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Liquid Solid Separator Recirculation Systems

Abstract

A liquid solid separator has a main container wherein a rotating filter belt receives influent for liquid sold mixture sieve processing. Various recirculation systems are proposed including an external pump sump, internal pump recirculation and dual pumps with one disposed externally in a sump and one internally in the lower basin of the container. Recirculation points include an inflow pipe connection, an influent basin connection located above the influent basin and influent basin connection located underneath the liquid solid mixture influent level.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATION [0001] This application is a divisional of and claims benefit of previously filed U.S. Non-Provisional patent application Ser. No. 17/535,618 that was filed on 25 Nov. 2021; this patent application is hereby incorporated by reference in its entirety.

Field of the Invention

[0002] The invention herein described relates to devices for the separation of solids from liquids. More particularly, this invention relates to recirculation systems that are external or internal to liquid solid separators.

BACKGROUND OF THE INVENTION

General Prior Art Concept

[0003] Gravity Flow Rotating Belt Filters is a class of system that feeds raw water onto the rotating belt filter via gravity. This system class is common in water treatment plants that incorporate a full water treatment process before and after the rotating filter belt. In this regard, an original raw liquid solid mixture undergoes treatment processes prior (a pre-treatment) to arriving at the rotating belt filter; typically called headworks, these treatment processes include coarse and fine screening sub-systems. The liquid solid mixture having been processed by this pre-treatment enters the liquid solid separator and is processed therein.

[0004] Upon exiting the liquid solid separator and its associated rotating belt filter, final processing is accomplished in another unit or system. This is usually considered secondary treatment with the introduction of biologicals and aeration for further purification of the liquids and solids therewith. These Gravity Flow Rotating Filter Belt systems are common for municipal water treatment plants and eliminates pumping between different treatment processes.

[0005] Pumped Flow Rotating Belt Filters are more commonly used for pre-treatment in industrial settings. Typically, all industrial plant waste waters are collected in a sump from various places/processes in the industrial plant then these are pumped into the Rotating Belt Filter Liquid Solid Separator for screening. Headworks are usually not present and secondary treatment is optional depending on the type of wastewater and the local requirements of the local municipality. If the industrial operators are discharging directly to the environment, a NP DES permit (issued by the EPA or State DNR) will typically dictate the discharge requirements, which normally will require secondary treatment, tertiary treatment and disinfection treatment.

[0006] There are liquid solid separator systems having rotating belt filters that utilize internal sump pumps to recycle reject streams. Using a sump pump internal to the liquid solid separator eliminates the need for another handler unit for additional processing of reject waste streams. However, the use of an internal pump creates various maintenance issues which needs to be solved in order to reliably to use the liquid solid separator.

[0007] A critical problem with an internal sump pump in a liquid solid separator is that the pump sometimes fails and inspection, maintenance or replacement of the pump requires downtime and the provision of specialized equipment and personnel for accessibility and repair thereof. Additionally, repeated breakdowns and downtime cost more to the operator.

[0008] Accordingly, there needs to be some solutions to overcome the aforementioned problems discussed above.

SUMMARY OF THE INVENTION

[0009] The present invention overcomes the deficiencies of the known art and the problems that remain unsolved by providing:

[0010] A liquid solid separator has a main container wherein a rotating filter belt receives influent for liquid sold mixture sieve processing.

[0011] Various recirculation systems are proposed including an external pump sump, internal pump recirculation and dual pumps with one disposed externally in a sump and one internally in the lower basin of the container.

