** and at least one outlet opening **346**. In the illustrated embodiment, the fluid passage **342** is accessible via an inlet opening **344**A defined in the lower wall **340**B of the insert **340**. The fluid passage **342** is also accessible via a first outlet **346**A defined in the upper wall **340**A of the insert **340** and an adjacent second outlet **346**B defined in the upper wall **340**A relative to the upper wall **340**A. Such uses of the inlet opening **344**A and the first and second outlet openings **346**A, **346**B are described in more detail below.
[0135] While the first inlet **344**A is defined in the lower wall **340**B of the insert **340** and the first and second outlets **346**A, **346**B are defined in the upper wall **340**A, a first inlet and first and second outlets of an insert may be defined in any portion of the insert. In one exemplary embodiment, a first inlet and first and second outlets of an insert may both be defined in a bottom wall of the insert. In another exemplary embodiment, a first inlet and first and second outlets of an insert may both be defined in a top wall of the insert. In another exemplary embodiment, a first inlet and first and second outlets of an insert may both be defined in a peripheral wall of the insert. In another exemplary embodiment, a first inlet of an insert may be defined in one of first, second, and third walls of the insert, a first outlet of an insert may be defined in one of first, second, and third walls of the insert, and a second outlet of an insert may be defined in one of first, second, and third walls of the insert.
[0136] Still referring to FIG. **5**B, the insert **340** may also include a flow director or baffle **348**. The flow director **348** is operably engaged with the peripheral wall **340**C of the insert **340** proximate to the lower wall **340**B and the first inlet **344**A of the insert **340**. As described in more detail below, the flow director **348** creates a specific flow to a continuous fluid stream that is pumped into the insert **340**; the flow director **348** in this embodiment creates a non-laminar flow pattern on the continuous fluid stream.
[0137] While a single flow director **348** is provided with the insert **340**, any suitable number of

flow directors may be installed in an insert for various considerations, including the desired dwell time of the continuous fluid stream inside of the insert, the intensity and desired turbulence of a continuous fluid stream, and other various considerations. While a flow director **348** is positioned proximate to the first inlet **344**A of the insert **340**, a flow director may be positioned along any suitable position inside of an insert for various considerations, including the desired dwell time of the continuous fluid stream inside of the insert, the intensity and desired turbulence of a continuous fluid stream, and other various considerations.

[0138] Still referring to FIG. **5**B, the at least one inlet connection **350** may be operably engaged with the housing **320** and/or insert **340** for delivering a continuous fluid stream “LS” or a continuous sonic optimization fluid stream “US” for dissociation purposes. In the illustrated embodiment, a first inlet connection **350**A is operably engaged with the housing **320** (substantially similar to the first inlet connection **50**A and housing **20** described above) and operably engaged with the insert **340** via the first inlet opening **344**A. As shown in FIG. **5**B, the first inlet connection **350**A is configured to direct the continuous fluid stream “LS” from a fluid source (i.e., a body of water or fluid) and into the fluid passage **342** of the insert **340** via the fluid communication between the first inlet connection **350**A and the insert **340**. In addition, a second inlet connection **350**B is operably engaged with the housing **320** via the second inlet **326**A. As shown in FIG. **5**B, the second inlet connection **350**B is configured to direct the continuous sonic optimization fluid stream “US” from a sonic optimization fluid source into the housing **320** via the fluid communication between the second inlet connection **350**B and the housing **320** (substantially similar to the housing **20** described above). The first inlet connection **350**A isolates the continuous fluid stream “LS” from the continuous sonic optimization fluid stream “US” pumped into the housing **320** to prevent any mixing of or interaction between the continuous fluid stream “LS” and the continuous sonic optimization fluid stream “US” during a solids dissociation process as described above.

[0139] Still referring to FIG. **5**B, at least one outlet connection **352** may be operably engaged with the housing **320** and/or insert **340** for delivering a continuous fluid stream “LS” with dissociated substances and/or solids or delivering a continuous sonic optimization fluid stream “US” from the housing **320** for dissociation purposes. In the illustrated embodiment, a first outlet connection **352**A is operably engaged with the housing **320** (substantially similar to the first outlet connection **52**A and housing **20** described above) and operably engaged with the insert **340** via the first outlet opening **346**A. As shown in FIG. **5**B, the first outlet connection **352**A is configured to direct the continuous fluid stream “LS” with dissociated substances and/or solids (i.e., simple constituents) from the fluid passage **342** of the insert **340** to a first output device. In one exemplary embodiment, an output device may be a solids separation apparatus, such as SSA **12**, for separating the dissociated substances and/or solids from the continuous fluid stream for purification/cleaning purpose. In another exemplary embodiment, an output device may be another solids dissociation apparatus, such as SDA **10**, SDA **210**, or SDA **310**, or other suitable SDAs described herein for providing another process of dissociation.

[0140] Additionally, a second outlet connection **352**B is operably engaged with the housing **320** (substantially similar to the first outlet connection **52**A and housing **20** described above) and operably engaged with the insert **340** via the second outlet opening **346**B. As shown in FIG. **5**B, the second outlet connection **352**B is configured to direct the continuous fluid stream “LS” with dissociated substances and/or solids (i.e., simple constituents) from the fluid passage **342** of the insert **340** to a second output device. In one exemplary embodiment, an output device may be a solids separation apparatus, such as SSA **12**, for separating the dissociated substances and/or solids from the continuous fluid stream for purification/cleaning purpose. In another exemplary embodiment, an output device may be another solids dissociation apparatus, such as SDA **10**, SDA **210**, or SDA **310**, or other suitable SDAs described herein, for providing another process of dissociation.

[0141] The configuration of the insert **340** with the first and second outlet connections **352**A, **352**B, via the first and second outlets **346**A, **346**B, is considered advantageous at least because the fluid stream "LS" with dissociated substances and solids may be outputted to different devices and apparatuses for various fluid cleaning operations. In one instance, the first and second outlet connections **352**A, **352**B may be in fluid communication with first and second SSAs, such as SSA **12**, to allow for more than one SSA to separate dissociated substances from the fluid stream "LS" in the fluid treatment system **301**. In another instance, the first outlet connection **352**A may be in fluid communication with a SSA, such as SSA **12**, to separate dissociated substances from the fluid stream "LS" in the fluid treatment system **301**, and the second outlet connection **352**B may be in fluid communication with another SDA, such as SDA **10**, SDA **210**, or SDA **310**, to provide further dissociation of the dissociated substances in the fluid stream "LS" in the fluid treatment system **301**.

[0142] Still referring to FIG. **5**B, a third outlet connection **352**C is operably engaged with the housing **320** (substantially similar to the second outlet connection **52**B operably engaged with the housing **20**). The third outlet connection **352**C is configured to direct the continuous sonic optimization fluid stream "US" from the housing **320** to a sonic optimization fluid output device or to the original sonic inlet device. Such pumping and removing of sonic optimization fluid "US" allows for a continuous flow of sonic optimization fluid into the housing **320** for adequate generation of sonic waves during dissociation processes, which is described in more detail below.

[0143] FIG. **5**C illustrates another fluid treatment system **401** having at least one SDA **410**. The SDA **410** is substantially similar to the SDAs **10**, **210**, **310** of the fluid treatment systems **1**, **201**, **301** described above and illustrated in FIGS. **1**A-**1**B, **2**, **3**, and **5**A-**5**B expect as detailed hereinafter. The SDA **410** includes a housing **420**, at least one insert **440** operably engaged with the housing **420**, at least one inlet connection **450** operably engaged with the housing **410**, at least one outlet connection **452** operably engaged with the housing **410**, and a transducer **460** operably engaged inside of the housing **420** disposed about the insert **440** and operatively connected with a generator **466**, via an electrical connection **467**, to generate a traveling sonic wave **468**.

[0144] It should be understood that FIG. **5**C is diagrammatic only for the SDA **410** and does not illustrate exact and precise dimensions of any component or assembly of the SDA **410** provided herein. Such diagrammatic illustrations of the SDA **410** shown in FIG. **5**C should not limit the exact positioning, orientation, or location of the SDA **410**.

[0145] As illustrated in FIG. **5**C, the SDA **410** includes a single insert **440** to help isolate dissociation and disintegration of complex substances and solids. The insert **440** includes a first or upper wall **440**A, an opposing second or bottom wall **440**B, and a longitudinal axis "X**2**" defined therebetween. As shown in FIG. **5**C, the longitudinal axis "X**2**" of the insert **440** is parallel with a longitudinal axis "X**1**" of the housing **420**. The insert **440** also includes a peripheral wall **440**C that extends between the upper wall **440**A and the lower wall **440**B along an axis parallel with the longitudinal axis "X**2**" of insert **440**. The peripheral wall **440**C also defines a diameter or width "W**3**" as shown in FIG. **5**C; the width "W**3**" of the insert **440** is equal to the widths "W**1**", "W**2**" of the inserts **240**, **340** of the SDA **210**, **310** described and illustrated herein. In the illustrated embodiment, the insert **440** is tubular and/or cylindrically-shaped. In other exemplary embodiments, an insert may have any shape or configuration based on various considerations. Examples of suitable shapes or configuration for an insert include spherical, cubical, cuboidal, conical, triangular, torus-shaped, pyramidal, polyhedron-shaped, and other suitable shapes or configuration for an insert of a SDA.

[0146] Still referring to FIG. **5**C, a fluid passage **442** is collectively defined by the upper wall **440**A, the lower wall **440**B, and the peripheral wall **440**C of the insert **440**. The fluid passage **442** is accessible via at least one inlet opening **444** and at least one outlet opening **446**. In the illustrated embodiment, the fluid passage **442** is accessible via a first inlet opening **444**A defined in the lower wall **440**B of the insert **440**. The fluid passage **442** is also accessible via a first outlet **446**A defined in the upper wall **440**A of the insert **440**. Such uses of the first inlet opening **444**A and the first outlet opening **446**A are described in more detail below.

[0147] While the first inlet **444**A is defined in the lower wall **440**B of the insert **440** and the first outlet **446**A is defined in the upper wall **440**A, a first inlet and a first outlet of an insert may be defined in any portion of the insert. In one exemplary embodiment, a first inlet and a first outlet of an insert may both be defined in a bottom wall of the insert. In another exemplary embodiment, a first inlet and a first outlet of an insert may both be defined in a top wall of the insert. In another exemplary embodiment, a first inlet and a first outlet of an insert may both be defined in a peripheral wall of the insert. In another exemplary embodiment, a first inlet of an insert may be defined in one of first, second, and third walls of the insert and a first outlet of an insert may be defined in one of first, second, and third walls of the insert.

[0148] Still referring to FIG. **5**C, the insert **440** may also include at least one flow director or baffle **448**. The at least one flow director **448** of the insert **440** is different than the flow directors **48**, **348** of the inserts **40**, **340** described above. In the illustrated embodiment, a first flow director **448**A operably engages with the lower wall **440**B of the insert **440** and extends upwardly away from the lower wall **440**B towards the upper wall **440**A. A second flow director **448**B is operably engaged with the upper wall **440**A of the insert **440** and extends downwardly away from the upper wall **440**A towards the lower wall **440**B. The first and second flow directors **448**A, **448**B collectively define a flow path **448**C inside of the insert **440** where the flow path **448**C provides the fluid stream “LS” in a laminar flow state. The configurations of the flow directors **448**A, **448**B are considered advantageous at least because the flow directors **448**A, **448**B extend the dwell time of the fluid stream “LS” inside of the insert **440** so that the fluid stream “LS” may experience a desired amount of cavitation inside of the insert **440**. Such extended dwell time inside of insert **440** may allow for a greater occurrence of dissociation for the complex substances present in the fluid stream “LS”.

[0149] While two flow directors **448**A, **448**B are provided with the insert **440**, any suitable number of flow directors may be installed with an insert for various considerations, including the intensity and desired turbulence of a continuous fluid stream. While the first and second flow directors **448**A, **448**B are oriented on axes parallel with the longitudinal axis “X**2**” of the insert, any flow director may be oriented at any suitable angle or position inside of an insert for various considerations, including the intensity and desired turbulence of a continuous fluid stream. In one exemplary embodiment, first and second flow directors may be oriented on axes orthogonal to a longitudinal axis of an insert. In another exemplary embodiment, a first flow director may be oriented on an axis parallel to a longitudinal axis of an insert, and a second flow director may be oriented on an axis orthogonal to the longitudinal axis of the insert. In another exemplary embodiment, a first flow director may be oriented on a first axis measured at a first angle relative to a longitudinal axis of an insert, and a second flow director may be oriented on a second axis measured at a second angle measured relative to the longitudinal axis of the insert where the first and second angle are different from one another.

[0150] FIGS. **5**D-**5**E illustrate another fluid treatment system **501** having at least one SDA **510**. The SDA **510** is substantially similar to the SDAs **10**, **210**, **310**, **410** of the fluid treatment systems **1**, **201**, **301**, **401** described above and illustrated in FIGS. **1**A-**1**B, **2**, **3**, and **5**A-**5**C expect as detailed hereinafter. The SDA **510** includes a housing **520**, at least one insert **540** operably engaged with the housing **520**, at least one inlet connection **550** operably engaged with the housing **510**, at least one outlet connection **552** operably engaged with the housing **510**, and a transducer **560** operably engaged inside of the housing **520** disposed about the insert **540** and operatively connected with a generator **566**, via an electrical connection **567**, to generate a traveling sonic wave **568**.

[0151] It should be understood that FIGS. **5**D-**5**E are diagrammatic only for the SDA **510** and does not illustrate exact and precise dimensions of any component or assembly of the SDA **510** provided herein. Such diagrammatic illustrations of the SDA **510** shown in FIGS. **5**D-**5**E should not limit the exact positioning, orientation, or location of the SDA **510**.

[0152] As illustrated in FIG. 5D, the SDA **10** includes a single insert **540** to help isolate dissociation and disintegration of complex substances and solids. The insert **540** includes a first or upper wall **540**A, an opposing second or bottom wall **540**B, and a longitudinal axis “X**2**” defined therebetween. As shown in FIGS. **5**D-**5**E, the longitudinal axis “X**2**” of the insert **540** is parallel with a longitudinal axis “X**1**” of the housing **520**. The insert **540** also includes a first or outer peripheral wall **540**C that extends between the upper wall **540**A and the lower wall **540**B along an axis parallel with the longitudinal axis “X**2**” of the insert **540**. The outer peripheral wall **540**C also defines a diameter or width “W**4**” as shown in FIG. **5**E. The insert **540** also includes a second or inner peripheral wall **540**D that extends between the upper wall **540**A and the lower wall **540**B along an axis parallel with the longitudinal axis “X**2**” of the insert **540**. The inner peripheral wall **540**D is positioned interior to the outer peripheral wall **540**D of the insert **540**. The inner peripheral wall **540**D also defines a diameter or width “W**5**” as shown in FIG. **5**E; the width “W**5**” defined by the inner peripheral wall **540**D is less than the width “W**4**” defined by the outer peripheral wall **540**C. In the illustrated embodiment, the insert **540** is tubular and/or cylindrically-shaped. In other exemplary embodiments, an insert may have any shape or configuration based on various considerations. Examples of suitable shapes or configuration for an insert include spherical, cubical, cuboidal, conical, triangular, torus-shaped, pyramidal, polyhedron-shaped, and other suitable shapes or configuration for an insert of a SDA.

[0153] Still referring to FIGS. **5**D-**5**E, a first or outer fluid passage **542**A is collectively defined by the upper wall **540**A, the lower wall **540**B, and the outer peripheral wall **540**C of the insert **540**. Additionally, a second or inner fluid passage **542**B is collectively defined by the upper wall **540**A, the lower wall **540**B, and the inner peripheral wall **540**D of the insert **540**. The outer and inner fluid passages **542**A, **542**B are accessible via at least one inlet opening **344** and at least one outlet opening **346**. In the illustrated embodiment, the outer fluid passage **542**A is accessible via a first inlet opening **544**A defined in the lower wall **540**B of the insert **540**. The outer fluid passage **542**A is also accessible via a first outlet opening **546**A defined in the upper wall **540**A of the insert **540**. Additionally, the inner fluid passage **542**B is accessible via a second inlet opening **544**B defined in the lower wall **540**B of the insert **540**. The inner fluid passage **542**B is also accessible via a second outlet opening **546**B defined in the upper wall **540**A of the insert **540**.

[0154] While the first and second inlets **544**A, **544**B are defined in the lower wall **540**B of the insert **540** and the first and second outlets **546**A, **546**B is defined in the upper wall **340**A, first and second inlets and first and second outlets of an insert may be defined in any portion of the insert.

[0155] Still referring to FIGS. **5**D-**5**E, the insert **540** may also include at least one flow director or baffle **548**. In the illustrated embodiment, a first flow director **548**A is operably engaged with the outer peripheral wall **540**C of the insert **540** proximate to the lower wall **540**B and the first inlet **544**A of the insert **540**. Additionally, a second flow director **548**B is operably engaged with the inner peripheral wall **540**D of the insert **540** proximate to the lower wall **540**B and the second inlet **544**B of the insert **540**. Each of the first and second flow directors **548**A, **548**B create a specific flow to first and second continuous fluid streams “LS**1**”, “LS**2**” that are pumped into the insert **540**; the first and second flow directors **548**A, **548**B in this embodiment create non-laminar flow patterns on the first and second continuous fluid streams “LS**1**”, “LS**2**”. In other exemplary embodiments, flow directors or baffles may be omitted from an insert.