[0012] Recirculation points include an inflow pipe connection, an influent basin connection located above the influent basin and influent basin connection located underneath the liquid solid mixture influent level.
[0013] These and other aspects, features, and advantages of the present invention will become more readily apparent from the attached drawings and the following detailed description of the preferred embodiments.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0014] The preferred embodiments of the invention will hereinafter be described in conjunction with the appended drawings provided to illustrate and not to limit the invention, in which:
[0015] FIG. **1** presents a Liquid Solid Separator Recycling System in a first embodiment disclosed herein.
[0016] FIG. **2** presents a Liquid Solid Separator Recycling System in a second embodiment disclosed herein.
[0017] FIG. **3**A presents a front view of a Liquid Solid Separator Recycling System in an embodiment disclosed herein made up of three potential variations described in FIGS. **3**B, **3**C, **3**D.
[0018] FIG. **3**B presents a rotated view of the Liquid Solid Separator Recycling System of FIG. **3**A in a third embodiment disclosed herein.
[0019] FIG. **3**C presents a rotated view of the Liquid Solid Separator Recycling System of FIG. **3**A in in a fourth embodiment disclosed herein.
[0020] FIG. **3**D presents a rotated view of the Liquid Solid Separator Recycling System of FIG. **3**A in a fifth embodiment disclosed herein.
[0021] FIG. **4** presents a Liquid Solid Separator Recycling System in a sixth embodiment disclosed herein.
[0022] FIG. **5** presents a Liquid Solid Separator Recirculation System in a seventh embodiment disclosed herein.
[0023] FIG. **6** presents an isometric view of a Liquid Solid Separator Recycling System Container disclosed herein showing the recycling pipe on a side thereof returning liquids above the influent basin above the rotating filter belt.
[0024] Like reference numerals refer to like parts throughout the several views of the drawings.
DETAILED DESCRIPTION
[0025] The following detailed description is merely exemplary in nature and is not intended to limit the described embodiments or the application and uses of the described embodiments. As used herein, the word exemplary or illustrative means serving as an example, instance, or illustration. Any implementation described herein as exemplary or illustrative is not necessarily to be construed as preferred or advantageous over other implementations. All of the implementations described below are exemplary implementations provided to enable persons skilled in the art to make or use the embodiments of the disclosure and are not intended to limit the scope of the disclosure, which is defined by the claims. For purposes of description herein, the terms upper, lower, left, rear, right, front, vertical, horizontal, and derivatives thereof shall relate to the invention as oriented in each figure. Furthermore, there is no intention to be bound by any expressed or implied theory presented in the preceding technical field, background, brief summary or the following detailed description. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification, are simply exemplary embodiments of the inventive concepts defined in the appended claims. Hence, specific dimensions and other physical characteristics relating to the embodiments disclosed herein are not to be considered as limiting, unless the claims expressly state otherwise.

Liquid Solid Separator—Pump Locations

[0026] General Solution: There are two general types of pump dispositions that are contemplated: A) liquid solid separators having an internal pump; and B) liquid solid separators that do not have an internal pump. Both of these solutions are directed to handling of reject stream contained in the lower collection basin tank of a liquid solid separator.

[0027] Liquid Solid Separator—Internal Pump: First, in a liquid solid separator having an Internal Pump there are several connections added to the lower collection basin tank where the pump is located; these are namely, a drain connection and an overflow connection. As an added measure, provisions can be made to bypass the pump in the event of failure.

[0028] Liquid Solid Separator—External Pump: In a second type of system, the sump pump is relocated to a place where the pump is more easily accessible providing a more simple maintenance solution whereby costs are greatly reduced as a result. Also, the External Pump type has several connections added to the lower collection basin tank; these are namely, a drain connection and an overflow connection.

Liquid Solid Separator—System Solutions

[0029] There are further two specific classes of system solutions regarding the above general solutions. One class is for Gravity Flow Rotating Belt Filters and the other class is for Pumped Flow Rotating Belt Filters.

[0030] Gravity Flow Solutions: Because the lower collection basin tank drain is below the liquid level of the raw influent and filtered outlet, reject from the lower collection basin tank must be pumped unless there is a sufficient differential in liquid level from the Rotating Belt Filter stage outlet (e.g. liquid solid separator having a Rotating Filter Belt) versus the downstream processes that would facilitate a gravity flow solution. If there is sufficient level differential in the downstream process, the reject can be blended with the Rotating Belt Filter effluent using gravity flow without needing to be collected. Otherwise, the reject must be collected and pumped to one of three locations. These locations are defined: [0031] Location 1 is the Rotating Belt Filter housing but specifically above the belt via piping and conduit within the filter system. [0032] Location 2 would be any place upstream of the Rotating Belt Filter liquid solid separator system. [0033] Location 3 would be any location downstream of the Rotating Belt Filter liquid solid separator system (also considered blending but through collecting and pumping).

[0034] Pumped Flow Solutions: All the options of gravity flow are available for pumped flow. Additionally, there will normally be an option to drain the reject to a raw water sump in front of the Rotating Belt Filter without collection or need for a separate pump. Collection can either be in a ground pit/sump or in a tank located below the bottom of the lower collection basin. When using an external tank, usually the Rotating Belt Filter System (liquid solid separator device) is raised to achieve the necessary headroom to drain to the external tank.

[0035] When using a pump to recirculate reject liquids back upstream of the filter belt, a level sensing device is necessary that communicates with a control system; this control system is able to turn the pump on when needed and turn the pump off when a desired level is achieved based on information provided by the level sensing device through mechanical, electromechanical, electronic and or electrical devices. This is necessary not only to prevent an operator from manually having to control the pump but also to prevent the pump from running dry and overheating. The following different solutions are contemplated:

External Pump Solutions

[0036] 1. An External Pump is located in an external collector and pumps back above the Rotating Filter Belt. [0037] 2. An External pump is located in an external collector and pumps upstream of the Rotating Belt Filter Belt.

Internal Pump Solutions

[0038] 3. Pump Bypass System: a pump is located in the lower collection basin tank with a pump fault detection and bypass system. This fault detection and bypass system detects a pump failure and as a result opens a motor operated valve on the drain that blends reject with Rotating Belt Filter effluent. [0039] 4. Pump Bypass System: a pump is located in the lower collection basin tank with a pump fault detection and bypass system. This fault detection and bypass system upon detection of a failure of the pump transmits a command on a control line or electronic bus to to a motor operated valve in order to command the opening thereof. The electric motor operated valve upon receiving the command on a control line or electronic bus opens thereby releasing liquids from the lower collection basin tank to a drain when the pump fails that drains reject to collector and external redundant pump.

Liquid Solid Separator—Embodiments

[0040] FIG. **1** presents a Liquid Solid Separator Recycling System in a first embodiment disclosed herein. The drawing generally shows a liquid solid separator which is generally defined by the container **100** on the left having liquids (defined as being comprised of raw unscreened liquid and or solid mixture) flowing into it from the left at inlet **110**. The liquids are transmitted by fluid force into an influent basin **120** (at left in container **100**) above a rotating filter belt **130** mounted within container **100**. Unprocessed liquid solid mixture passes into a collector **140** having overflow weirs **150**, where an augur **160** mounted on the container rotates within (or otherwise associated therewith) the collector **140** and a cage (not shown; rotating or otherwise) compacting solids from the liquid solid mixture for outflow out a side door (not shown) of the container **100**; also, overflow weirs **150** permit liquids to fall into a lower basin **170** for further processing thereof.

[0041] Liquids processed through the rotating filter belt **130** pass there through and on to a diverter panel **180** mounted to the container within the confines of the rotating filter belt **130**. This diverter panel **180** having exit windows **190** receives filtered liquids **200** from the rotating filter belt **130**; from there the filtered liquids **200** leave the diverter panel through exit windows **190**. At this point, the filtered liquids **200** flow into filtered liquid basin(s) **210** (on two sides of the rotating filter belt) having connections between the two sides thereof that proceed to exit the container through an outflow **220**. It is understood that there are various other types of components in the general construction of these types of machines such as brushes, cage, motor(s) and so forth. There is an overflow weir **350** welded to the left inside of the container **100** for overflow problems. In the event that influent liquids enter the container **100** at a flow rate faster than can be processed by the filter belt **130**, the liquid level will rise to the elevation of the influent section overflow weir **350** and will spill into the overflow trough where they exit the container thru the overflow connection **380**. Overflow from the influent section can either be directed to an external sump **240** or blended with the effluent **220**.

[0042] A pump **230** is located in an external sump (pond, structure or vessel) **240**. The pump **230** is connected to a pipe **250**A (conduit, hose or similar) at connection **250** (screwed with matching threads between pipe and pump connector, welded or otherwise). The other end of pipe **250**A is welded to or otherwise connected (thread to thread connection between pipe **250**A and connector **260**) to a dedicated tank connector **260** located on a back side of the container **100** above the influent basin **120** such that tank connector **260** is above highest overflow weir **350** and therefore above the maximum normal operating liquid level. A level detection device (LT) **270** (float switch or level transmitter) is located in the external sump (pond, structure or vessel) **240** that is able through a PLC to turn pump **230** on and off based on desired level of the sump **240**. Typically, if the sump **240** is too high it turns ON the pump **230** and if the sump **240** it is too low then it turns OFF the pump **230**. This operation works in coordination with the needs of a Programmable Logic Controller PLC that receives signals from the Level Detection Device **270** and commands transport of liquids only if there is a need to based upon operational needs. The level detection device **270** has some form of electrical connection to the PLC. These include wired, wireless, electromagnetic, magnetic, infrared, optical or other types thereof. The Sump **240** and its pump **230** is located in a convenient location whereby the external sump **240** can be utilized depending upon the needs of the implementation.