[0156] While a single flow director **548**A, **548**B is provided inside each fluid passage **542**A, **542**B, any suitable number of flow directors may be installed in a fluid passage of an insert for various considerations, including the desired dwell time of the continuous fluid stream inside of the insert, the intensity and desired turbulence of a continuous fluid stream, and other various considerations. While the first and second flow directors **548**A, **542**A are positioned proximate to the first and second inlet openings **544**A, **544**B of the insert **540**, flow directors may be positioned along any suitable position inside of an insert for various considerations, including the desired dwell time of the continuous fluid stream inside of the insert, the intensity and desired turbulence of a continuous fluid stream, and other various considerations.

[0157] Still referring to FIG. **5**D-**5**E, the at least one inlet connection **550** may be operably engaged with the housing **520** and/or insert **540** for delivering a continuous fluid stream “LS” or a continuous sonic optimization fluid stream “US” for dissociation purposes. As illustrated in FIG. **5**D, a first inlet connection **550**A is operably engaged with the housing **520** (substantially similar to the first inlet connection **50**A and housing **20** described above) and operably engaged with the insert **540** via the first inlet opening **544**A. As shown in FIG. **5**D, the first inlet connection **550**A is configured to direct the first continuous fluid stream “LS**1**” from a fluid source (i.e., a body of water or fluid) and into the outer fluid passage **542**A of the insert **540** via the fluid communication between the first inlet connection **550**A and the insert **540**. As illustrated in FIG. **5**D, a second inlet connection **550**B is operably engaged with the housing **520** and operably engaged with the insert **540** via the second inlet opening **544**B. As shown in FIG. **5**D, the second inlet connection **550**B is configured to direct the second continuous fluid stream “LS**2**” from a fluid source (i.e., a body of water or fluid) or another device in the fluid treatment system **501** (such as a SSA described herein or another SDA **510** or similar SDA described herein) and into the inner fluid passage **542**B of the insert **540** via the fluid communication between the second inlet connection **550**B and the insert **540**.

[0158] In addition, a third inlet connection **550**C is operably engaged with the housing **320** (substantially similar to the engagement between the second inlet connection **50**B and housing **20** described above). As shown in FIG. **5**D, the third inlet connection **550**C is configured to direct and/or pump the continuous sonic optimization fluid stream “US” from a sonic optimization fluid source into the housing **520** via the fluid communication between the third inlet connection **550**C and the housing **520** (substantially similar to the housing **20** described above).

[0159] With these configurations, the first and second inlet connections **550**A, **550**B isolate the first and second continuous fluid streams “LS**1**”, “LS**2**” from the continuous sonic optimization fluid stream “US” pumped into the housing **520**. Such configuration prevents any mixing of or interaction between first and second continuous fluid streams “LS**1**”, “LS**2**” and the continuous sonic optimization fluid stream “US” during a solids dissociation process as described above in previous solids dissociation processes.

[0160] Referring to FIGS. **5**D-**5**E, at least one outlet connection **552** may be operably engaged with the housing **520** and/or insert **540** for delivering a continuous fluid stream “LS” with dissociated substances and/or solids or delivering a continuous sonic optimization fluid stream “US” from the housing **520** for dissociation purposes. In the illustrated embodiment, a first outlet connection **552**A is operably engaged with the housing **520** (substantially similar to the first outlet connection **52**A and housing **20** described above) and operably engaged with the insert **540** via the first outlet opening **546**A. As shown in FIG. **5**D, the first outlet connection **552**A is configured to direct the first continuous fluid stream “LS**1**” with dissociated substances and/or solids from the outer fluid passage **542**A of the insert **540** to a first output device. In one exemplary embodiment, an output device may be a solids separation apparatus, such as SSA **12**, for separating the dissociated substances and/or solids from the continuous fluid stream for purification/cleaning purpose. In another exemplary embodiment, an output device may be another solids dissociation apparatus, such as SDA **10**, SDA **210**, SDA **310**, SDA **410**, SDA **510**, or other SDAs described and illustrated herein, for providing another process of dissociation.

[0161] Additionally, a second outlet connection **552**B is operably engaged with the housing **520** (substantially similar to the first outlet connection **52**A and housing **20** described above) and operably engaged with the insert **540** via the second outlet opening **546**B. As shown in FIG. **5**D, the second outlet connection **552**B is configured to direct the second continuous fluid stream “LS**2**” with dissociated substances and/or solids from the inner fluid passage **542**B of the insert **540** to a second output device. In one exemplary embodiment, an output device may be a solids separation apparatus, such as SSA **12** or other SSA described and illustrated herein, for separating the dissociated substances and/or solids from the continuous fluid stream for purification/cleaning purpose. In another exemplary embodiment, an output device may be another solids dissociation apparatus, such as SDA **10**, SDA **210**, SDA **310**, SDA **410**, SDA **510**, or other SDAs described and illustrated herein, for providing another process of dissociation.

[0162] The configuration of the insert **540** with the first and second outlet connections **552**A, **552**B, via the first and second outlets **546**A, **546**B, is considered advantageous at least because the first and second continuous fluid stream "LS**1**", "LS**2**" with dissociated substances and solids may be outputted to different devices and apparatuses for various fluid cleaning operations. In one instance, the first and second outlet connections **552**A, **552**B may be in fluid communication with first and second SSAs, such as SSA **12**, to allow for more than one SSA to separate dissociated substances from the first and second continuous fluid streams "LS**1**", "LS**2**" in the fluid treatment system **501**. In another instance, the first outlet connection **552**A may be in fluid communication with a SSA, such as SSA **12**, to separate dissociated substances from the first continuous fluid stream "LS**1**" in the fluid treatment system **501**, and the second outlet connection **552**B may be in fluid communication with another SDA, such as SDA **10**, SDA **210**, SDA **310**, SDA **410**, or SDA **510**, or other SDAs described and illustrated herein, to provide further dissociation of the dissociated substances in the second continuous fluid stream "LS**2**" in the fluid treatment system **501**.

[0163] Referring to FIG. **5**D, a third outlet connection **552**C is operably engaged with the housing **520** (substantially similar to the second outlet connection **52**B operably engaged with the housing **20**). The third outlet connection **552**C is configured to direct and/or pump the continuous sonic optimization fluid stream "US" from the housing **520** to a sonic optimization fluid output device or to the original sonic inlet device. Such pumping and removing of sonic optimization fluid "US" allows for a continuous flow of sonic optimization fluid into the housing **520** for adequate generation of sonic waves during dissociation processes, which are described in more detail below.

[0164] FIG. **5**F illustrates another fluid treatment system **601** having at least one SDA **610**. The SDA **610** is substantially similar to the SDAs **10**, **210**, **310**, **410**, **510** of the fluid treatment systems **1**, **201**, **301**, **401**, **501** described above and illustrated in FIGS. **1**A-**1**B, **2**, **3**, and **5**A-**5**E expect as detailed hereinafter. The SDA **610** includes at least one flange **640**, at least one inlet connection **650** operably engaged with the at least one flange **640**, at least one outlet connection **652** operably engaged with the at least one flange **640**, and a transducer **660** operably engaged with the at least one flange **640** about said at least one flange **640**. It should be understood that FIG. **5**F is diagrammatic only for the SDA **610** and does not illustrate exact and precise dimensions of any component or assembly of the SDA **610** provided herein. Such diagrammatic illustrations of the SDA **610** shown in FIG. **5**F should not limit the exact positioning, orientation, or location of the SDA **610**.

[0165] In the illustrated embodiment, the SDA **610** includes two flanges **640** operably engaged with the transducer **650** as compared to the insert **40**, **240**, **340**, **440**, **540** being operably engaged with the housing **20**, **220**, **320**, **420**, **520** and being separate from the transducer **60**, **260**, **360**, **460**, **560** as presented in SDAs **10**, **210**, **310**, **410**, **510** described and illustrated herein. As such, the flange **640** is directly abutting a circumferential interior wall of the transducer **660** to maximize space between the flanges **640** and the transducer **660**. Additional sealing members, such as first and second couples **554**A, **554**B or other suitable sealing members, may be used for sealing a continuous fluid stream "LS" inside of the flanges **640**.

[0166] Such configuration between the flanges **640** and the transducer **660** of SDA **610** is considered advantageous at least because this configuration provides a smaller form factor as compared to the other SDAs **10**, **210**, **310**, **410**, **510** described and illustrated herein. This small form factor of SDA **610** may be used in tight or small fluid source spaces where the SDA **610** would perform dissociated processes on a smaller volume of fluid stream passing through the SDA **610**.

[0167] In one exemplary embodiment, an insert of an SDA may have a greater length than the inserts described and illustrated herein, such as inserts **40**, **240**, **340**, **440**, **540**, **640** of SDAs **10**, **210**, **310**, **410**, **510**, **610**, to prolong dwell time of a continuous fluid stream flowing through the insert. Such additional dwell time allows for the continuous fluid stream to experience a greater time of cavitation inside of the insert for dissociating substances and solids provided in said continuous fluid stream. Additionally, this insert of this exemplary SDA may define any suitable shape to prolong dwell time of a continuous fluid stream flowing through the insert. Examples of suitable shapes and/or configurations for this insert may include coil-shaped, helical-shaped, serpentine-shaped, spiral-shaped, zig-zag-shaped, and any other suitable shapes and/or configurations to prolong dwell time of a continuous fluid stream flowing through the insert.
[0168] FIG. **6** illustrates another fluid treatment system **701** having a first SDA **710**A and a second SDA **710**B operably engaged with at least one SSA **712**. The first and second SDA **710**A, **710**B are substantially similar to the SDA **10** of the fluid treatment system **1** described above and illustrated in FIGS. **1**A-**1**B, **2**, **3**, and **4**A-**4**B, expect as detailed hereinafter. The SSA **712** is also substantially similar to the SSA **12** of the fluid treatment system **1** described above and illustrated in FIGS. **1**A-**1**B, **2**, **3**, and **4**A-**4**B, expect as detailed hereinafter.
[0169] It should be understood that FIG. **6** is diagrammatic only for the fluid treatment system **701** and do not illustrate exact and precise dimensions of any component, assembly, or apparatus provided herein. Such diagrammatic illustrations of the at least one SDA **710** and the at least one SSA **712** of the fluid treatment system **701** shown in FIG. **6** should not limit the exact positioning, orientation, or location of the at least one SDA **710** and the at least one SSA **712** relative to one another.
[0170] As illustrated in FIG. **6**, the first SDA **710**A includes a housing **720**A, an insert **740**A operably engaged with the housing **720**A inside said housing **720**A, a first inlet connection **750**A operably engaged with the housing **720**A and the insert **740**A where the first inlet connection **750**A directs a continuous fluid stream “LS” into the insert **740**A, a second inlet connection **750**AA operably engaged with the housing **720**A where the second inlet connection **750**AA directs a continuous sonic optimization fluid stream “US” into the housing **720**A, a first outlet connection **752**A operably engaged with the housing **720**A and the insert **740**A where the first outlet connection **752**A directs the fluid stream “LS” out from the insert **740**A, a second outlet connection **752**AA operably engaged with the housing **720**A where the second outlet connection **752**AA directs the continuous sonic optimization fluid stream “US” from the housing **720**A, and a transducer **760**A operably engaged with the housing **720**A inside said housing **720**A and disposed about the insert **740**A.
[0171] Similarly, the second SDA **710**B includes a housing **720**B, an insert **740**B operably engaged with the housing **720**B inside said housing **720**B, a first inlet connection **750**B operably engaged with the housing **720**B and the insert **740**B where the first inlet connection **750**B directs a continuous fluid stream “LS” into the insert **740**B, a second inlet connection **750**BB operably engaged with the housing **720**B where the second inlet connection **750**BB directs a continuous sonic optimization fluid stream “US” into the housing **720**B, a first outlet connection **752**B operably engaged with the housing **720**B and the insert **740**B where the first outlet connection **752**B directs the fluid stream “LS” out from the insert **740**B, a second outlet connection **752**BB operably engaged with the housing **720**B where the second outlet connection **752**BB directs the continuous sonic optimization fluid stream “US” from the housing **720**B, and a transducer **760**B operably engaged with the housing **720**B inside said housing **720**B and disposed about the insert **740**B.
[0172] Still referring to FIG. **6**, the SSA **712** includes a tower **770** having at least a first stage **772**A and a second stage **772**B. In the first stage **772**A of the tower **770**, a first fluid stream inlet **778** is defined in the tower **770** for providing fluid access into the tower **770**, specifically into a chamber **775** defined by the tower **770**. Additionally, a first inlet connection **780**A operably engages with the

first SDA **710**A and the SSA **712** to provide fluid communication between said first SDA **710**A and said SSA **712**. In the illustrated embodiment, the first inlet connection **780**A and the at least one outlet connection **752**A are separate connections that are operably engaged with one another. In one exemplary embodiment, a first inlet connection of a tower and at least one outlet connection of a first SDA are a single, unitary member providing fluid communication between the tower and the first SDA.

[0173] Still referring to FIG. **6**, the first stage **772**A of the tower **770** defines a first set of ports **782**A substantially similar to the first set of ports **82**A defined in the first stage **72**A of the tower **70** in the fluid cleaning system **1** described above. Additionally, the first stage **772**A of the tower **770** also defines a first set of passageways **785**A between the first set of ports **782**A and a first effluent outlet **786**A defined in the first stage **772**A of the tower **770**. Such configuration between the first set of ports **782**A, the first set of passageways **785**A, and the first effluent outlet **786**A is substantially similar to the configuration between the first set of ports **82**A, the first set of passageways **85**A, and the first effluent outlet **86**A of the first stage **72**A of the tower **70** in the fluid cleaning system **1** described above. A first effluent outlet connection **788**A may be also be operably engaged with the tower **770** to provide fluid communication between the first effluent outlet **786**A and an output device or facility for delivering dissociated solids and effluent fluids. Moreover, a first set of shutters **790**A may be operably engaged with the first stage **772**A of the tower to control the flow rate of the fluid stream “LS” flowing through the first stage **772**A of the tower **770**; the first set of shutters **790**A are substantially similar to the first set of shutters **90**A of the first stage **72**A of the tower **70** in the fluid cleaning system **1** described above.

[0174] Referring to FIG. **6**, the tower **770** also defines a first stream outlet **792** that provides fluid communication to the first stage **772**A. The first stream outlet **792** also allows a first transfer connection **794**A to operably engage with the tower **770** to transfer fluid from the first stage **772**A of the tower **770** to the second SDA **710**B. Such transferring of fluid from the first stage **772**A of the tower **770** to the second SDA **710**B is described in more detail below.

[0175] Similarly, a second fluid stream inlet **793** is defined in the tower **770** for providing fluid access into the tower **770**. Additionally, a second inlet connection **780**B operably engages with the second SDA **710**B and the SSA **712** to provide fluid communication between said second SDA **710**B and said SSA **712**. Additionally, the second stage **772**B of the tower **770** defines a second set of ports **782**B substantially similar to the second set of ports **82**B defined in the second stage **72**B of the tower **70** in the fluid cleaning system **1** described above. Additionally, the second stage **772**B of the tower **770** also defines a second set of passageways **785**B between the second set of ports **782**B and a second effluent outlet **786**B defined in the second stage **772**B of the tower **770**. Such configuration between the second set of ports **782**B, the second set of passageways **785**B, and the second effluent outlet **786**B is substantially similar to the configuration between the second set of ports **82**B, the second set of passageways **85**B, and the second effluent outlet **86**B of the second stage **72**B of the tower **70** in the fluid cleaning system **1** described above. A second effluent outlet connection **788**B may be also be operably engaged with the tower **770** to provide fluid communication between the second effluent outlet **786**B and an output device for delivering dissociated solids and effluent fluids. Moreover, a second set of shutters **790**B may be operably engaged with the second stage **772**B of the tower to control the flow rate of the fluid stream “LS” flowing through the second stage **772**B of the tower **770**; the second set of shutters **790**B are substantially similar to the second set of shutters **90**B of the second stage **72**B of the tower **70** in the fluid cleaning system **1** described above.

[0176] Moreover, the SSA **712** also includes an adjustable transducer **810**, an adjustable reflector **830**, and an adjustable diaphragm **840** for fine tuning and precisely adjusting the standing sonic wave **816** inside of the tower **770**. The adjustable transducer **810**, adjustable reflector **830**, and adjustable diaphragm **840** are substantially similar to the adjustable transducer **110**, adjustable reflector **130**, and adjustable diaphragm **140** of the SSA **12** in the fluid cleaning apparatus **1** described above.

[0177] Having now described the components and assemblies of the fluid cleaning system **701**, the method of use is described in more detail below. The method of using the fluid cleaning system **701** is substantially similar to the method of using the fluid cleaning system **1** described above, except as detailed below.

[0178] Similar to fluid cleaning system **1**, a continuous fluid stream “LS” in a first state, which is generally referred to as “LS**1**” via arrows in FIG. **6**, is pumped into the first SDA **710**A, via the first inlet connection **750**A, to provide continuous dissociation and disintegration of complex substances and solids found in the fluid steam “LS**1**”. Once the complex substances and solids provided in the fluid stream “LS” are dissociated by the first SDA **710**A, the continuous fluid stream “LS” of the first state “LS**1**” transitions to a continuous fluid stream of a second state, which is generally referred to as “LS**2**” via arrows in FIG. **6**, containing dissociated substances and solids. Such dissociation of the complex substances and solids occurs via the operation of the transducer **760**A is substantially similar to the operations performed by the transducer **60** described above.

[0179] Still referring to FIG. **6**, the continuous fluid stream “LS**2**” is then pumped into the first stage **772**A of the tower **770** via the first fluid steam inlet connection **780**A. Once inside of the first stage **772**A of the tower **770**, a first plurality of dissociated solids “S**1**” is separated from the continuous fluid stream “LS**2**” through the first set of ports **782**A, the first set of passageways **785**A, and the first effluent outlet **786**A. The first plurality of dissociated solids “S**1**” is denoted by arrows labeled “S**1**” in FIG. **6**. Once the first plurality of dissociated solids “S**1**” is separated, the continuous fluid stream of the second state “LS**2**” transitions to a continuous fluid stream of a third state, which is generally referred to as “LS**3**” via arrows in FIG. **6**.