[0043] Finally, it should be apparent that there is a lower basin drain line **300**A having an integral flanged connector attached to a section of pipe attached to the side of the container **100** that also has its own integral flanged connector; the attachment between these two is made using bolts-nuts or welding at **300**. The drain line **300**A drains from the lower basin of container **100** into the sump **240**. Additionally, there is a lower basin overflow line **310**A (located at a right side in the drawing above the outflow **220**) that drains into sump **240** for preventing internal liquid solid separator overflows. The lower basin overflow line **310**A is connected at **310** using its integral flanged connector that is attached to a section of pipe attached to the side of the container **100** that also has its own integral flanged connector; the attachment between these two flanged connectors is made using bolts-nuts or welding at **310**.

[0044] FIG. **2** presents a Liquid Solid Separator Recycling System in a second embodiment disclosed herein. This embodiment has two potential connections **290** and **330** as described herein below requiring check valves. This figure presents a side view of the liquid solid separator container **100** showing the fluid flow. The Sump **240** and its pump **230** is located in a convenient location whereby the external sump **240** can be utilized depending upon the needs of the implementation. In this embodiment of the invention, the previous embodiment is modified in that the pipe from pump **230** returns to another point on container **100** and is made of two pipes or two segments **250**A-**250**B together where now it is pipe segment **250**B that returns to a connector/connection of the liquid solid separator.

[0045] There are two possible connections (connectors) which are welded or otherwise connected to pipe segment **250**B; the first of these is an end of pipe segment **250**B welded to connection **330** which is a hole (or threaded hole for matching connection to a threaded end of pipe segment **250**B) on the back side of the container **100**. Of course, the other end of pipe **250**B is to a check valve **280** as described below. The other one a welded a connection **330** described in the following.

[0046] Here an end of pipe **250**B has a welded connection (or otherwise such as thread to thread connection between pipe **250**B and inlet pipe **110**A (to inlet pipe **110**A at an opening **290** in the inlet pipe **110**A). The inlet pipe **110**A providing influent into the container **100** has an integral flange that is connected at **110** to an integral flanged end of another pipe; the another pipe's other end opposite the another pipe's flanged end is welded or otherwise connected to the left side of the container thereby providing liquid solid mixture to the influent basin.

[0047] The first pipe segment **250**A is connected to pump **230** at an end thereof at **250** and at its other end with a first part of a check valve **280**. This check valve **280** is inserted between this first pipe segment **250**A (from the pump to the check valve **280**) and a second pipe segment **250**B (from the check valve **280** to a connection **290** to inlet pipe **110**A). A first end of the second segment **250**B is connected to the check valve **280** and it second end has a welded connection at **290** (or otherwise such as thread to thread connection between pipe **250**B and inlet pipe **110**A) so materials can flow through an opening in inlet pipe **110**A for this purpose therein.

[0048] The check valve **280** is utilized to prevent influent basin unscreened liquids from by-passing and going through the pipe now **250**A-B to the reject sump (**240**). However, if the sump pump is the same pump that feeds the filter raw influent liquids (raw unscreened liquid and or solid mixture in front of the rotating filter belt **130** at influent basin **120**), then a check valve **280** is not necessary. A level detection device (LT) **270** is (float switch or level transmitter) located in the external sump (pond, structure or vessel) **240** that is able to turn pump **230** on and off based on desired level of the sump **240**. Typically, if the sump **240** is too high it turns ON the pump **230** and if the sump **240** it is too low then it turns OFF the pump **230**. This operation works in coordination with the needs of a Programmable Logic Controller PLC that receives signals from the Level Detection Device **270** and transports new liquids only based upon operational needs.

[0049] The level detection device **270** has some form of electrical connection to PLC. These include wired, wireless electromagnetic, magnetic, infrared, optical or other types thereof. The Sump **240** and its pump **230** is located in a convenient location whereby the external sump **240** can be utilized depending upon the needs of the implementation. Finally, it should be apparent that there is a lower basin drain line **300**A which drains the lower basin into the sump **240** as described previously; additionally, there is a lower basin overflow line **310**A that drains into sump **240** for preventing internal liquid solid separator overflows as described previously.

[0050] FIG. **3**A presents a front section view of a Liquid Solid Separator Recycling System in an embodiment disclosed herein made up of three potential variations described in FIGS. **3**B, **3**C, **3**D. FIG. **3**A presents a front section view of the liquid solid separator tank showing the fluid flow. FIG. **3**A represents three configurations with no external sump having a fault detection system that allows for pump by-pass via blending reject with effluent during pump failure to prevent equipment downtime. There are three possible termination points for the pump recycle that are not clearly shown in FIG. **3**A, but the pump could go to **260**, **290** or **330** and these are shown in more detail in FIGS. **3**B, **3**C and **3**D.

[0051] This embodiment differs from the first two in that the pump **230** is located internally to the liquid solid separator container **100** and is situated within the lower basin **170** which receives reject streams from the collector **140** and from portions of the rotating filter belt **130** in the figure. The pump **230** has a pipe **320** that recycles liquids from the lower basin **170** up towards one of three points. These are namely, i) a connector **330** on the back side of container **100** below the overflow weir **350** (and within the zone considered the influent basin) above and near where the forward lowest portion of the recirculating belt approaches the left side of the container **100**; ii) a connector **260** above the overflow weir **350** and above the zone of the influent basin and above the rotating filter belt; and iii) a connector to inlet pipe **110**A at an opening therein at **290** welded to the inlet pipe **110**A. The connector **330** is utilized to agitate solids within the influent basin thereby preventing undesirable accumulation at this lowest point therein.

[0052] For a connection from the pump **230** and ultimately to inlet **110**, it should be apparent that a back flow of the raw liquids flowing through **110** to the pump **230** is an undesirable situation. Thus, a check valve **340** (for example, shown in FIG. **3**D) is inserted within the piping to prevent this possibility and thus uses two pipe segments **320**A-**320**B as follows (or a single pipe **320**A if it is practical to insert it directly within the pipe itself). The check valve **340** is inserted between this first pipe segment **320**A (from the pump to the check valve **340**) and a second pipe segment **320**B (from the check valve **340** to **290** connector opening at inlet pipe **110**A) whose other end is attached or welded to an opening in the inlet pipe **110**A for this purpose. A first end of the second segment **320**B has a first end connected to the check valve **340** and its second end has a welded connection **290** (or otherwise such as thread to thread connection between pipe **320**B and inlet pipe **110**A) to inlet pipe **110**A through an opening for this purpose therein. Pipe **320** (whether as a group of pipe segments **320**A-B welded together or as a single pipe) goes out hole **370** in container **100** and once outside container the pipe **320** (or segments **320**A-B depending upon where the designation of **320**A-**320**B ends) goes to a connection where the end of either **320** in some embodiments or **320**B in segments connects to.

[0053] A level detection device (LT) **270** (float switch or level transmitter) is located in the lower basin **170** that communicates information to a PLC that is able to turn pump **230** on and off based on desired level of the lower basin **170**. Typically, if the lower basin **170** is too high it turns ON the pump **230** and if the lower basin **170** it is too low then it turns OFF the pump **230**. This operation works in coordination with the needs of a Programmable Logic Controller PLC that receives signals from the Level Detection Device **270** and controls liquids based upon operational needs. The level detection device **270** has some form of electrical connection to the PLC. These include wireless, wired, electromagnetic, magnetic, infrared, optical or other types thereof. The PLC is able to detect problems with the pump, either by detecting a high level above normal operating levels or by a fault detection device on the pump. When a pump fault is detected or too high level in basin **170**, the PLC is capable of opening an automated valve (**206**) and by-passing the pump by allowing the reject to blend with the effluent.