[0180] Still referring to FIG. **6**, the continuous fluid stream “LS**3**” is then pumped from the first stage **772**A of the tower **770** and into the second SDA **710**B via the first transfer connection **794**A; the first transfer connection **794**A provides fluid communication between the first stage **772**A of the tower **770** and the second SDA **710**B. Similar to the first SDA **710**A, the second SDA **710**B provides an additional continuous dissociation and disintegration of complex substances and solids that may still be provided in the continuous fluid steam “LS**3**”. Once the complex substances and solids provided in the continuous fluid stream “LS**3**” are dissociated by the second SDA **710**B, the continuous fluid stream of the third state “LS**3**” transitions to a continuous fluid stream of a fourth state, which is generally referred to as “LS**4**” via arrows in FIG. **6**, containing dissociated substances and solids. Such dissociation of the complex substances and solids occurs via the operation of the transducer **760**B is substantially similar to the operations performed by the transducer **60** described above.

[0181] As such, this configuration of the fluid cleaning system **701** allows a continuous fluid stream to experience two operations of dissociation and disintegration in a single pass through the fluid cleaning system **701** via the use of the first and second SDAS **710**A, **710**B. With this configuration, any complex substances that may have remained associated or integrated during the first dissociation and disintegration operation and/or remained with the continuous fluid stream during the separation operation may now be fully dissociated and disintegrated before entering the second stage **772**B of the tower **770**.

[0182] Still referring to FIG. **6**, the continuous fluid stream “LS**4**” is then pumped into the second stage **772**B of the tower **770** via the second inlet connection **780**B; the second inlet connection **780**B provides fluid communication between the second SDA **710**B and the second stage **772**B of the tower **770**. Once inside of the second stage **772**B of the tower **770**, a second plurality of dissociated solids “S**2**” is separated from the continuous fluid stream “LS**4**” through the second set of ports **782**B, the second set of passageways **785**B, and the first effluent outlet **786**A. The second plurality of dissociated solids is denoted by arrows labeled “S**2**” in FIG. **6**. Once the second plurality of dissociated solids “S**2**” is separated, the continuous fluid stream of the fourth state “LS**4**” transitions to a continuous fluid stream of a fifth state, which is generally referred to as

"LS**5**" via arrows in FIG. **6**. The continuous fluid stream "LS**5**" is then pumped from the second stage **772**B of the tower **770** to a clean fluid container or vessel via at least one cleaned fluid outlet **796** defined in the tower **770** and at least one cleaned fluid outlet connection **798** operably engaged with the tower **770** and the clean fluid container or vessel.

[0183] While first and second SDAs **710**A, **710**B are used with a single SSA **712** described above, any suitable number of SDAs may be used with any suitable number of SSAs for dissociating complex substances and separating these dissociated complex substances to produce clean fluid. Additionally, while the first and second SDAS **710**A, **710**B of the fluid cleaning system **701** were similar to the SDA **10** of the fluid cleaning system **1** described above, any suitable SDA described and illustrated herein may be used such as SDA **10**, SDA **210**, SDA **310**, SDA **410**, SDA **510**, and SDA **610**.

[0184] FIG. **7** illustrates another fluid treatment system **901** having at least one SDA **910** and operably engaged with at least one SSA **912**. The at least one SDA **910** is substantially similar to the SDA **510** of the fluid treatment system **501** described above and illustrated in FIGS. **5**D-**5**E, expect as detailed hereinafter. The SSA **912** is also substantially similar to the SSA **12** of the fluid treatment system **1** described above and illustrated in FIGS. **1**A-**1**B, **2**, **3**, and **4**A-**4**B, expect as detailed hereinafter.

[0185] It should be understood that FIG. **7** is diagrammatic only for the fluid treatment system **901** and do not illustrate exact and precise dimensions of any component, assembly, or apparatus provided herein. Such diagrammatic illustrations of the at least one SDA **910** and the at least one SSA **912** of the fluid treatment system **901** shown in FIG. **7** should not limit the exact positioning, orientation, or location of the at least one SDA **910** and the at least one SSA **912** relative to one another.

[0186] As illustrated in FIG. **7**, a single SDA **910** is used in the fluid treatment system **901**. The SDA **910** includes a housing **920**, an insert **940** operably engaged with the housing **920** inside said housing **920**. As shown in FIG. **7**, the insert **940** has a first or outer fluid passage **942**A and a second or inner fluid passage **942**B substantially similar to the insert **540** that has outer and inner fluid passages **542**A, **542**B in SDA **510**. Additionally, first and second flow directors (not illustrated) are provided inside the outer and inner fluid passages **942**A, **942**B to direct the continuous fluid stream "LS" from the insert **940** and into the tower **970** of the SSA **912**. The SDA **910** also includes a first inlet connection **950**A and a first outlet connection **952**A operably engaged with the inlet **940** where the first inlet connection **950**A and the first outlet connection **952**A are in fluid communication with the outer fluid passage **942**A. The SDA **910** also includes a second inlet connection **950**B and a second outlet connection **952**B operably engaged with the inlet **940** where the second inlet connection **950**A and the second outlet connection **952**A are in fluid communication with the inner fluid passage **942**B. The SDA **910** also includes a third inlet connection **950**AA and third outlet connection **952**BB to provide a continuous sonic optimization fluid stream "US" through the housing **920** for cavitation operations (described previously). Additionally, the SDA **910** includes a transducer **960** to provide dissociation of complex substances and compounds provided in a continuous fluid stream "LS" traveling through the insert **940**.

[0187] Still referring to FIG. **7**, the SDA **910** defines an air gap **968** between the insert **940** and the SSA **912**. The air gap **968** between the SDA **910** and the SSA **912** isolates the traveling sonic wave (not illustrated) transmitted by the transducer **960** of the SDA **910** from the any sonic wave transmitted by a device in the SSA **912** during operation of the fluid treatment system **901**, which is described in more detail below.

[0188] Still referring to FIG. **7**, the SSA **912** includes a tower **970** having at least at one stage **972**. In the illustrated embodiment, the tower **970** includes a first stage **972**A and a second stage **972**B. In the first stage **972**A of the tower **970**, at least one fluid steam inlet **978** and at least one fluid stream outlet **980** is defined in the tower **970**. As illustrated in FIG. **7**, a first fluid stream inlet **978**A is defined in the tower **970** for providing fluid access into the tower **970**, specifically into the chamber **975** defined by the tower **970**. Additionally, a first inlet connection **980**A operably engages with the SDA **910**A and the SSA **912** to provide fluid communication between said first SDA **910**A and said SSA **912**. In the illustrated embodiment, the first inlet connection **980**A and the first outlet connection **952**A are separate connections that are operably engaged with one another. In one exemplary embodiment, a first inlet connection of a tower and at least one outlet connection of a SDA are a single, unitary member providing fluid communication between the tower and the SDA.

[0189] Still referring to FIG. **7**, the first stage **972**A of the tower **970** defines a first set of ports **982**A substantially similar to the first set of ports **82**A defined in the first stage **72**A of the tower **70** in the fluid cleaning system **1** described above. Additionally, the first stage **972**A of the tower **970** also defines a first set of passageways **985**A between the first set of ports **982**A and a first effluent outlet **986**A defined in the first stage **972**A of the tower **970**. Such configuration between the first set of ports **982**A, the first set of passageways **985**A, and the first effluent outlet **986**A is substantially similar to the configuration between the first set of ports **82**A, the first set of passageways **85**A, and the first effluent outlet **86**A of the first stage **72**A of the tower **70** in the fluid cleaning system **1** described above. A first effluent outlet connection **988**A may be also be operably engaged with the tower **970** to provide fluid communication between the first effluent outlet **986**A and an output device or facility for delivering dissociated solids and effluent fluids. Moreover, a first set of shutters **990**A may be operably engaged with the first stage **972**A of the tower **970** to control the flow rate of the fluid stream “LS” flowing through the first stage **972**A of the tower **970**; the first set of shutters **990**A are substantially similar to the first set of shutters **90**A of the first stage **72**A of the tower **70** in the fluid cleaning system **1** described above.

[0190] Similarly, a second fluid stream inlet **978**B is defined in the tower **970** for providing fluid access into the tower **970**, specifically the chamber **975** defined by the tower **770**. Additionally, a second inlet connection **980**B operably engages with the second SDA **910**B and the SSA **912** to provide fluid communication between said second SDA **910**B and said SSA **912**. In the illustrated embodiment, the second inlet connection **980**B and the second outlet connection **952**B are separate connections that are operably engaged with one another. In one exemplary embodiment, a second inlet connection of a tower and second outlet connection of a SDA are a single, unitary member providing fluid communication between the tower and the SDA.

[0191] Additionally, the second stage **972**B of the tower **970** defines a second set of ports **982**B substantially similar to the second set of ports **82**B defined in the second stage **72**B of the tower **70** in the fluid cleaning system **1** described above. Additionally, the second stage **972**B of the tower **970** also defines a second set of passageways **985**B between the second set of ports **982**B and a second effluent outlet **986**B defined in the second stage **972**B of the tower **970**. Such configuration between the second set of ports **982**B, the second set of passageways **985**B, and the second effluent outlet **986**B is substantially similar to the configuration between the second set of ports **82**B, the second set of passageways **85**B, and the second effluent outlet **86**B of the second stage **72**B of the tower **70** in the fluid cleaning system **1** described above. A second effluent outlet connection **988**B may be also be operably engaged with the tower **970** to provide fluid communication between the second effluent outlet **986**B and an output device for delivering dissociated solids and effluent fluids. Moreover, a second set of shutters **990**B may be operably engaged with the second stage **972**B of the tower to control the flow rate of the fluid stream “LS” flowing through the second stage **972**B of the tower **970**; the second set of shutters **990**B are substantially similar to the second set of shutters **90**B of the second stage **72**B of the tower **70** in the fluid cleaning system **1** described above.

[0192] Still referring to FIG. **7**, the tower **970** of the SSA **912** also defines at least one cleaned fluid outlet **996** defined in the tower **770** for pumping the cleaned fluid stream from the tower **970**. The SSA **912** also includes at least one cleaned fluid outlet connection **998** operably engaged with the tower **970** and a clean fluid container or vessel to direct the cleaned fluid stream from the tower

970.

[0193] Still referring to FIG. **7**, the SSA **912** also includes at least one air space **1000** defined in the tower **970** that extends from the first stage **972**A to the second stage **972**B. Such use of the at least one air space **1000** is substantially similar to the at least one air space **100** of the SSA **12** in the fluid treatment system **1** where the at least one air space **1000** isolates the traveling sonic wave (not illustrated) transmitted by the transducer **960** of the SDA **910** from the standing sonic wave **1015** transmitted by the transducer **1010** of the SSA **912** during operation of the fluid treatment system **901**.

[0194] Moreover, the SSA **912** also includes an adjustable transducer **1010**, an adjustable reflector **1030**, and an adjustable diaphragm **1040** for fine tuning and precisely adjusting the standing sonic wave **1016** inside of the tower **970**. The adjustable transducer **1010**, adjustable reflector **1030**, and adjustable diaphragm **1040** are substantially similar to the adjustable transducer **110**, adjustable reflector **130**, and adjustable diaphragm **140** of the SSA **12** in the fluid cleaning apparatus **1** described above.

[0195] In the fluid treatment system **901**, a portion of the SSA **912** is operably engaged inside of the SDA **910** to maximize the overall footprint of the fluid treatment system **901**. In particular, a portion of the tower **970** (specifically a portion of the first stage **972**A) along with the transducer **1010** of the SSA **912** is provided inside of the housing **920** of the SDA **910**. While the transducer **960** of the SDA **910** surrounds the tower **970** and the transducer **1010** of the SSA **912**, the at least one air space **1000** of the SSA **912** isolates the sonic waves generated by the transducer **960** of the SDA **910** from the sonic waves generated by transducer **1010** of the SSA **912** during operation of the fluid treatment system **901**. This configuration is considered advantageous at least because the fluid treatment system **1** is provided in a single, integrated member as compared to the other fluid treatment systems, particularly fluid treatments **1**, **701**, where the SDA and the SSA in other fluid treatment systems are positioned away from one another.

[0196] Having now described the components and assemblies of the fluid cleaning system **901**, the method of use is described in more detail below. The method of using the fluid cleaning system **901** is substantially similar to the method of using the fluid cleaning systems **1**, **701** described above, except as detailed below.

[0197] Similar to fluid cleaning systems **1**, **701**, a continuous fluid stream in a first state, which is generally referred to as "LS**1**" via arrows in FIG. **7**, is pumped into the outer fluid passage **942**A of insert **940** of the SDA **910** to provide continuous dissociation and disintegration of complex substances and solids found in the continuous fluid steam "LS**1**". Once pumped into the outer fluid passage **942**A, the continuous fluid stream "LS**1**" is directed inside of the outer fluid passage **942**A via a first flow director (not illustrated) based on the directional arrows labeled "LS**1**" in FIG. **7**. In the illustrated embodiment, the first flow director provides the continuous fluid stream "LS**1**" in a non-laminar flow state for a longer dwell time inside of the insert **940**; such purpose of a longer dwell time is described above. Once the complex substances and solids found in the continuous fluid stream "LS**1**" are dissociated by the SDA **910**, via the transducer **960**, the continuous fluid stream of the first state "LS**1**" transitions to a continuous fluid stream of a second state, which is generally referred to as "LS**2**" via arrows in FIG. **7**, containing dissociated substances and solids.

[0198] Still referring to FIG. **7**, the continuous fluid stream "LS**2**" is then pumped into the first stage **972**A of the tower **970** via the first outlet connection **952**A and the first fluid steam inlet connection **980**A. Once inside of the first stage **972**A of the tower **970**, a first plurality of dissociated solids is separated from the continuous fluid stream "LS**2**" through the first set of ports **982**A, the first set of passageways **985**A, and the first effluent outlet **986**A. The first plurality of dissociated solids is denoted by arrows labeled "S**1**" in FIG. **7**. Once the first plurality of dissociated solids "S**1**" is separated, the continuous fluid stream of the second state "LS**2**" transitions to a continuous fluid stream of a third state, which is generally referred to as "LS**3**" via arrows in FIG. **7**.

[0199] Still referring to FIG. **7**, the continuous fluid stream “LS**3**” is then pumped from the first stage **972**A of the tower **970** into the second SDA **910**B via the second inlet connection **950**A and a first transfer connection **994**A; the first transfer connection **994**A provides fluid communication between the first stage **972**A of the tower **970** and the inner fluid passage **942**B of the SDA **910**. In the illustrated embodiment, the second inlet connection **950**B and the first transfer connection **994**A are separate connections that are operably engaged with one another. In one exemplary embodiment, a second inlet connection of a SDA and a first transfer connection of a tower are a single, unitary member providing fluid communication between the SDA and the tower.
[0200] The SDA **910** then provides an additional continuous dissociation and disintegration of complex substances and solids found in the continuous fluid steam “LS**3**”. The continuous fluid stream “LS**3**” is directed inside of the inner fluid passage **942**B via a second flow director (not illustrated) based on the directional arrows labeled “LS**3**” in FIG. **7**. Once the complex substances and solids provided in the continuous fluid stream “LS**3**” are further dissociated by the SDA **910**, the continuous fluid stream of the third state “LS**3**” transitions to a continuous fluid stream of a fourth state, which is generally referred to as “LS**4**” via arrows in FIG. **7**, containing further dissociated substances and solids. As such, this configuration of the fluid cleaning system **901** allows a continuous fluid stream to experience two operations of dissociation and disintegration in a single pass through the fluid cleaning system **901** via the use of outer and inner fluid passages **942**A, **942**B of a single insert **940** of the SDA **910**. With this configuration, any complex substances that may have remained associated or integrated during the first dissociation and disintegration operation and/or remained with the continuous fluid stream during the separation operation may now be fully dissociated and disintegrated.
[0201] Still referring to FIG. **7**, the continuous fluid stream “LS**4**” is then pumped into the second stage **972**B of the tower **970** via the second outlet connection **952**B and the second inlet connection **980**B. Once inside of the second stage **972**B of the tower **970**, a second plurality of dissociated solids is separated from the continuous fluid stream “LS**4**” through the second set of ports **982**B, the second set of passageways **985**B, and the first effluent outlet **986**A. The second plurality of dissociated solids is denoted by arrows labeled “S**2**” in the FIG. **7** Once the second plurality of dissociated solids “S**2**” is separated, the continuous fluid stream of the fourth state “LS**4**” transitions to a continuous fluid stream of a fifth state, which is generally referred to as “LS**5**” via arrows in FIG. **7**. The continuous fluid stream “LS**5**” is then pumped from the second stage **972**B of the tower **970** to a clean fluid container or vessel for use.
[0202] While a single SDA **910** was used with a single SSA **712** described above, any suitable number of SDAs may be used with any suitable number of SSAs for dissociating complex substances and separating these dissociated complex substances to produce clean fluid. Additionally, while the SDA **910** of the fluid cleaning system **901** was similar to the SDA **510** of the fluid cleaning system **501** described above, any suitable SDA described and illustrated herein may be used such as SDA **10**, SDA **210**, SDA **310**, SDA **410**, and/or SDA **610**.
[0203] As provided herein, SDAs **10**, **210**, **310**, **410**, **510**, **610**, **710**A, **710**B, **910** are free from using any ancillary chemicals, membrane filtration or other additives to dissociate and disintegrate complex substances and solids provided in a continuous fluid stream. In other words, SDAs **10**, **210**, **310**, **410**, **510**, **610**, **710**A, **710**B, **910** only use sonic waves to dissociate and disintegrate complex substances and solids provided in a continuous fluid stream as compared to common operations and practices using ancillary chemicals, membrane or other additives. Additionally, SSAs **12**, **712**, **912** are also free from using any ancillary chemicals, membrane or other additives to remove and separate dissociated substances and solids from the continuous fluid stream. In other words, SSAs **12**, **712**, **912** only use sonic waves to remove and separate dissociated substances and solids from the continuous fluid stream as compared to common operations and practices using ancillary chemicals, membrane or other additives.
[0204] It should be understood that any transducer described and illustrated herein may transmit

sonic and/or ultrasonic frequencies to create standing waves in a SDA described and illustrated or traveling waves in a SSA described and illustrated herein. Additionally, the transducers described and illustrated herein may transmit waves from sonic frequencies that are within or below the audible frequencies.

[0205] Moreover, it should be understood that generator output signals outputted to transducers described and illustrated herein may be at any frequencies when transmitting traveling waves into SDAs described and illustrated and when transmitting standing waves into SSAs described and illustrated herein. In one exemplary embodiment, generator output signals outputted to transducers described and illustrated herein may be at fixed frequencies at desired fixed frequencies and amplitudes when transmitting traveling waves into SDAs described and illustrated and when transmitting standing waves into SSAs described and illustrated herein. In one exemplary embodiment, generator output signals outputted to transducers described and illustrated herein may be at modulated frequencies over a desired range of frequencies and amplitudes when transmitting traveling waves into SDAs described and illustrated and when transmitting standing waves into SSAs described and illustrated herein.

[0206] FIG. **8** illustrates a method **1100** of eviscerating contaminants in a continuous fluid stream. An initial step **1102** of method **1100** comprises pumping at least one continuous fluid stream into a fluid treatment apparatus, wherein the at least one continuous fluid stream includes contaminants. Another step **1104** comprises guiding the at least one continuous fluid stream, via at least one inlet connection, into at least one insert of the fluid treatment apparatus. Another step **1106** comprises generating sonic waves, via a transducer of the apparatus, inside of a housing of the fluid treatment apparatus, wherein the transducer is positioned at a distance away from the at least one insert. Another step **1108** comprises cavitating a continuous sonic stream inside of the housing. Another step **1110** comprises cavitating the at least one continuous fluid stream inside of the at least one insert, wherein the at least one continuous fluid stream is isolated from the continuous sonic stream. Another step **1112** comprises eviscerating the contaminants in the at least one continuous fluid stream.

[0207] In an exemplary embodiment, method **1100** may include additional steps of eviscerating contaminants in a continuous fluid stream. An optional step includes directing the at least one continuous fluid stream with eviscerated contaminants, via at least one outlet connection, to at least one output device. An optional step includes directing the at least one continuous fluid stream with eviscerated contaminants, via a second outlet connection, to a second output device. Optional steps include pumping a second continuous fluid stream into the fluid treatment apparatus, wherein the second continuous fluid stream includes one of contaminants and eviscerated contaminants; guiding the second continuous fluid stream, via a second inlet connection, into a second insert of the fluid treatment apparatus; cavitating the second continuous fluid stream inside of the at least one insert, wherein the at least one continuous fluid stream is isolated from the continuous sonic stream; eviscerating one of the contaminants and the eviscerated contaminants in the second continuous fluid stream; and directing the second fluid stream with eviscerated contaminants, via a second outlet connection, to a second output device. An optional step includes directing the at least one continuous fluid stream, via at least one director, in one of a non-laminar flow and a laminar flow.

[0208] FIG. **9** illustrates a method **1200** a method of removing solid concentrates from a fluid stream. An initial step **1202** of method **1200** comprises pumping the fluid stream into a tower of a solids separation apparatus, wherein the fluid stream includes solid concentrates of at least one configuration. Another step **1204** comprises generating a standing sonic wave, via a transducer of the solids separation apparatus, inside of the tower. Another step **1206** comprises reflecting the standing sonic wave, via a reflector of the solids separation apparatus, to the transducer. Another step **1208** comprises adjusting one or both of the transducer and the reflector. Another step **1210** comprises forcing the solid concentrates of the at least one configuration in the fluid stream, via the standing sonic wave, into the at least one set of ports of at least one removal stage of the tower. Another step **1212** comprises removing the solid concentrates of the at least one configuration from the fluid stream into the at least one set of ports.

[0209] In an exemplary embodiment, method **1200** may include additional steps of removing solid concentrates from a fluid stream. An optional step comprises directing the solid concentrates of the at least one configuration, via an effluent outlet, from the tower to at least one effluent output. An optional step comprises transferring the standing sonic wave, via a diaphragm, from the at least one solids removal stage to a second solids removal stage of the tower. An optional step comprises directing the fluid stream, via at least one plumbing member, from the first solids separation stage of the tower to a second solids separation stage of the tower. An optional step comprises moving at least one set of shutters along an interior wall of the tower to control the flow rate of the fluid stream in the tower. Optional steps comprise forcing solid concentrates of a second configuration in the fluid stream, via the standing sonic wave, into a second set of ports of the second stage of the tower, wherein the solid concentrates of a second configuration are smaller than the solid concentrates of the at least one configuration; and removing the solid concentrates of the second configuration from the fluid stream into second set of ports. An optional step comprises directing the solid concentrates of the second configuration, via a second effluent outlet, from the tower to a second effluent output. An optional step comprises that wherein the step of adjusting the one or both of the transducer and the reflector further includes anti-nodes of the standing sonic wave transmitted by the transducer are aligned with at least one set of ports defined in the tower.

[0210] FIG. **10** illustrates a method **1300** of separating contaminants from a continuous fluid. An initial step **1302** of the method **1300** comprises pumping at least one continuous fluid stream into a fluid treatment apparatus, wherein the at least one continuous fluid stream includes contaminants. Another step **1304** comprises generating a traveling sonic wave, via a transducer of the apparatus, inside of a housing of the fluid treatment apparatus. Another step **1306** comprises cavitating the at least one continuous fluid stream inside of the at least one insert, wherein the at least one continuous fluid stream is isolated from the continuous sonic stream. Another step **1308** comprises eviscerating the contaminants in the at least one continuous fluid stream. Another step **1310** comprises pumping the at least one continuous fluid stream into a tower of a solids separation apparatus, wherein the fluid stream includes eviscerated contaminants of at least one configuration. Another step **1312** comprises generating a standing sonic wave, via a transducer of the solids separation apparatus, inside of the tower. Another step **1314** adjusting one or both of the transducer and the reflector. Another step **1316** comprises forcing the eviscerated contaminants of the at least one configuration, via the standing sonic wave, into the at least one set of ports of at least one removal stage of the tower. Another step **1318** comprises removing the eviscerated contaminants of the at least one configuration from the fluid stream into the at least one set of ports.

[0211] In an exemplary embodiment, method **1200** may include additional steps of separating contaminants from a continuous fluid. Optional steps may include pumping the at least one continuous fluid stream into a second fluid treatment apparatus; generating a second traveling sonic wave, via a second transducer of the second fluid treatment apparatus, inside of a second housing of the second fluid treatment apparatus; cavitating the at least one continuous fluid stream inside of a second insert, wherein the at least one continuous fluid stream is isolated from a second continuous sonic stream; and eviscerating the contaminants in the at least one continuous fluid stream. An optional step may include transferring the standing sonic wave, via a diaphragm, from the at least one solids removal stage to a second solids removal stage of the tower. An optional step may include directing the fluid stream, via at least one plumbing member, from the first solids separation stage of the tower to a second solids separation stage of the tower. Optional steps may include forcing eviscerated contaminants of a second configuration in the fluid stream, via the standing sonic wave, into a second set of ports of the second stage of the tower, wherein the eviscerated contaminants of a second configuration are smaller than the eviscerated contaminants of the at least one configuration; and removing the eviscerated contaminants of the second configuration from the fluid stream into second set of ports. An optional step comprises that wherein the step of adjusting the one or both of the transducer and the reflector further includes anti-nodes of the standing sonic wave transmitted by the transducer are aligned with at least one set of ports defined in the tower.

[0212] FIGS. **11** and **12** illustrate a fluid treatment loop system **1400** (hereinafter loop system **1400**) that is configured to treat resultant permeate and effluent discharges from processing a fluid based medium to remove dissociated and total dissolved solids resulting from desalination processes. As described below, the effluent discharges created in the fluid treatment loop system **1400** is a concentrated waste stream that will be referred herein as “brine.” The following disclosure relates to at least one system and at least one method of processing brine and processing clean water generated from the at least one desalination process. The following disclosure also relates to at least one system and at least one method of reclaiming viable materials and/or minerals entrained in a wastewater source fluid through multiple treatment processes that are in fluid communication with the at least one desalination process.

[0213] Referring to FIG. **11**, at least one inflow source stage or wastewater stage **1402** is provided in the fluid treatment loop system **1400**. In the illustrated loop system **1400**, the at least one inflow source stage **1402** is a seawater source that may provide contaminated and/or salt water streams in the fluid treatment loop system **1400**. In other exemplary embodiments, the inflow source stage **1402** may include any brine compositions and/or contaminated fluid source that is desired to be treated by the fluid treatment loop system **1400**. Examples of suitable streams source with brine compositions and/or contaminated fluid include process water from various processing industries (e.g., manufacturing, mining, agriculture, medical, and other various processing industries producing fluid with brine compositions), brackish water streams, gray water streams, runoff water streams, salt water streams and/or sources, and other various fluid streams and/or sources that include brine compositions.

[0214] Still referring to FIG. **11**, at least one inflow source connection **1404** provides fluid communication between the inflow source stage **1402** and at least one desalination source process cell stage, which is described in more detail below. In the illustrated embodiment, a first inflow source connection **1404**A and a second inflow source connection **1404**B provide fluid communication between the at least one inflow source stage **1402** and the at least one desalination source process cell stage of the fluid treatment loop system **1400**. In the illustrated embodiment, the first inflow source connection **1404**A may provide a fluid stream that include brine compositions, and the second inflow source connection **1404**B may provide a salt water stream from a seawater source. Such desalination processing of the brine compositions and the salt water by at least one desalination source process cell stage is described in more detail below.

[0215] Still referring to FIG. **11**, the fluid treatment loop system **1400** includes at least one desalination or acoustic source process cell stage (hereinafter “SPCS”) generally referred to reference number **1406**. The at least one SPCS **1406** is configured for freshwater production and generation of brine waste effluent. As described in more detail below, a single SPCS **1406** is provided in the illustrated fluid treatment loop system **1400** for freshwater production and generation of brine waste effluent. In other exemplary embodiments, any suitable number of SPCSs may be used in a single fluid treatment loop system described and illustrated herein. In the illustrated loop system, the SPCS **1406** is also configured to perform acoustic desalination process (or ADP) to produce freshwater permeate fluid streams and brine water effluent fluid streams. In other exemplary embodiments, any other conventional desalinations processes may be used to produce freshwater permeate fluid streams and brine water effluent fluid streams.

[0216] The SPCS **1406** includes at least one SDA **1408** for dissociating and eviscerating brine compositions and/or minerals in the salt water found in the seawater stream. In the illustrated embodiment, the SPCS **1406** includes a first SDA **1408**A and a second SDA **1408**B for dissociating and eviscerating brine compositions and/or minerals in the salt water found in the seawater stream. As illustrated in FIG. **11**, the first SDA **1408**A is configured to perform a first dissociation and/or evisceration process during operation for dissociating and eviscerating brine compositions and/or minerals in the salt water found in the seawater stream. The second SDA **1408**B is configured to perform a second, separate dissociation and/or evisceration process during operation for dissociating and eviscerating brine compositions and/or minerals in the salt water found in the seawater stream, which is described in more detail below. As illustrated herein, the second SDA **1408**B performs the second, separate dissociation and/or evisceration process subsequent to first dissociation and/or evisceration process by the first SDA **1408**A.

[0217] The first SDA **1408**A and the second SDA **1408**B may be any suitable SDA described and illustrated herein based on the specific application, specifically SDA **10**, **210**, **310**, **410**, **510**, **610**, **710**, and **910** described and illustrated herein and any other suitable and available SDAs. As illustrated, the first SDA **1408**A and the second SDA **1408**B are in communication with one another inside of the SPCS **1406** via at least one SSA, which is described in more detail below. In other exemplary embodiment, a first SDA and a second SDA of a SPCS may be directly in fluid communication with one another based on the desired operation of the SPCS of a fluid treatment loop system (e.g., the second SDA may perform a second dissociation and/or evisceration process on the fluid stream subsequent to the first SDA performing a first dissociation and/or evisceration process on the fluid stream where the first SDA and the second SDA are directly connected with one another). Additionally, while the first SDA **1408**A and the second SDA **1408**B are illustrated as being separate SDAS, the first and second SDAs **1408**A, **1408**B may also be a single, unitary SDA that is configured to perform first and second dissociation processes on fluid streams (e.g., SDA **510**).

[0218] The SPCS **1406** includes at least one SSA stage **1410** in an SSA for removing the dissociated brine compositions and/or minerals from the fluid stream and producing freshwater. In the illustrated embodiment, the SPCS **1406** includes a first SSA stage **1410**A and a second SDA **1410**B in a single SSA for removing the dissociated brine compositions and/or minerals from the fluid stream and producing freshwater. As illustrated in FIG. **11**, the first SSA stage **1410**A is configured to perform a first removal process by removing dissociated and eviscerated brine compositions and/or minerals from the stream (i.e., producing brine water effluent streams) to produce freshwater (i.e., producing freshwater permeate streams). The second SSA stage **1410**B is configured to perform a second removal process by further removing dissociated and eviscerated brine compositions and/or minerals from the stream that passed through the first SSA stage **1410**A to produce freshwater. As illustrated herein, the second SSA stage **1410**B performs the second, separate removal process subsequent to first removal process performed by the first SSA stage **1410**A.

[0219] The first SSA stage **1410**A and the second SSA stage **1410**B in the single SSA may be any suitable SSA described and illustrated herein based on the specific application, specifically SSAs **12**, **712**, and **912** described and illustrated herein and any other suitable and available SDAs. As illustrated, the first SSA stage **1410**A and the second SSA stage **1410**B are in communication with one another inside of the SPCS **1406** via the second SDA **1408**B. In other exemplary embodiment, a first SSA and a second SSA of a SPCS may be directly in fluid communication with one another based on the desired operation of the SPCS of a fluid treatment loop system (e.g., the second SSA may perform a second removal process on the fluid stream subsequent to the first SSA performing a first removal process on the fluid stream where the first SSA is directly in fluid communication with the second SSA).

[0220] Still referring to FIG. **11**, at least one SPCS connection **1412** may operably connect the at least one SDA **1408** with the at least one SSA **1410**. In the illustrated embodiment, a first SPCS connection **1412**A operably connects a fluid outlet of the first SDA **1408**A with a fluid inlet of the first SSA stage **1410**A to provide fluid communication between the first SDA **1408**A and the first

SSA stage **1410**A. In the loop system **1400**, the first SPCS connection **1412**A transports and/or communicates the fluid having the dissociated and eviscerated brine compositions and/or minerals, via the first dissociation and eviscerated process of the SDA **1408**A, from the first SDA **1408**A to the first SSA stage **1410**A. With this communication, the first SSA stage **1410**A is configured to remove the dissociated and eviscerated brine compositions and/or minerals from the fluid, via the first removal process, and produce freshwater, which is described in more detail below.

[0221] Still referring to FIG. **11**, the loop system **1400** also includes a second SPCS connection **1412**B that operably connects a fluid outlet of the first SSA stage **1410**A with a fluid inlet of at least one mining process cell stage provided in the loop system **1400**, which is described in more detail below. The second SPCS connection **1412**B transports and delivers an effluent and/or brine stream from the first SSA stage **1410**A to the at least one mining process cell stage provided in the loop system **1400** for mining process separate from the desalination process performed by the SPCS **1406**. As such, the effluent and/or brine stream is a concentrated brine stream that has solid concentrates or dissolved concentrates that are removed and/or separated from freshwater inside of the first SSA stage **1410**A. Such removal and separation of the concentrated brine from freshwater inside of the first SSA stage **1410**A as previously described above.

[0222] Still referring to FIG. **11**, the loop system **1400** also includes a third SPCS connection **1412**C that operably connects another fluid outlet of the first SSA stage **1410**A with a fluid inlet of the second SDA **1408**B to provide fluid communication between the second SDA **1408**B and the first SSA stage **1410**A. In the loop system **1400**, the third SPCS connection **1412**C transports and/or communicates the fluid with remaining dissociation and eviscerated effluent, via the first removal process of the first SSA stage **1410**A, from the first SSA stage **1410**A to the second SDA **1408**B. With this communication, the second SDA **1408**B is configured perform a second dissociation and/or evisceration process on the stream to further dissociate and/or eviscerate any remaining brine compositions and/or solid concentrates remaining in the fluid for freshwater production.

[0223] Still referring to FIG. **11**, the loop system **1400** also includes a fourth SPCS connection **1412**D that operably connects a fluid outlet of the second SDA **1408**B with a fluid inlet of the second SSA stage **1410**B to provide fluid communication between the second SDA **1408**B and the second SSA stage **1410**B. In the loop system **1400**, the fourth SPCS connection **1412**D transports and/or communicates the fluid having the remaining dissociated and eviscerated brine compositions and/or minerals, via the second dissociation and eviscerated process of the SDA **1408**A, from the second SDA **1408**B to the second SSA stage **1410**B. With this communication, the second SSA stage **1410**B is configured to remove the remaining dissociated and eviscerated brine compositions and/or minerals from the fluid, via the second removal process, to produce freshwater, which is described in more detail below.