[0054] The valve **206** is attached at **300** to a pipe attached a first end (typically welded) to an opening in the right side of container **100** and at its other end to valve **206**. The valve **206** other end is attached to a pipe **300**A; this pipe **300**A has another end attached (typically welded) to an opening in an effluent pipe **390** flowing from the outflow **220**; this outflow **220** is a pipe having a first end welded to the right side of container and its flanged other end attached to an effluent pipe **390** flanged end. Finally, the lower basin overflow line **310**A is connected at **310** using its integral flanged connector that is attached to a pipe attached to the side of the container **100** that also has its own integral flanged connector; the attachment between these two integral flanged connectors is made using bolts-nuts or welding at **310**. The lower basin overflow line **310**A is attached at another end to an opening in the effluent pipe **390** through welding or similar connection.
[0055] FIG. **3**B presents a rotated section view of the Liquid Solid Separator Recycling System of FIG. **3**A in a third embodiment disclosed herein. FIG. **3**B represents one configuration with internal sump pump going to **260**.
[0056] The pump **230** is attached to a pipe **320**A that recycles liquids from the lower basin **170** up towards a connector **260** (a hole to which pipe **320**A is typically welded to). In order to arrive at this connector **260**, the pipe **320**A proceeds through a hole **370** in the back side of container outside of container **100** and using an L shaped section of this pipe is connected to connector **260**. Connector **330** is blinded or blocked in this implementation but could be used if desired by a user.
[0057] In the event of a pump failure, the liquid in the lower basin **170** would rise and risk fouling the treated liquids leaving the container through outflow line **220**. A PLC is provided that is able to detect problems with the pump, either by detecting a high level above normal operating levels or by a fault detection device on the pump. Therefore, the level detection device (LT) **270** (float switch or level transmitter) senses the rising of the liquid reject within the lower basin **170**. It transmits a signal to the PLC which in turn communicates through wired or wireless communication to electronically controls the OPEN and CLOSED state of electromechanical valve **206**. Thus, the system by-passes the pump by allowing the reject from lower basin **170** to blend with the effluent where effluent liquids and reject liquids from the lower basin are mixed such that outflow line **220** treated liquids and reject liquids mix at a connection (not shown) between a pipe **390** connected to outflow line **220** externally to container **100**, and a reject line connected to the valve **206** connected to pipe **390** as described previously.
[0058] FIG. **3**C presents a rotated section view of the Liquid Solid Separator Recycling System of FIG. **3**A in a fourth embodiment disclosed herein. FIG. **3**C represents one configuration with internal sump pump going to **330** with check valve. FIG. **3**C presents a similar disposition of elements as **3**B with the two differences: i) a check valve **340** is attached between two sections **320**A, **320**B of pipe **320** (collectively pipe **320**); and ii) the pipe **320**, specifically section **320**B is attached to connector **330**. This connector **330** is typically an opening in back side of container **100** to which pipe **320** is attached; it can also be welded/bolted/thread to thread connection. The connector **330** is situated below the another connector **260** which is located on the same side of container **100** as the connector **330** where connector **260** is above weir **350** and connector **330**. In this embodiment the connector **260** is blinded or closed but is still available for some other use in the event a user wishes to use it.
[0059] Connector **330** is located near or at the lowest (and near or at narrowest) possible point (in the influent basin region) between the filter belt lowest end in container **100** and the corresponding side of the container **100** facing the filter belt. Pipe section **320**A is connected to the pump and exits the back side of the container **100** at **370** opening (hole) and is attached to the check valve **340** whilst section **320**B is connected to check valve **340** and to connector **330**. The operation is the same as FIG. **3**C with the addition that since there is a check valve **340** then liquids in the influent basin above the filter belt are prevented from flowing back through the pipe **320** to pump **230**.
[0060] FIG. **3**D presents a rotated section view of the Liquid Solid Separator Recycling System of FIG. **3**A in a fifth embodiment disclosed herein. FIG. **11**D represents one configuration same as **3**C

except the recycle is connected to external piping at **290**. FIG. **3**D presents a similar disposition of elements as **3**C with the the difference being: the pipe **320** (specifically section **320**A) passes through an opening **370** (a hole through which pipe **320** passes) in the side of container **100** and is attached to a check valve **340**. The pipe **320** section **320**B is attached to a check valve **340** and its L shaped portion is connected to an opening in inlet pipe **110**A. Here, a portion of the pipe (**320**B) has a welded connection (or otherwise such as thread to thread connection) between pipe section **320**B and inlet pipe **110**A at an opening **290** in the inlet pipe **110**A. The inlet pipe has a flanged welded/bolted connection to inflow small pipe at **110**.