[0224] Still referring to FIG. **11**, the loop system **1400** also includes a fifth SPCS connection **1412**E that operably connects a fluid outlet of the second SSA stage **1410**B with another fluid inlet of the at least one mining process cell stage provided in the loop system **1400**, which is described in more detail below. The fifth SPCS connection **1412**E transports and delivers an effluent and/or brine stream from the second SSA stage **1410**B to the at least one mining process cell stage provided in the loop system **1400** for mining processes separate from the desalination process performed by the SPCS **1406**. As such, the effluent and/or brine stream is a concentrated brine stream that has solid concentrates or dissolved concentrates that are removed and/or separated from freshwater inside of the second SSA stage **1410**B.

[0225] Still referring to FIG. **11**, the loop system **1400** also includes a sixth SPCS connection **1412**F that operably connects another fluid outlet of the second SSA stage **1410**B with at least one permeate outlet of the loop system **1400**, which is described in more detail below. The sixth SPCS connection **1412**F transports and/or delivers freshwater produced by the second removal process of the second SSA stage **1410**B along with the processes performed by previous first SDA **1408**A, the

second SDA **1408**B, and the first SSA stage **1410**A, to the at least one permeate outlet of the loop system **1400**. Similarly, the loop system **1400** also includes a seventh SPCS connection **1412**G that operably connects another fluid outlet of the second SSA stage **1410**B with at least another permeate outlet of the loop system **1400**, which is described in more detail below. The seventh SPCS connection **1412**G transports and/or delivers freshwater produced by the second removal process of the second SSA stage **1410**B along with the processes performed by previous first SDA **1408**A, the second SDA **1408**B, and the first SSA stage **1410**A, to the at least another permeate outlet of the loop system **1400**. Such permeate outlets provided in the loop system **1400** is described in more detail below.
[0226] Still referring to FIG. **11**, the loop system **1400** also includes at least one mining process cell stage (hereinafter "MPCS") for mining and extracting concentrated minerals and matter that are desired and/or valuable for stages inside of the loop system **1400** and for products separate from the loop system **1400**. In other words, the at least one MPCS is configured to recover minerals and/or products that may be used for generating byproducts viable for separate operations and processes remote from the loop system **1400**. In the illustrated embodiment, a first MPCS **1414** ("hereinafter MPCS**1** **1414**") is operably connected with the SPCS **1406** via the second SPCS connection **1412**B and the fifth SPCS connection **1412**E. More particular, the first MPCS**1** **1414** is operably connected with the first SSA stage **1410**A of the SPCS **1406**, via the second SPCS connection **1412**B, and operably connected with the second SSA stage **1410**B of the SPCS **1406** via the fifth SPCS connection **1412**E.
[0227] It should be understood that any conventional methods and/or techniques may be used with a MPCS (e.g., MPCS**1**) described and illustrated herein for mining and extracting concentrated and valuable minerals from the brine composition and/or effluent streams outputted by the SPCS **1406**. As such, any suitable machines, apparatuses, systems, and/or devices may be used to perform the conventional mining and extracting operations for mining and extracting concentrated and valuable minerals from the brine composition and/or effluent streams outputted by the SPCS **1406**. Examples of suitable processes for mining and extracting desired minerals from brine concentrate and effluent streams include electrodialysis, reverse osmosis with electrodialysis, membrane distillation, membrane distillation crystallization, adsorption and/or desorption crystallization, evaporation and/or crystallization, and any other suitable processes of the like for mining and extracting desired minerals from brine concentrate and effluent streams.
[0228] It should also be understood that the desalination processes performed by the SDAs **1408**A, **1408**B and the SSAs **1410**A, **1410**B of the SPCS **1406** provides the MPCS**1** **1414** with a brine concentrate and/or effluent concentrate due to the dissociations processes, performed by the SDAs **1408**A, **1408**B, and the removal and/or separation processes of the brine compositions and/or solids concentrate from freshwater, performed by the SSAs **1410**A, **1410**B. With such processes, the MPCS**1** **1414** is able to immediately use the brine compositions and/or solids concentrate from the SPCS **1406** due to the fluid already being in concentrate form. As such, the MPCS**1** **1414** is enabled to perform immediate mining and extraction operations of the concentrated brine and minerals that may be useful for auxiliary methods and systems provided in the loop system **1400**. Such immediate mining and extraction operations by the MPCS**1** **1414** may lower economic costs and additional power expenditures of the MPCS**1** **1414** due to the fluid already being in concentrate form via the SPCS **1406**.
[0229] It should also be understood that the MPSC**1** **1414** may be configured to mine and extract certain and/or desired minerals from the brine and/or effluent fluid stream received by the MPCS**1** **1414** from both the SPCS **1406** and the brine system **1416**. Such minerals specifically mined and extracted by the MPSC**1** **1414** may be viable for stages in the loop system **1400**, which are described in more detail below, or may be sold for economic gain separate from the loop system **1400** (e.g., selling raw material to others in the related fields). Examples of suitable minerals mined and extracted by a MPSC**1** from the brine and/or effluent fluid stream received by the MPCS**1** from

both a SPCS and a brine system include sodium, magnesium, calcium, potassium, strontium, chloride, sulfate, bicarbonate, bromine, borate, fluorine, boron, lithium, uranium, and other suitable minerals mined and extracted by a MPSC**1** from the brine and/or effluent fluid stream received by the MPCS**1** from both a SPCS and a brine system.

[0230] In addition, the loop system **1400** may include a brine system **1416** operably connected with the MPSC**1** **1414** and separate and independent of the SPCS **1406**. As illustrated in FIG. **11**, the brine system **1416** includes a brine source and/or outlet **1418** that is configured to provide brine from conventional desalination processes different than the desalination processes described and illustrated in the SPCS **1406**. A brine connection **1419** of the brine system **1416** also operably connects a fluid output of the brine source **1418** with a fluid inlet of a brine concentration process cell stage (hereinafter CPCS) **1420** of the brine system **1416**. The CPCS **1420** is configured to provide concentrated brine transported and delivered from the brine source **1418**. As such, the CPCS **1420** may use any conventional processes and/or methods to provide concentrated brine in either a continuous processing stage or in batch processing stages. A brine concentration connection **1421** of the brine system **1416** also operably connects a fluid outlet of the CPCS **1420** with another fluid inlet of the MPCS**1** **1414**. Such fluid communication between the CPCS **1420** and the MPCS**1** **1414**, via the brine concentration connection **1421**, enables the MPCS**1** **1414** to further mine and extract concentrated minerals and matter that are desired and/or valuable for auxiliary products, which are described in more detail below. In other words, the MPCS**1** **1414** is configured to recover minerals and/or products that may be used for generating byproducts viable for separate operations and processes from the brine concentrated generated by the CPCS **1420**, which are also described in more detail below.

[0231] It should be understood that any conventional methods and/or techniques may be used with a CPCS (e.g., CPCS **1420**) described and illustrated herein for providing brine concentrate. As such, any suitable machines, apparatuses, systems, and/or devices may be used to perform suitable operations concentration processes for providing brine concentrate from a brine mixture. Examples of suitable processes to achieve dissociation and removal of brine compositions and/or solids concentrates from a water source include acoustic desalination process, direct contact membrane distillation, electrodialysis, electrodialysis reversal, forward osmosis, multi-effect distillation, multistage flash distillation, reverse osmosis, vapor compression distillation, and other suitable process to achieve dissociation and removal of brine compositions and/or solids concentrates from a water source.

[0232] As discussed above, at least one permeate outlet may be operably engaged with the SPCS **1406** for receiving permeate water from the SPCS **1406**. In the illustrated loop system **1400**, a first permeate outlet **1424** operably connects with the SPCS **1406** via the sixth SPCS connection **1412**F. Specifically a fluid inlet of the first permeate outlet **1424** operably connects with another fluid outlet of the second SSA stage **1410**B via the sixth SPCS connection **1412**F. The sixth SPCS connection **1412**F transports and/or delivers permeate water and/or freshwater produced by the second removal process of the second SSA stage **1410**B to the first permeate outlet **1424**. In the illustrated loop system **1400**, a second permeate outlet **1426** also operably connects with the SPCS **1406** via the seventh SPCS connection **1412**G. Specifically, a fluid inlet of the second permeate outlet **1426** operably connects with another fluid outlet of the second SSA stage **1410**B via the seventh SPCS connection **1412**G. The seventh SPCS connection **1412**G transports and/or delivers permeate water and/or freshwater produced by the second removal process of the second SSA stage **1410**B to the second permeate outlet **1426**.

[0233] Referring back to MPCS**1** **1414** in FIG. **11**, the MPCS**1** **1414** may transport and/or output extracted concentrated and minerals and/or via at least one mined connection **1428** to various stages and/or outputs provided in the loop system **1400** for various auxiliary products and/or productions provided in the loop system **1400**. Such connection between the MPSC**1** **1414** and various stages and/or outputs provided in the loop system **1400** are described in more detail below.

[0234] In one instance, a first mined connection **1428**A may operably connect a fluid outlet of the MPCS**1 1414** with a fluid inlet of at least one permeate outlet of the loop system **1400**, specifically to the second permeate outlet **1426**. In this instance, the first mined connection **1428**A is configured to transport a chloride solution from the MPCS**1 1414** to the second permeate outlet **1426** to treat and/or polish freshwater permeate to produce potable water; as described above, chloride is one of the mined and extracted minerals from the brine and/or effluent fluid stream received by the MPCS**1 1414** from both the SPCS **1406** and the brine system **1416**. It should be noted that this first mined connection **1428**A is optional and may be omitted from the loop system **1400** if desired based on various considerations, including the implementation or layout of the loop system **1400**.

[0235] In another instance, a second mined connection **1428**B may operably connect a fluid outlet of the MPCS**1 1414** with a fluid inlet of at least one battery process cell stage of the loop system **1400**, which is described in more detail below. In this instance, the second mined connection **1428**B is configured to transfer a brine solution with sodium chloride from the MPCS**1 1414** to the at least one battery process cell stage of the loop system **1400**; the sodium chloride transferred to the at least one battery process cell stage of the loop system **1400** is mined and extracted by the MPCS**1 1414** during conventional mining operations from the brine and/or effluent fluid stream received by the MPCS**1 1414** from both the SPCS **1406** and the brine system **1416**.

[0236] In another instance, a third mined connection **1428**C may operably connect another fluid outlet of the MPCS**1 1414** to a fluid inlet of at least one hydrogen fuel cell generator process cell stage of the loop system **1400**, which is described in more detail below. In this instance, the third mined connection **1428**C is configured to send a brine solution with sodium chloride from the MPCS**1 1414** to the at least one hydrogen process cell stage of the loop system **1400**. In the illustrated loop system **1400**, the brine solution with sodium chloride transported to the at least one hydrogen fuel cell generator process cell stage via the third mined connection **1428**C is reduced and/or more diluted than the brine solution with sodium chloride transported to the at least one battery process cell stage via the second mined connection **1428**B; the sodium chloride transferred to the at least one hydrogen fuel cell generator process cell stage of the loop system **1400** is also mined and extracted by the MPCS**1 1414** during conventional mining operations from the brine and/or effluent fluid stream received by the MPCS**1 1414** from both the SPCS **1406** and the brine system **1416**.

[0237] In another instance, a fourth mined connection **1428**D may operably connect another fluid outlet of the MPCS**1 1414** to a fluid inlet of the inflow source stage **1402**. In this instance, the brine concentrate and minerals that are not viable and/or not useful for downstream processes in the loop system **1400** may be outputted to the inflow source stage **1402**, via the fourth mined connection **1428**D, for further dissociation and separation processes by the DSPC **1406** (which are described above).

[0238] Still referring to FIG. **11**, the first permeate outlet **1424** is also operably connected with a freshwater channel **1430** via a freshwater connection **1431**. More particular, a fluid outlet of the first permeate outlet **1424** is operably connected with a fluid inlet of the freshwater channel **1430** via the freshwater connection **1431**. The freshwater channel **1430** may be operably connected with various freshwater applications and outlets (such as freshwater outlet **1464**) for providing freshwater based on various considerations, including the location, environment, and climate of the loop system. Examples of suitable freshwater applications for outputting freshwater produced by the loop system **1400** via the SPCS **1406** include interconnected regional and/or national water grids, drip irrigation system for expanded agriculture use, drip irrigation for reforestation and carbon dioxide capture, replenishment of water storage and reservoirs, expansion of inhabited, stressed areas, improved living conditions in semi-arid areas, development of arid areas for suitable living conditions, eliminated invasive species and/or micro-organisms in specific regions and/or areas, provide process water for industries, other various applications of the like that may benefit from and/or utilize freshwater produced by the loop system **1400** via the SPCS **1406**.

[0239] Still referring to FIG. **11**, the second permeate outlet **1426** is also operably connected with a potable water channel **1432** via a potable water connection **1433**. More particular, a fluid outlet of the second permeate outlet **1426** is operably connected with a fluid inlet of the potable water channel **1432** via the potable water connection **1433**. The potable water channel **1432** may be stored in any suitable storage structure and/or reservoir that allows for the consumption of the potable water. At this stage, the potable water provided in the potable water channel **1432** is safe for human consumption either for drinking, food preparation, and/or conventional human uses of potable water.

[0240] Still referring to FIG. **11**, the loop system **1400** also includes an electrical controller (hereinafter "EC") generally referred to as **1434**. EC **1434** is configured to provide electrical power and control to each stage provided in the loop system **1400**. The illustrated EC **1434** is powered by an external power source **1436** which provides power to the EC **1434** and all stages and/or systems provided in the loop system **1400**. Such external power source may be any suitable power source that provides a suitable amount of power to power stages of a loop system and to power an EC to control each stage of the loop system. Examples of suitable external power sources include electrical grid power, solar power, wind power, natural gas power, hydro power, hydrogen power, nuclear power, and any other renewable or non-renewable suitable power that is capable of providing a suitable amount of power to each stage of a loop system and to power an EC to control each stage of the loop system. While the EC **1434** and the external power source **1436** are illustrated as separate components, an EC and a power source may be a single, unitary device for reducing the size and configuration of the EC and the power source.

[0241] Still referring to FIG. **11**, at least one electrical connection **1438** is provided to electrically connect the external power source **1436** with the EC **1434** and at least one stage of the loop system **1400**. In the illustrated embodiment, a first electrical connection **1438**A electrically connects the external power source **1436** with EC **1434**. More particularly, the first electrical connection **1438**A electrically connects an electrical input of the EC **1434** with an electrical output of the external power source **1436**. The first electrical connection **1438**A provides the power generated by the external power source **1436** to the EC **1434** and to the stages provided in the loop system **1400**.

[0242] Still referring to FIG. **11**, at least another electrical connection **1438** may electrically connect the EC **1434** with at least one stage provided in the loop system **1400**. In the illustrated loop system **1400**, a second electrical connection **1438**B electrically connects the EC **1434** with the SPCS **1406**. More particularly, the second electrical connection **1438**B electrical connects an electrical output of the EC **1434** with the SPCS **1406**. With the second electrical connection **1438**B, each of the first SDA **1408**A, the second SDA **1408**B, the first SSA stage **1410**A, and the second SSA stage **1410**B is powered by the external power source **1436** and is electrically controlled by the EC **1434**. As such, the EC **1434** is configured to individually control the first SDA **1408**A, the second SDA **1408**B, the first SSA stage **1410**A, and the second SSA stage **1410**B during fluid treatment operations.

[0243] Still referring to FIG. **11**, a third electrical connection **1438**C electrically connects the EC **1434** with at least one hydrogen process cell stage of the loop system **1400**, which is described in more detail below. More particularly, the third electrical connection **1438**C electrical connects another electrical output of the EC **1434** with the at least one hydrogen process cell stage of the loop system **1400**. With this third electrical connection, the at least one hydrogen process cell stage of the loop system **1400** is electrically powered by the external power source **1436** and electrically controlled by the EC **1434**.

[0244] Still referring to FIG. **11**, a fourth electrical connection **1438**D electrically connects the EC **1434** with at least battery process cell stage of the loop system **1400**, which is described in more detail below. More particularly, the fourth electrical connection **1438**D electrical connects another electrical output of the EC **1434** with the at least one battery process cell stage of the loop system **1400**. With this fourth electrical connection, the at least one battery process cell stage of the loop system **1400** is electrically powered by the external power source **1436** and electrically controlled by the EC **1434**.

[0245] It should be understood that conventional electrical components and/or devices are included with the EC **1434** for providing electrical power to specific stages of the loop system **1400** and for providing control over the specific stages of the loop system **1400** via the EC **1434**.

[0246] Referring now to FIG. **12**, the loop system **1400** also includes at least one battery process cell stage (hereinafter BPCS) generally referred to as **1440**. In the illustrated loop system **1400**, a single BPCS **1440** is provided. In other exemplary embodiments, any suitable number of BPCSs may be provided in a loop system for various considerations, including the size and/or production capability of viable minerals provided in the brine solution. As described in more detail below, the BPCS **1440** is configured to produce minerals such as hydrogen, sodium hydroxide, chlorine, and/or hydrochloric acid from the brine composition transferred from the MPCS**1 1414**; such use and purpose of these minerals produced by the BPCS **1440** is described in more detail below. It should be understood that that BPCS **1440** may use any suitable process in achieving the functions provided in the BPCS **1440**, including electrosynthesis, electrolysis, and other viable processes in achieving the functions provided in the BPCS **1440**.

[0247] As previously described, the BPCS **1440** is operably connected with the MPCS**1 1414** via the second mined connection **1428**B. More particularly, as shown in FIGS. **11** and **12**, a fluid input of the BPCS **1440** is operably connected with a fluid outlet of the MPCS**1 1414** via the second mined connection **1428**B. As described previously, the second mined connection **1428**B transports and delivers brine with sodium chloride to the BPCS **1440** for operational use. Such sodium chloride delivered to the BPCS **1440** may be used to replace depleted brine electrolyte with brine with sodium chloride mined by the MPCS**1 1414**.

[0248] Still referring to FIG. **12**, the BPCS **1440** is electrically connected with the EC **1434** via the fourth electrical connection **1438**D. As previously described above, the fourth electrical connection between the EC **1434** and the BPCS **1440** enables the power source **1436** to provide power to the BPCS **1440**, via the EC **1434**, and enables EC **1434** to operably control the BPCS **1440** during operation (e.g., operably control machines, apparatuses, devices, components, and other suitable devices provided in the BPCS **1440**).

[0249] Referring to FIGS. **11** and **12**, at least one battery process connection **1442** operably connects the BPCS **1440** with other stages and machines provided in the loop system **1400** for various reasons. In one instance, a first battery process connection **1442**A operably connects an electrical output of the BPCS **1440** with an input of the EC **1434**. Such connection between the BPCS **1440** and the EC **1434** enables the BPCS **1440** to transfer electricity generated by at least one hydrogen fuel cell generator process cell stage of the loop system and stored by the BPCS **1440** to the EC **1434**, which is described in more detail below.

[0250] Referring to FIG. **12**, a second battery process connection **1442**B operably connects a fluid output of the BPCS **1440** with another fluid input of MPCS **1 1414** and another fluid input of the inflow source stage **1402** to transport and deliver chlorine solution from the BPCS **1440** to the MPCS**1 1414** and to the inflow source stage **1402** separately. In this process connection, the second battery process connection **1442**B is split into a first portion **1442**B**1**, a second portion **1442**B**2**, and a third portion **1442**B**3** to transport and deliver chlorine solution from the BPCS **1440** to the MPCS**1 1414**, to the inflow source stage **1402**, and to the second permeate outlet **1426** separately. As such, the first portion **1442**B**1** of the second battery process connection **1442**B operably connects a fluid output of the BPCS **1440** with another fluid input of the MPCS**1 1414**. During operation, the chlorine transferred from the BPCS **1440** to the MPCS**1 1414** may be used for recovery action with other materials provided in the MPCS**1 1414**. Additionally, the second portion **1442**B**2** of the second battery process connection **1442**B transports and delivers chlorine solution from the BPCS **1440** to the inflow source stage **1402** for reducing seawater alkalinity and corrosion of system components provided in the loop system **1400**. Moreover, the third portion **1442**B**3** of the second battery process connection **1442**C transports and delivers chlorine solution from the BPCS **1440** to the second permeate outlet **1426** for treating and/or polishing freshwater permeate to produce potable water.

[0251] Still referring to FIG. **12**, a third battery process connection **1442**C operably connects another fluid output of the BPCS **1440** with a fluid input of at least one hydrogen process stage of the loop system **1400**, which is described in more detail below. The third battery process connection **1442**C is configured to transport and deliver additional electricity and/or energy from the BPCS **1440** to the at least one hydrogen process stage of the loop system **1400**.

[0252] Still referring to FIG. **12**, a fourth battery process connection **1442**D operably connects another fluid output of the BPCS **1440** with another fluid input of the inflow source stage **1402** via a concentrate line of the loop system **1400**, which is described in more detail below. The fourth battery process connection **1442**D is configured to transport and deliver hydrochloric acid solution from the BPCS **1440** to the inflow source stage **1402** for desired purposes, including reducing seawater alkalinity, reducing corrosion of system components, and selling the hydrochloric acid solution as a raw material to others in relevant fields.

[0253] Still referring to FIG. **12**, a fifth battery process connection **1442**E operably connects another fluid output of the BPCS **1440** with a fluid input of at least one hydrogen fuel cell generator process cell stage, a fluid input of at least one sodium hydroxide concentrate outlet and/or storage facility of the loop system **1400**, which is described in more detail below, and another fluid input of the inflow source stage **1402**. In this process connection, the fifth battery process connection **1442**E bifurcates into a first portion **1442**E**1** and a second portion **1442**E**2** to transport and deliver sodium hydroxide solution from the BPCS **1440** to the at least one sodium hydroxide concentrate outlet and to the inflow source stage **1402** separately. The first portion **1442**E**1** of the fifth battery process connection **1442**E operably connects the BPCS **1440** with the inflow source stage **1402** to transport and delivers sodium hydroxide solution to the inflow source stage **1402**. Additionally, the second portion **1442**E**2** of the fifth battery process connection **1442**E transports and delivers sodium hydroxide solution from the BPCS **1440** to the at least one sodium hydroxide concentrate outlet of the loop system **1400** for raw material storage and/or future use of sodium hydroxide in the loop system **1400**. Moreover, main connection of the fifth battery process connection **1442**E operably connects another fluid output of the BPCS **1440** with a fluid input of the GPCS **1444**. During operation, the sodium hydroxide solution transferred from the BPCS **1440** to the at least one hydrogen fuel cell generator process cell stage GPCS **1444** may be used for electrolyte purposes in the conventional processes and procedures used in at least one hydrogen fuel cell generator process cell stage GPCS **1444** (described in more detail below).

[0254] Still referring to FIG. **12**, a sixth battery process connection **1442**F operably connects another fluid output of the BPCS **1440** with another fluid input of at least one hydrogen fuel cell generator process cell stage of the loop system **1400**, which is described in more detail below. The sixth battery process connection **1442**F is configured to transport and deliver hydrogen solution from the BPCS **1440** to the at least one hydrogen fuel cell generator process cell stage of the loop system **1400** for desired purposes, including the supply of hydrogen for operating and using hydrogen fuel cells of the at least one hydrogen fuel cell generator process cell stage.

[0255] Still referring to FIG. **12**, a seventh battery process connection **1442**G operably connects another fluid output of the BPCS **1440** with a fluid input of a zero liquid discharge process cell stage of the loop system **1400**, which is described in more detail below. The seventh battery process connection **1442**G is configured to transport and deliver brine solution from the BPCS **1440** to the zero liquid discharge process cell stage of the loop system **1400** for desired purposes, including transferring depleted brine electrolyte to the zero liquid discharge process cell stage of the loop system **1400** for deliquifying purposes (which are described in more detail below).

[0256] It should be understood that the sodium hydroxide and chlorine produced by the BPCS **1440** may be used for other reasons outside of the loop system **1400**. Specifically, the sodium hydroxide and chlorine produced by the BPCS **1440** may be available for revenue generation and/or sold for raw materials to others in relevant fields.

[0257] Still referring to FIG. **12**, the loop system **1400** includes at least one hydrogen fuel cell generator process cell stage (hereinafter GPCS) generally referred to as **1444**. In the illustrated loop system **1400**, a single GPCS **1444** is used in this system. In other exemplary embodiment, any suitable number of GPCSs described and illustrated herein may be used in a loop system for various reasons, including the size and configuration of a loop system. As previously described, the GPCS **1444** is operably engaged with the EC **1434** and the BPCS **1440** for fluid and electrical connections.

[0258] Generally, the GPCS **1444** provides conventional functions and procedures necessary for a hydrogen fuel cell generator to operate and to produce electricity and brine solution for additional stages and/or processes in the loop system **1400**, which is described in more detail below. As such, conventional machines, assemblies, apparatuses, systems, and devices may be used to operate for a hydrogen fuel cell generator and to produce electricity and brine solution for additional stages and/or processes in the loop system **1400**. Examples of conventional and suitable hydrogen fuel cell generator methods and processes to be performed by a GPCS includes electrochemical redox reaction and other to perform for a hydrogen fuel cell generator.

[0259] As previously described, various process connections operably engage the GPCS **1444** with other various stages and components of the loop system **1400**. As such, fifth battery process connection **1442**E operably connects a fluid inlet of the GPCS **1444** with a fluid outlet of the BPCS **1440**. As stated previously, the fifth battery process connection **1442**E transports and delivers sodium hydroxide solution from the BPCS **1440** to the GPCS **1444** for use as an electrolyte for general and/or conventional hydrogen fuel cell generating processes. Additionally, the sixth battery process connection **1442**F also operably connects another fluid inlet of the GPCS **1444** with another fluid outlet of the BPCS **1440**. As stated previously, the sixth battery process connection **1442**F transports and delivers hydrogen solution from the BPCS **1440** to the GPCS **1444** for operating and using hydrogen fuel cells of the at least one hydrogen fuel cell generator process cell stage.

[0260] Still referring to FIG. **12**, the loop system **1400** includes at least one sodium hydroxide concentrate outlet generally referred to as **1446**. In the illustrated loop system **1400**, a single sodium hydroxide concentrate outlet **1446** is used in this system. In other exemplary embodiment, any suitable number of sodium hydroxide concentrate outlets described and illustrated herein may be used in a loop system for various reasons, including the size and configuration of a loop system. As previously described, the sodium hydroxide concentrate outlet is operably engaged with the BPCS **1440** for fluid connections. More particularly, the second portion **1442**E**2** of the fifth battery process connection **1442**E**3** operably connects the sodium hydroxide concentrate outlet **1446** with the BPCS **1440** for fluid communication. In the loop system **1400**, the sodium hydroxide concentrate outlet **1446** is configured to store raw sodium hydroxide solution for storage purposes and/or future use of sodium hydroxide solution in the loop system **1400**.

[0261] Still referring to FIG. **12**, the loop system **1400** also includes at least one generator process connection **1448** that operably connects the GPCS **1444** with other stages and/or components provided in the loop system **1400** for electrical and/or fluid purposes. The loop system **1400** includes a first generator process connection **1448**A that operably connects an output of the GPCS **1444** with an input of the BPCS **1440**. In the illustrated loop system **1400**, the first generator process connection **1448**A is configured to transfer and deliver electricity generated from the GPCS **1444** to the BPCS **1440**. Such electricity transferred from the GPCS **1444** to the BPCS **1440** is provided in storage for the BPCS **1440** where the BPCS **1440** and/or the EC **1434** may use such stored electricity if needed. The loop system **1400** includes a second generator process connection **1448**B that operably connects another output of the GPCS **1444** with an input of a zero liquid discharge process cell stage of the loop system **1400**, which is described in more detail below. The second generator process connection **1448**B is configured to transport and deliver depleted brine electrolyte to the zero liquid discharge process cell stage of the loop system **1400** for deliquifying processes and/or procedures, which is described in more detail below.

[0262] Still referring to FIG. **12**, the loop system **1400** also includes at least one hydrogen process cell stage (hereinafter "HPCS") generally referred to as **1450**. In the illustrated loop system **1400**, a single HPCS **1450** is provided in the system. In other exemplary embodiments, any suitable number of HPCSs described and illustrated herein may be used in a loop system for various reasons, including the size and configuration of a loop system. As previously described, the HPCS **1450** is operably connected with the MPCS**1 1414**, the EC **1434**, the BPCS **1440**, and the GPCS **1444**. As to the MPCS**1 1414**, the third mined connection **1428**C operably connects a fluid outlet of the MPCS**1 1414** with a fluid inlet of the HPCS **1450** to transport and deliver brine solution for hydrogen production processes conventionally performed by HPCS **1450**. As to the EC **1434**, the third electrical connection **1438**C electrically connects an electrical output of the EC **1434** with an electrical input of the HPCS **1450** to enable the EC to provide electrical power and control over the HPCS **1450** during operation. As to the BPCS **1440**, the third battery process connection **1442**C operably connects a fluid outlet of the BPCS **1440** with a fluid inlet of the GPCS **1444** to transport and deliver additional electricity and/or energy generated from the BPCS **1440**.

[0263] It should be understood that the HPCS **1450** may be configured with conventional methods and procedures for producing hydrogen in the illustrated loop system **1400**. As such, the HPCS **1450** is configured with conventional machines, assemblies, apparatuses, systems, and devices for performing conventional methods and procedures for producing hydrogen in the illustrated loop system **1400**. Examples of suitable and conventional methods and procedures used by a HPCS described and illustrated herein include alkaline electrolysis and other conventional methods and procedures used by a HPCS for producing hydrogen.

[0264] Still referring to FIG. **12**, the loop system **1400** also includes at least one hydrogen process connection operably connecting the HPCS **1450** with at least one stage or component provided in the loop system **1400**. In the illustrated loop system **1400**, a first hydrogen process connection **1452**A operably connects a fluid outlet of the HPCS **1450** with a fluid inlet of the GPCS **1444** for fluid processes. The first hydrogen process connection **1452**A in the loop system **1400** is configured to transfer and deliver hydrogen solution from the HPCS **1450** to the GPCS **1444** for operating and using hydrogen fuel cells of the GPCS **1444**. In the illustrated loop system **1400**, a second hydrogen process connection **1452**B operably connects another fluid outlet of the HPCS **1450** with a fluid inlet a zero liquid discharge process cell stage of the loop system **1400**, which is described in more detail below. The second hydrogen process connection **1452**B in the loop system **1400** is configured to transfer and deliver brine solution from the HPCS **1450** to the zero liquid discharge process cell stage of the loop system **1400**, which is also described in more detail below.

[0265] Still referring to FIG. **12**, the loop system **1400** also includes at least one zero liquid discharge process cell stage (hereinafter ZPCS) generally referred to as **1454**. The illustrated ZPCS **1454** is configured to deplete and reduce brine solution received from various stages and/or components in the loop system **1400**, particularly at the DPCS **1406**, for deliquifying processes.

[0266] In the illustrated ZPCS **1454**, the ZPCS **1454** includes a deliquify SDA/SSA **1456** apparatus that is configured to use acoustic desalination processes to deplete and reduce brine solution received from various stages and/or components in the loop system **1400**, including from the DPCS **1406**, while producing freshwater for numerous applications. Such operation of the deliquify SDA/SSA **1456** is described in more detail below.

[0267] The illustrated ZPCS **1454** also includes a mining process cell stage (hereinafter MPCS**2**) **1458** that is operably connected with the deliquify SDA/SSA **1456**. The MPCS**2 1458** is capable of recovering minerals and other valuable compositions that were failed to be recovered by the MPCS**1 1414** in earlier stages of the loop system **1400**. In other words, the brine transferred to the MPCS**2 1458** is the most concentrated brine fluid in the loop system **1400**. The illustrated ZPCS

1454 also includes a recover dispose output **1460** that is operably connected with the deliquify SDA/SSA **1456** and the MPCS**2** **1458**. The recover dispose outlet **1460** is configured to recover any crystals and/or solid concentrates that were not captured and/or recovered by any preceding stage in the loop system **1400**.

[0268] It should be understood that the ZPCS **1454** may use any suitable processes and/or procedures for depleting and reducing brine solution received from various stages and/or components in the loop system **1400**. As such, conventional machines, assemblies, apparatuses, systems, and devices may be used in the ZPCS **1454** for depleting and reducing brine solution received from various stages and/or components in the loop system **1400**. Examples of suitable processes performed by a ZPCS for depleting and reducing brine solution received from various stages and/or components in a loop system include acoustic desalination processes, multi-effect distillation, multistage flash distillation, adsorption, desorption, or crystallization, evaporation or crystallization, solar evaporation (e.g., field or saltern pans), vacuum evaporation, and any other suitable processes performed by a ZPCS for depleting and reducing brine solution received from various stages and/or components in a loop system

[0269] As previously described, various process connections of the loop system **1400** operably connect the ZPCS **1454** with other stages and components provided in the loop system **1400**. In the illustrated loop system **1400**, the seventh battery process connection **1442**G operably connects a fluid outlet of the BPCS **1440** with a fluid inlet of the deliquify SDA/SSA **1456** of the ZPCS **1454**. As previously described, the seventh battery process connection **1442**G is configured to transfer brine solution from the BPCS **1440** to the deliquify SDA/SSA **1456** of the ZPCS **1454** for depleting and reducing brine accumulated at the DPCS **1406** in the loop system **1400**. In the illustrated loop system **1400**, the second generator process connection **1448**B also operably connects a fluid outlet of the GPCS **1444** with another fluid inlet of the deliquify SDA/SSA **1456** of the ZPCS **1454**. As previously described, the second generator process connection **1448**B is configured to transfer brine solution from the GPCS **1444** to the deliquify SDA/SSA **1456** of the ZPCS **1454** for depleting and reducing brine accumulated at the DPCS **1406** in the loop system **1400**. In the illustrated loop system **1400**, the second hydrogen process connection **1452**B also operably connects a fluid outlet of the HPCS **1450** with another fluid inlet of the deliquify SDA/SSA **1456** of the ZPCS **1454**. As previously described, the second hydrogen process connection **1452**B is configured to transfer brine solution from the HPCS **1450** to the deliquify SDA/SSA **1456** of the ZPCS **1454** for depleting and reducing brine accumulated at the DPCS **1406** in the loop system **1400**.

[0270] Still referring to FIG. **12**, the loop system **1400** includes at least one discharge connection **1462** that operably connects the ZPCS **1454** with other stages and components provided in the loop system **1400**. In the illustrated loop system **1400**, a first discharge connection **1462**A operably connects a fluid outlet of the deliquify SDA/SSA **1456** with a fluid inlet of a freshwater outlet **1464**. The freshwater outlet **1464** may be operably connected with various freshwater applications for providing freshwater based on various considerations, including the location, environment, and climate of the loop system. Examples of suitable freshwater applications include interconnected regional and/or national water grids, drip irrigation system for expanded agriculture use, drip irrigation for reforestation and carbon dioxide capture, replenishment of water storage and reservoirs, expansion of inhabited, stressed areas, improved living conditions in semi-arid areas, development of arid areas for suitable living conditions, eliminated invasive species and/or micro-organisms in specific regions and/or areas, provide process water for industries, other various applications of the like that may benefit from and/or utilize freshwater.