[0061] FIG. **4** presents a Liquid Solid Separator Recycling System in a seventh embodiment disclosed herein on the side of container **100**. FIG. **4** represents redundant pump both internal and external and represents six configurations. The check valve isn't shown but implied for connection to **330** and **290**. Thus, the various attachments could be made at any one of the possible connections provided as is already implied from the sketch. There are six possible connection variations with IP meaning internal pump connection, EP meaning external pump connection: 1) IP **260** EP **290**, **330** blocked; 2) IP **260** EP **330**, **290** blocked; 3) IP **290** EP **260**, **330** blocked; 4) IP **290**, EP **330**, **260** blocked; 5) IP **330** EP **260**, **290** blocked; 6) IP **330** EP **290**, **260** blocked.

[0062] This embodiment is a modification of the first with the differences being: i) there are three return paths for liquids from external pump **230** situated in sump **240** that end in one of connections/connectors **260**, **290** and **330**; ii) the addition of an internal pump **230** within the lower basin of container **100** using one of the unused return paths to an unused connection/connector not used by the external sump **240** pump **230**; and iii) the lower basin drain line has an automated valve **206** (controlled by the PC) within it to control the path of liquids therein. It should be appreciated that any unused connections/connectors **260**, **290**, **330** would be blinded/blocked in this or other embodiments.

[0063] Again the pipe **320**A section passes through the hole **370** in the back side of the container to one of the unused return paths to a connection/connector **260**, **290**, **330**. The connector **330** is situated below the another connector **260** which is located on the same side of container **100** as the connector **330** where connector **260** is above weir **350** and connector **330**. Connector **330** is located near or at the lowest (and near or at narrowest) possible point between the filter belt lowest top portion facing the influent basin and the corresponding side of the container **100** facing the filter belt. Pipe section **320**A is connected to the internal pump **230** within lower collection basin **170** and passes out through a hole **370** in the back side of container **100** to one of the unused connector/connections **260**, **290**, **330**.

[0064] Care should be taken that if the connector/connection is under the liquid level of the influent basin then a check valve is used in the piping to prevent back flow. For example, a check valve **340** is inserted between this first pipe segment **320**A (from the pump to the check valve **340**) and a second pipe segment **320**B (from the check valve **340** to a connection **290** to inlet pipe **110**A). A first end of the second segment **320**B has a first end connected to the check valve **340** and it second end has a welded connection **290** (or otherwise such as thread to thread connection between pipe **250**B and inlet pipe **110**A) to inlet pipe **110**A through an opening for this purpose therein. The check valve **340** is utilized to prevent influent basin unscreened liquids from by-passing and going through the pipe **320**B to the pump **230**. However, if the pipe **320**A from the pump **230** inside the container **100** is to connector **260**, then it proceeds as shown in FIG. **3**B through a hole **370** without a second pipe **320**B. Also, the other connector/connection **260**, **290**, **330** would remain unused. The various six combinations described above are possible and would have back flow preventer or check valves if the liquid level could cause a back flow through the piping to a pump. As an alternative, the valve could be located integrally within the pipe so there would be a single pipe line **320**A instead of the two for a valving system.

[0065] When the Level Detection Device **270** (level sensor) detects that liquids in the lower basin **170** are too high (or that the pump has failed through a control system or dedicated electric summation circuit) it transmits a signal to the PLC of the system informing it of this fact. As a result the PLC transmits an OPEN signal to valve **206** on lower basin drain line **300**. This signal can be direct to a valve micro-controller or electronic circuitry controlling the electric motor of the valve. When level detection device (LT) **270** (float switch or level transmitter) detects that the liquids in the lower collection basin **170** are too low (or that the pump is working again through a control system or dedicated electric summation circuit) then it transmits a CLOSE signal to check valve **206** to resume normal operation.