[0271] Still referring to FIG. **12**, the illustrated loop system **1400** also includes a second discharge process connection **1462**B that operably connects another fluid outlet of the deliquify SDA/SSA **1456** with the MPCS**2** **1458**. Similar to the connection and function between the DPCS **1406** and the MPCS**1** **1414**, the deliquify SDA/SSA **1456** outputs minerals and other suitable solids concentrates removed from the freshwater to the MPCS**2 1458**, via the second discharge process connection **1462**B, for recovery of any valuable minerals for the loop system **1400** or for economic value. The MPCS**2 1458** may also transfer any crystals and/or solid concentrates to the recover dispose outlet **1460** that were not captured and/or recovered by any preceding stage in the loop system **1400**. Such crystals may also be safely returned to sea water and/or oceans or be disposed on land.

[0272] Still referring to FIG. **12**, the illustrated loop system **1400** also includes a third discharge process connection **1462**C (labeled "CONCENTRATE LINE" in FIG. **12**) that operably connects the deliquify SDA/SSA **1456** with another fluid inlet of the inflow source stage **1402**. The third discharge process connection **1462**C is configured to transfer and deliver brine solution and/or solids concentrate from the deliquify SDA/SSA **1456** to the inflow source stage **1402** to allow the DPCS **1406** to perform further desalination processes on brine solutions flowing through the loop system **1400**. Such transfer of the remaining brine solution may be reprocessed for further removal trace minerals, metals, and/or solids that may be escaped through the SPCS **1406** and the ZPCD **1454**.

[0273] As illustrated in FIG. **12**, various process connections in the illustrated loop system **1400** operably connect with the third discharge process connection **1462**C for transferring and/or removing brine solution from various stages. In one instance, the second portion **1442**B**2** of the second battery process connection **1442**B operably engages with the third discharge process connection **1462**C to deliver chlorine (produced by the BPCS **1440**) from the BPCS **1440** to the inflow source stage **1402**. In another instance, the fourth battery process connection **1442**D operably engages with the third discharge process connection **1462**C to transport and deliver hydrochloric acid solution (produced by the BPCS **1440**) from the BPCS **1440** to the inflow source stage **1402**. In another instance, the fifth battery process connection **1442**E**1** operably engages with the third discharge process connection **1462**C to transport and deliver sodium hydroxide solution (produced by the BPCS **1440**) from the BPCS **1440** to the inflow source stage **1402**.

[0274] Having now described the stages and components of the loop system **1400**, a method of using the loop system **1400** for removing brine and contaminants from a water source and producing freshwater is described in more detail below.

[0275] During operation, a continuous raw inflow fluid stream from the inflow source stage **1402** enters into the loop system **1400** for treatment purposes. Specifically, the continuous raw inflow fluid stream from the inflow source stage **1402** enters into the loop system **1400** to remove brine and contaminants and to produce freshwater for freshwater applications or potable water for human consumption. In the illustrated loop system **1400**, a continuous inflow of seawater is fed into the loop system **1400** for treatment purposes. In other exemplary embodiments described above, any suitable fluid may be continuously fed into the loop system **1402** from the inflow source stage **1402** to remove brine compositions and/or solids concentrate and produce freshwater for freshwater applications or potable water for human consumption. As such, the seawater may contain brine compositions and/or contaminated compositions along with salt concentrates that are desired to be dissociated and removed from the water source in order to produce freshwater for freshwater applications and/or potable water for human consumption.

[0276] As illustrated in FIG. **11**, the seawater provided in the inflow source stage **1402** may be transferred into the SPCS **1406** via at least one inflow source connection **1404**. In the illustrated embodiment, the brine solution of the seawater may transfer to the SPCS **1406** via the first inflow source connection **1404**A, and the salt water of the seawater may transfer to the SPCS **1406** via the second inflow source connection **1404**B. At this point, the seawater is fed into at least one SDA **1408** of the SPCS **1406** for at least one dissociation and/or evisceration process. In the illustrated loop system **1400**, the brine solution and the salt water of the seawater is transferred into the first SDA **1408**A, via the first and second inflow source connections **1404**A, **1404**B, for a first dissociation and/or evisceration process. Such dissociation and/or evisceration process performed by the first SDA **1408**A is substantially similar to the dissociation and/or evisceration process performed by the SDA **10** described above. In other exemplary embodiments, the first SDA **1408**A may be any suitable SDA described and illustrated herein, including SDAs **210**, **310**, **410**, **510**, **610**, **710**, and **910**.

[0277] Once the first SDA **1408**A performs a first dissociation and/or evisceration process, the seawater having dissociated solids concentrate and dissociated brine compositions is transferred to the first SSA stage **1410**A for a first removal and separation process via the first SPCS connection **1412**A. Such removal and/or separation process performed by the first SSA stage **1410**A is substantially similar to the removal and separation process performed by the first stage of the SSA **12** described above. In other exemplary embodiments, the first SSA stage **1410**A may be any suitable SSA described and illustrated herein, including SSAs **12**, **712**, and **912**.

[0278] Once the first SSA stage **1410**A performs a first removal and separation process, the first SSA stage **1410**A may transfer dissociated brine composition and/or dissociated solids concentrate removed from the water source to the MPCS**1** **1414** via the second SPCCS connection **1412**B; such method of using the MPCS**1** **1414** is described in more detail below.

[0279] The first SSA stage **1410**A may also transfer the seawater that endured the first removal and separation process to the second SDA **1408**B for a second dissociation and/or evisceration process via the third SPCS connection **1412**C. Such dissociation and/or evisceration process performed by the second SDA **1408**B is also substantially similar to the dissociation and/or evisceration process performed by the SDA **10** described above. In other exemplary embodiments, the second SDA **1408**B may be any suitable SDA described and illustrated herein, including SDAs **210**, **310**, **410**, **510**, **610**, **710**, and **910**. While the first SDA **1408**A and the second SDA **1408**B are illustrated as separate SDAs, the first SDA **1408**A and the second SDA **1408**B may be a single SDA that is capable of performing first and second dissociation and/or evisceration processes (e.g., SDA **510**).

[0280] Once the second SDA **1408**B performs a second dissociation and/or evisceration process, the seawater having dissociated solids concentrate and dissociated brine compositions is then transferred to the second SSA stage **1410**B for a second removal and separation process via the fourth SPCS connection **1412**D. Such removal and/or separation process performed by the second SSA **1410**A is substantially similar to the removal and separation process performed by the second stage of the SSA **12** described above. In other exemplary embodiments, the second SSA stage **1410**B may be any suitable SSA described and illustrated herein, including SSAs **12**, **712**, and **912**.

[0281] Once the second SSA stage **1410**B performs a second removal and separation process, the second SSA stage **1410**B may transfer dissociated brine composition and/or dissociated solids concentrate removed from the water source to the MPCS**1** **1414** via the fifth SPCS connection **1412**E; such method of using the MPCS **1414** is described in more detail below. The second SSA stage **1410**B may also transfer the seawater that endured the second removal and separation processes to at least one permeate outlet **1422**. In the illustrated loop system **1400**, the second SSA stage **1410**B transfers the water source that endured the second removal and separation processes to the first permeate outlet **1424** via the sixth SPCS connection **1412**F and to the second permeate outlet **1426** via the seventh SPCS connection **1412**G. As described above, the first permeate outlet **1424** is configured to provide a final permeate and/or treatment on the water source to provide freshwater to a freshwater channel **1430** via the freshwater connection **1431**. Additionally, the second permeate outlet **1426** is configured to provide another final permeate and/or treatment on the water source to provide potable water to a potable water channel **1432** via the potable water connection **1433**.

[0282] During operation, the EC **1434** is configured to provide power, via the external power source **1436**, and configured to control the operation of the SPCS **1406** by the first electrical connection **1438**A. In order to operate and use the SPCS **1406**, the EC **1434** must be enabled to an ON state or a similar state that provides power and control to the SPCS **1406** to perform desalination processed on fluid entering into the SPCS **1406** via the inflow source stage **1402**.

[0283] Still referring to FIG. **11**, the MPCS**1 1414** is configured to mine and/or extract desired minerals from the brine solutions and/or solids concentrate received from the SPCS **1406** and the brine system **1416** (described in detail above). During operation, the MPCS**1 1414** is configured with conventional machines, assemblies, apparatuses, and systems in order to mine and extract desired minerals considered useful for stages in the loop system **1400** or economically viable for commercial use outside of the loop system **1400**. In the illustrated loop system **1400**, the MPCS**1 1414** is configured to transfer different types of brine solutions and other extracted minerals to various stages in the loop system **1400**. During operation, the MPCS**1 1414** may generate a chlorine solution which is transported from the MPCS**1 1414** to the second permeate outlet **1426** to treat and/or polish freshwater permeate to produce potable water (via the first mined connection **1428**A) if desired by skilled artisans; as previously stated, the first mined connection **1428**A may be omitted if desired by skilled artisans based on various considerations listed above. The chloride solution generated by the MPCS**1 1414** may be also be transported to the inflow source stage **1402** for further desalination processes performed by the SPCS **1406** (via the fourth mined stage **1438**D). The MPCS**1 1414** also generates brine solution with sodium chloride during operation which is transported from the MPCS**1 1414** to the BPCS **1440** (via the second mined connection **1428**B). The MPCS**1 1414** also generates a brine solution with reduced and/or diluted sodium chloride during operation which is transported from the MPCS**1 1414** to the HPCS **1450** (via the third mined connection **1428**C).
[0284] Referring to FIG. **12**, the BPCS **1440** is configured to receive and transfers different fluids and/or energy during operation. In the illustrated loop system **1400**, the BPCS **1440** is configured to receive power, via the external power source **1436**, and configured to be controlled by the EC **1434** by the second electrical connection **1438**B. Similar to the operation of the SPCS **1406**, the EC **1434** must be enabled to an ON state or a similar state that provides power and control to the BPCS **1440** to produce brine solutions, to produce minerals useful in this loop system **1400**, and to produce energy for stages interconnected with the BPCS **1440** in the loop system **1400**.
[0285] During operation, the BPCS **1440** is configured to transfer energy and/or electricity to the EC **1434** from the GPCS **1444** via the first generator process connection **1448**A interconnecting the BPCS **1440** and the GPCS **1444** and the first battery process connection **1442**A interconnecting the EC **1434** with the BPCS **1440**. In this process connection, the BPCS **1440** is configured to store the electrically generated by and transferred from the GPCS **1444** during operation. As such, the EC **1434** is enabled to utilize this stored electricity from the BPCS **1440**, if needed, during operation of the loop system **1400**. Additionally, the BPCS **1440** is also enabled to use this stored electricity, if needed, during operation of the loop system **1400**. As such, the stored energy generated by and transferred from the GPCS **1444** may useful if the EC **1434** is unable to provide power to the GPCS **1444** for various reasons.
[0286] Still referring to FIG. **12**, the BPCS **1440** is also configured to produce various minerals from the brine solution transferred from the MPSC**1 1414** via the second mined connection **1428**B. As described above, the minerals produced by the BPCS **1440** are provided by conventional and known techniques and methods using known machines, apparatuses, devices, and components known in the art. In one operation, the BPCS **1440** is configured to produce chloride that is transferred to the MPSC**1 1414**, via a first portion **1442**B**1** of the second battery process connection **1442**B, and to the inflow source stage **1402**, via the connection between the second portion **1442**B**1** of the of the second battery process connection **1442**B and the third discharge connection **1462**C, further desalination processes by the DSPC **1406**. In another operation, the BPCS **1440** is configured to produce energy and/or electricity to the HPCS **1450** via the third battery process connection **1442**C. In another operation, the BPCS **1440** is also configured to produce hydrochloric acid solution that is transferred to the inflow source stage **1402**, via the connection between the fourth battery process connection **1442**D and the third discharge connection **1462**C, for further desalination processes by the DSPC **1406**. In another operation, the BPCS **1440** is also configured

to produce and transfer sodium hydroxide solution to the GPCS **1444** for hydrogen fuel cell generation processes, via the fifth battery process connection **1442**E, to the inflow source stage **1402**, via the connection between the first portion **1442**E**1** of the of the fifth battery process connection **1442**E and the third discharge connection **1462**C, further desalination processes by the DSPC **1406**, and to the sodium hydroxide output **1446** for storage purposes via the second portion **1442**E**2** of the of the fifth battery process connection **1442**E. In another operation, the BPCS **1440** is configured to produce and transfer hydrogen solution to the GPCS **1444** for hydrogen fuel cell generation processes via the sixth battery process connection **1442**F. In another operation, the BPCS **1440** is also configured to produce and transfer brine solution to the ZPCS **1454**, specifically the deliquify SDA/SSA **1456**, for further desalination processes by the deliquify SDA/SSA **1456**.

[0287] During operation, the GPCS **1444** is configured to generate and transfer energy and/or electricity to the EC **1434** based on the conventional hydrogen fuel cell generation processes in the GPCS **1444**. As such, the energy and/or electricity is transferred to the EC **1434** via the first generator process connection **1448**A interconnecting the BPCS **1440** and the GPCS **1444** and the first battery process connection **1442**A interconnecting the EC **1434** with the BPCS **1440**. In this process connection, the BPCS **1440** is configured to store the electrically generated by and transferred from the GPCS **1444** during operation. As such, the EC **1434** is enabled to utilize this stored electricity from the BPCS **1440**, if needed, during operation of the loop system **1400**. Additionally, the BPCS **1440** is also enabled to use this stored electricity, if needed, during operation of the loop system **1400**. As such, the stored energy generated by and transferred from the GPCS **1444** may useful if the EC **1434** is unable to provide power to the GPCS **1444** for various reasons. During operation, the GPCS **1444** is also configured to produce and transfer brine solution to the ZPCS **1454**, specifically the deliquify SDA/SSA **1456**, for further desalination processes by the deliquify SDA/SSA **1456**; such transfer of the brine solution from the GPCS **1444** to the ZPCS **1454** occurs via the second generator process connection **1448**B.

[0288] Referring to FIG. **12**, the HPCS **1450** is also configured to receive and transfers different fluids and/or energy during operation. In the illustrated loop system **1400**, the HPCS **1450** is configured to receive power, via the external power source **1436**, and configured to be controlled by the EC **1434** by the third electrical connection **1438**C. Similar to the operation of the SPCS **1406**, the EC **1434** must be enabled to an ON state or a similar state that provides power and control to the HPCS **1450** to produce brine solutions, to produce minerals useful in this loop system **1400**, and to produce energy for stages interconnected with the BPCS **1440** in the loop system **1400**.

[0289] During operation, the HPCS **1450** is configured to produce hydrogen by conventional techniques and processes known in the art with conventional and machines, assemblies, apparatuses, systems, and components known in the art for producing hydrogen. Once hydrogen is generated by the HPCS **1450**, the hydrogen is transferred to the GPCS **1444**, via the first generator process connection **1448**A, to provide hydrogen fuel cell processes. Additionally, the HPCS **1450** is configured to produce brine solution that is transferred to the ZPCS **1454**, specifically the deliquify SDA/SSA **1456**, for further desalination processes by the deliquify SDA/SSA **1456**; such transfer of the brine solution from the HPCS **1450** to the ZPCS **1454** occurs via the second hydrogen process connection **1452**B.

[0290] Still referring to FIG. **12**, the ZPCS **1454** is configured to receive excess brine solution from each of the BPCS **1440**, the GPCS **1444**, and the HPCS **1450**. As such, the deliquify SDA/SSA **1456** receives brine solution from the BPCS **1440** via the seventh battery process connection **1442**G, the GPCS **1444** via the second generator process connection **1448**B, and the HPCS **1450** via the second hydrogen process connection **1452**B. During operation, the deliquify SDA/SSA **1456** is configured to perform desalination processes on the brine solutions to further dissociate brine compositions and/or solids concentrate, remove the dissociated brine compositions and/or solids concentrate, and produce freshwater for freshwater applications. In one operation, the deliquify SDA/SSA **1456** produces freshwater and transfers the freshwater to the freshwater outlet **1464** via the first discharge connection **1462**A. In another operation, the deliquify SDA/SSA **1456** produces dissociated brine composites and solids concentrate removed from the freshwater source in which such dissociated brine composites and solids concentrate are transferred to the MPSC**2** **1458**. Similar to the MPSC**1** **1414**, the MPSC**21** **1458** performs mining and extracting operations for extracting and recovering desired minerals from the dissociated brine composites and solids concentrate. Any crystalized brine compositions or solids concentrate are then transferred to the recover dispose **1460** of the ZPCS **1454**. In another operation, the deliquify SDA/SSA **1456** may also transfer dissociated brine composition and solids concentrate to the inflow source stage **1402**, via the third discharge connection **1462**C, for further treatment and processing performed by the loop system **1400**.

[0291] Various inventive concepts may be embodied as one or more methods, of which an example has been provided. The acts performed as part of the method may be ordered in any suitable way. Accordingly, embodiments may be constructed in which acts are performed in an order different than illustrated, which may include performing some acts simultaneously, even though shown as sequential acts in illustrative embodiments.

[0292] While various inventive embodiments have been described and illustrated herein, those of ordinary skill in the art will readily envision a variety of other means and/or structures for performing the function and/or obtaining the results and/or one or more of the advantages described herein, and each of such variations and/or modifications is deemed to be within the scope of the inventive embodiments described herein. More generally, those skilled in the art will readily appreciate that all parameters, dimensions, materials, and configurations described herein are meant to be exemplary and that the actual parameters, dimensions, materials, and/or configurations will depend upon the specific application or applications for which the inventive teachings is/are used. Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, many equivalents to the specific inventive embodiments described herein. It is, therefore, to be understood that the foregoing embodiments are presented by way of example only and that, within the scope of the appended claims and equivalents thereto, inventive embodiments may be practiced otherwise than as specifically described and claimed. Inventive embodiments of the present disclosure are directed to each individual feature, system, article, material, kit, and/or method described herein. In addition, any combination of two or more such features, systems, articles, materials, kits, and/or methods, if such features, systems, articles, materials, kits, and/or methods are not mutually inconsistent, is included within the inventive scope of the present disclosure.

[0293] The above-described embodiments can be implemented in any of numerous ways. For example, embodiments of technology disclosed herein may be implemented using hardware, software, or a combination thereof. When implemented in software, the software code or instructions can be executed on any suitable processor or collection of processors, whether provided in a single computer or distributed among multiple computers. Furthermore, the instructions or software code can be stored in at least one non-transitory computer readable storage medium.

[0294] Also, a computer or smartphone utilized to execute the software code or instructions via its processors may have one or more input and output devices. These devices can be used, among other things, to present a user interface. Examples of output devices that can be used to provide a user interface include printers or display screens for visual presentation of output and speakers or other sound generating devices for audible presentation of output. Examples of input devices that can be used for a user interface include keyboards, and pointing devices, such as mice, touch pads, and digitizing tablets. As another example, a computer may receive input information through speech recognition or in other audible format.

[0295] Such computers or smartphones may be interconnected by one or more networks in any

suitable form, including a local area network or a wide area network, such as an enterprise network, and intelligent network (IN) or the Internet. Such networks may be based on any suitable technology and may operate according to any suitable protocol and may include wireless networks, wired networks or fiber optic networks.
[0296] The various methods or processes outlined herein may be coded as software/instructions that is executable on one or more processors that employ any one of a variety of operating systems or platforms. Additionally, such software may be written using any of a number of suitable programming languages and/or programming or scripting tools, and also may be compiled as executable machine language code or intermediate code that is executed on a framework or virtual machine.
[0297] In this respect, various inventive concepts may be embodied as a computer readable storage medium (or multiple computer readable storage media) (e.g., a computer memory, one or more floppy discs, compact discs, optical discs, magnetic tapes, flash memories, USB flash drives, SD cards, circuit configurations in Field Programmable Gate Arrays or other semiconductor devices, or other non-transitory medium or tangible computer storage medium) encoded with one or more programs that, when executed on one or more computers or other processors, perform methods that implement the various embodiments of the disclosure discussed above. The computer readable medium or media can be transportable, such that the program or programs stored thereon can be loaded onto one or more different computers or other processors to implement various aspects of the present disclosure as discussed above.
[0298] The terms “program” or “software” or “instructions” are used herein in a generic sense to refer to any type of computer code or set of computer-executable instructions that can be employed to program a computer or other processor to implement various aspects of embodiments as discussed above. Additionally, it should be appreciated that according to one aspect, one or more computer programs that when executed perform methods of the present disclosure need not reside on a single computer or processor, but may be distributed in a modular fashion amongst a number of different computers or processors to implement various aspects of the present disclosure.
[0299] Computer-executable instructions may be in many forms, such as program modules, executed by one or more computers or other devices. Generally, program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract data types. Typically, the functionality of the program modules may be combined or distributed as desired in various embodiments.
[0300] Also, data structures may be stored in computer-readable media in any suitable form. For simplicity of illustration, data structures may be shown to have fields that are related through location in the data structure. Such relationships may likewise be achieved by assigning storage for the fields with locations in a computer-readable medium that convey relationship between the fields. However, any suitable mechanism may be used to establish a relationship between information in fields of a data structure, including through the use of pointers, tags or other mechanisms that establish relationship between data elements.
[0301] All definitions, as defined and used herein, should be understood to control over dictionary definitions, definitions in documents incorporated by reference, and/or ordinary meanings of the defined terms.
[0302] “Logic”, as used herein, includes but is not limited to hardware, firmware, software, and/or combinations of each to perform a function(s) or an action(s), and/or to cause a function or action from another logic, method, and/or system. For example, based on a desired application or needs, logic may include a software controlled microprocessor, discrete logic like a processor (e.g., microprocessor), an application specific integrated circuit (ASIC), a programmed logic device, a memory device containing instructions, an electric device having a memory, or the like. Logic may include one or more gates, combinations of gates, or other circuit components. Logic may also be fully embodied as software. Where multiple logics are described, it may be possible to incorporate

the multiple logics into one physical logic. Similarly, where a single logic is described, it may be possible to distribute that single logic between multiple physical logics.

[0303] Furthermore, the logic(s) presented herein for accomplishing various methods of this system may be directed towards improvements in existing computer-centric or internet-centric technology that may not have previous analog versions. The logic(s) may provide specific functionality directly related to structure that addresses and resolves some problems identified herein. The logic(s) may also provide significantly more advantages to solve these problems by providing an exemplary inventive concept as specific logic structure and concordant functionality of the method and system. Furthermore, the logic(s) may also provide specific computer implemented rules that improve on existing technological processes. The logic(s) provided herein extends beyond merely gathering data, analyzing the information, and displaying the results. Further, portions or all of the present disclosure may rely on underlying equations that are derived from the specific arrangement of the equipment or components as recited herein. Thus, portions of the present disclosure as it relates to the specific arrangement of the components are not directed to abstract ideas. Furthermore, the present disclosure and the appended claims present teachings that involve more than performance of well-understood, routine, and conventional activities previously known to the industry. In some of the method or process of the present disclosure, which may incorporate some aspects of natural phenomenon, the process or method steps are additional features that are new and useful.

[0304] The articles “a” and “an,” as used herein in the specification and in the claims, unless clearly indicated to the contrary, should be understood to mean “at least one.” The phrase “and/or,” as used herein in the specification and in the claims (if at all), should be understood to mean “either or both” of the elements so conjoined, i.e., elements that are conjunctively present in some cases and disjunctively present in other cases. Multiple elements listed with “and/or” should be construed in the same fashion, i.e., “one or more” of the elements so conjoined. Other elements may optionally be present other than the elements specifically identified by the “and/or” clause, whether related or unrelated to those elements specifically identified. Thus, as a non-limiting example, a reference to “A and/or B”, when used in conjunction with open-ended language such as “comprising” can refer, in one embodiment, to A only (optionally including elements other than B); in another embodiment, to B only (optionally including elements other than A); in yet another embodiment, to both A and B (optionally including other elements); etc. As used herein in the specification and in the claims, “or” should be understood to have the same meaning as “and/or” as defined above. For example, when separating items in a list, “or” or “and/or” shall be interpreted as being inclusive, i.e., the inclusion of at least one, but also including more than one, of a number or list of elements, and, optionally, additional unlisted items. Only terms clearly indicated to the contrary, such as “only one of” or “exactly one of,” or, when used in the claims, “consisting of,” will refer to the inclusion of exactly one element of a number or list of elements. In general, the term “or” as used herein shall only be interpreted as indicating exclusive alternatives (i.e. “one or the other but not both”) when preceded by terms of exclusivity, such as “either,” “one of,” “only one of,” or “exactly one of,” “consisting essentially of,” when used in the claims, shall have its ordinary meaning as used in the field of patent law.

[0305] As used herein in the specification and in the claims, the phrase “at least one,” in reference to a list of one or more elements, should be understood to mean at least one element selected from any one or more of the elements in the list of elements, but not necessarily including at least one of each and every element specifically listed within the list of elements and not excluding any combinations of elements in the list of elements. This definition also allows that elements may optionally be present other than the elements specifically identified within the list of elements to which the phrase “at least one” refers, whether related or unrelated to those elements specifically identified. Thus, as a non-limiting example, “at least one of A and B” (or, equivalently, “at least one of A or B,” or, equivalently “at least one of A and/or B”) can refer, in one embodiment, to at least one, optionally including more than one, A, with no B present (and optionally including elements other than B); in another embodiment, to at least one, optionally including more than one, B, with no A present (and optionally including elements other than A); in yet another embodiment, to at least one, optionally including more than one, A, and at least one, optionally including more than one, B (and optionally including other elements); etc.

[0306] When a feature or element is herein referred to as being “on” another feature or element, it can be directly on the other feature or element or intervening features and/or elements may also be present. In contrast, when a feature or element is referred to as being “directly on” another feature or element, there are no intervening features or elements present. It will also be understood that, when a feature or element is referred to as being “connected”, “attached” or “coupled” to another feature or element, it can be directly connected, attached or coupled to the other feature or element or intervening features or elements may be present. In contrast, when a feature or element is referred to as being “directly connected”, “directly attached” or “directly coupled” to another feature or element, there are no intervening features or elements present. Although described or shown with respect to one embodiment, the features and elements so described or shown can apply to other embodiments. It will also be appreciated by those of skill in the art that references to a structure or feature that is disposed “adjacent” another feature may have portions that overlap or underlie the adjacent feature.

[0307] Spatially relative terms, such as “under”, “below”, “lower”, “over”, “upper”, “above”, “behind”, “in front of”, and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if a device in the figures is inverted, elements described as “under” or “beneath” other elements or features would then be oriented “over” the other elements or features. Thus, the exemplary term “under” can encompass both an orientation of over and under. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly. Similarly, the terms “upwardly”, “downwardly”, “vertical”, “horizontal”, “lateral”, “transverse”, “longitudinal”, and the like are used herein for the purpose of explanation only unless specifically indicated otherwise.

[0308] Although the terms “first” and “second” may be used herein to describe various features/elements, these features/elements should not be limited by these terms, unless the context indicates otherwise. These terms may be used to distinguish one feature/element from another feature/element. Thus, a first feature/element discussed herein could be termed a second feature/element, and similarly, a second feature/element discussed herein could be termed a first feature/element without departing from the teachings of the present invention.

[0309] An embodiment is an implementation or example of the present disclosure. Reference in the specification to “an embodiment,” “one embodiment,” “some embodiments,” “one particular embodiment,” “an exemplary embodiment,” or “other embodiments,” or the like, means that a particular feature, structure, or characteristic described in connection with the embodiments is included in at least some embodiments, but not necessarily all embodiments, of the invention. The various appearances “an embodiment,” “one embodiment,” “some embodiments,” “one particular embodiment,” “an exemplary embodiment,” or “other embodiments,” or the like, are not necessarily all referring to the same embodiments.

[0310] If this specification states a component, feature, structure, or characteristic “may”, “might”, or “could” be included, that particular component, feature, structure, or characteristic is not required to be included. If the specification or claim refers to “a” or “an” element, that does not mean there is only one of the element. If the specification or claims refer to “an additional” element, that does not preclude there being more than one of the additional element.

[0311] As used herein in the specification and claims, including as used in the examples and unless

otherwise expressly specified, all numbers may be read as if prefaced by the word “about” or “approximately,” even if the term does not expressly appear. The phrase “about” or “approximately” may be used when describing magnitude and/or position to indicate that the value and/or position described is within a reasonable expected range of values and/or positions. For example, a numeric value may have a value that is +/−0.1% of the stated value (or range of values), +/−1% of the stated value (or range of values), +/−2% of the stated value (or range of values), +/−5% of the stated value (or range of values), +/−10% of the stated value (or range of values), etc. Any numerical range recited herein is intended to include all sub-ranges subsumed therein.
[0312] Additionally, the method of performing the present disclosure may occur in a sequence different than those described herein. Accordingly, no sequence of the method should be read as a limitation unless explicitly stated. It is recognizable that performing some of the steps of the method in a different order could achieve a similar result.
[0313] In the claims, as well as in the specification above, all transitional phrases such as “comprising,” “including,” “carrying,” “having,” “containing,” “involving,” “holding,” “composed of,” and the like are to be understood to be open-ended, i.e., to mean including but not limited to. Only the transitional phrases “consisting of” and “consisting essentially of” shall be closed or semi-closed transitional phrases, respectively.
[0314] To the extent that the present disclosure has utilized the term “invention” in various titles or sections of this specification, or in the context of those sections, this term has been included as required by the formatting requirements of word document submissions (i.e., docx submissions) pursuant the guidelines/requirements of the United States Patent and Trademark Office and shall not, in any manner, be considered a disavowal of any subject matter.
[0315] In the foregoing description, certain terms have been used for brevity, clearness, and understanding. No unnecessary limitations are to be implied therefrom beyond the requirement of the prior art because such terms are used for descriptive purposes and are intended to be broadly construed.
[0316] Moreover, the description and illustration of various embodiments of the disclosure are examples and the disclosure is not limited to the exact details shown or described.

Claims

1. A method, comprising step of: pumping a continuous fluid stream, via a fluid source, into a solids dissociation apparatus (SDA) of an acoustic source process cell stage (SPCS); generating a traveling sonic wave, via a transducer of the SDA, inside of a housing of the SDA; cavitating the continuous fluid stream inside of at least one insert of the SDA, wherein the at least one continuous fluid stream is isolated from the continuous sonic stream; dissociating contaminants, via the transducer of the SDA, from the continuous fluid stream; pumping the continuous fluid stream into a tower of a solids separation apparatus (SSA) of the SPCS, wherein the fluid stream includes the dissociated contaminants; removing the dissociated contaminants, via the SSA of the SPCS, from the continuous fluid stream; outputting the dissociated contaminants, via an effluent connection, to at least one mining process cell stage (MPCS); and outputting permeate water, via a permeate connection, to one of at least one permeate output and at least one freshwater output.
2. The method of claim 1, further comprising: generating a standing sonic wave, via a transducer of the SSA, inside of the tower; adjusting one or both of the transducer of the SSA and a reflector of the SSA until anti-nodes of the standing sonic wave or nodes of the standing sonic wave are aligned with at least one set of ports defined in the tower; and forcing the dissociated contaminants, via the standing sonic wave, into the at least one set of ports of at least one removal stage of the tower of the SSA.
3. The method of claim 2, further comprising: mining at least one mineral, via the at least one MPCS, from the dissociated contaminants, wherein the at least one mineral is a mixture of brine

and sodium chloride; and outputting the at least one mineral, via at least one battery process connection, to at least one battery process cell stage (BPCS).

4. The method of claim 3, further comprising: mining at least another mineral, via the at least one MPCS, from the dissociated contaminants, wherein the at least another mineral is a mixture of brine and sodium chloride; and outputting the at least another mineral, via at least one generator process connection, to at least one hydrogen production stage (HPCS).

5. The method of claim 3, further comprising: transporting at least one battery fluid stream, via at least one generator process connection, from at least one hydrogen fuel cell generator process cell stage (GPCS) to the at least one BPCS.

6. The method of claim 5, wherein the at least one battery fluid stream transported from the at least one BPCS to the at least one GPCS includes one of hydrogen solution and sodium hydroxide solution.

7. The method of claim 5, further comprising: outputting a first battery fluid stream of the at least one battery fluid stream, via a first generator process connection, from the at least one GPCS to the at least one BPCS, wherein the first battery fluid stream includes hydrogen; and outputting a second battery fluid stream of the at least one battery fluid stream, via a second generator process connection, from the at least one GPCS to the at least one BPCS, wherein the second battery fluid stream includes sodium hydroxide.

8. The method of claim 4, further comprising: outputting at least one hydrogen stream, via at least one hydrogen production connection, from the at least one HPCS to the at least one GPCS.

9. The method of claim 8, further comprising: outputting at least one brine stream, via at least one brine stream connection, from at least one of the at least one BPCS, the at least one GPCS, and the at least one HPCS to a liquid discharge process cell stage (LPCS).

10. The method of claim 9, further comprising: outputting at least one freshwater stream from the LPCS to the at least one freshwater output.

11. The method of claim 9, further comprising: outputting concentrate brine, via at least one concentrate brine connection, from the LPCS to the at least one SPCS.

12. The method of claim 5, further comprising: powering at least one of the SPCS, the at least one BPCS, the at least one GPCS, and the at least one HPCS, via at least one electrical connection, from an electrical controller.

13. The method of claim 1, wherein the at least one insert is adapted to receive the continuous fluid stream; and wherein the transducer is disposed about the at least one insert at a distance away from the at least one insert inside of the housing.

14. The method of claim 2, wherein the step of adjusting one or both of the transducer of the SSA and the reflector of the SSA further includes that the transducer and the reflector are linearly moveable relative to the tower to linearly move the standing sonic wave.

15. The method of claim 1, further comprising: eviscerating the dissociated contaminants, by a second SDA, in the continuous fluid stream in a second treatment process.

16. The method of claim 15, further comprising: receiving the dissociated contaminants from the second SDA, by a second SSA, in the second treatment process; and separating the dissociated contaminants from the continuous fluid stream, by the second SSA, in the second treatment process.

17. The method of claim 16, further comprising: transporting the dissociated contaminants of the second treatment process, by a second effluent connection, from the second SSA to the at least one MPCS.

18. The method of claim 1, further comprising: transporting the permeated water from the at least one permeate outlet to the at least one potable water channel.

19. The method of claim 1, wherein pumping the continuous fluid stream into the tower of the SSA further includes that the fluid stream is pumped into a pressurized chamber of the tower defined between a first end of the tower and a second end of the tower; and wherein the pressurized chamber is held at a pressure that is one of greater than atmospheric pressure surrounding the tower, less than atmospheric pressure surrounding the tower, and equal to the atmospheric pressure surrounding the tower.

20. The method of claim 1, further comprising: connecting with a preexisting desalination process.