[0066] A second level detection device **270** located in sump **240** also determines the level of liquid within external sump **240** therein. In the event that this level detection device **270** determines too high a level for the external sump **240**, then it sends a signal to the PLC associated with the liquid solid separator warning of an external problem through a marked light on the panel or computer display warning that the external sump **240** has an overflow problem.

[0067] FIG. **5** presents a Liquid Solid Separator Recycling System in an eighth embodiment disclosed herein. FIG. **5** represents the configuration where the pump is in fact the primary influent pump. Since the primary pump is being used for the recycle and there is no second pump and a check valve is not required.

[0068] This embodiment is a variation of that shown in FIG. **1** with these distinct differences: i) pump **230** is attached at **250** to a pipe **110**A and situated within an external sump **240** wherein the pipe **110**A is directly attached to inlet **110** through welding, dual flanged bolt, thread to thread connection or similar connection; ii) overflow pipe **310**A is connected to a side of container **100** at **310** and this pipe **310**A empties into external sump **240**; ii) lower collection basin drain line **300** has a pipe **300**A connected thereto; this pipe **300**A has an end that is welded or otherwise attached to an opening in the side of overflow pipe **310**A so that it also empties to the sump **240**. Municipal provided liquids or otherwise sourced liquids are provided for refilling the external sump **240** using pipe **360**.

[0069] When Level Detection Device **270** situated in sump **240** determines that liquids level in sump **240** are too low then it transmits this fact to a PLC controlling the operation of the Liquid Solid Separation for presentation to a user display. Similarly, when Level Detection Device **270** situated in sump **240** determines that liquids level in sump **240** are available or too high then it transmits this fact to a PLC controlling the operation of the Liquid Solid Separation for presentation to a user display.

[0070] FIG. **6** presents an isometric view of a Liquid Solid Separator Recycling System Container disclosed herein showing the recycling pipe on a side thereof returning liquids above the influent basin above the rotating filter belt to connector **260**. Here the pipe **320**A attached to an internal pump exits the container through a hole **370** therein (could be welded, fitting, bracketed or otherwise attached to hole **370**). The pipe is made of several portions and fittings to arrive at the connector **260**. However, it could be a single pipe that has been made from machined, bent metal and or plastic extrusion passing through a hole **370** to arrive at connection/connector **260**.

Other Considerations

[0071] It is intended that the above novel embodiments be utilized with appropriate connection the Liquid Solid Separator System taught in U.S. patent application Ser. No. 14/470,794 filed on 27 Aug. 2014.

[0072] A liquid solid separator has a main container wherein a rotating filter belt receives influent for liquid sold mixture sieve processing. Various recirculation systems are proposed including an external pump sump recirculation, internal pump recirculation and dual pumps with one disposed externally in a sump and one internally in the lower basin of the container. Recirculation points include an inflow pipe connection, an influent basin connection located above the influent basin, and an influent basin connection located under the liquid solid mixture influent level. The influent basin connection location under the liquid solid mixture influent level is typically the lowest level between the container wall facing the angled portion of the rotating filter belt and the angled

portion of the rotating filter belt.
[0073] Thus, when looking at FIG. **1**, for example, a portion of rotating filter belt **130** receiving liquid solid mixture from the left in the figure is a hypotenuse of a hypothetical triangle; also, the container wall facing this portion of rotating filter belt (RFB) **130** is an adjacent hypothetical side of this hypothetical triangle and when lines are drawn by downwards extension they meet at a point and as near as practical between the RFB **130** and the wall forms a location for placement of a connector on a back side of the container **100**.
[0074] Check Valve: A check valve is defined as any device designed to restrict flow of liquids and or liquid solid mixtures to one direction down a pipe, hose or other channel. For example, a check valve can alternatively be replaced with an electric automated ball valve that only opens when the pump is on. Additionally, the check valve can alternatively be physically inserted within a single pipe itself rather than two pipe segments.
[0075] Unused Connections: It should be appreciated that any unused connections/connectors **260**, **290**, **330** would be blinded/blocked in this or other embodiments. Of course, they could be reopened and utilized if desired by the end user.
[0076] Priorities: Other Connection **260** is the preferred connection because it eliminates the need for a check valve and therefore is the most efficient place for the recycle operation. Connection **330** may be desired in order to agitate the lower portion of the influent basin where solids could settle in certain applications with heavy solids. Connection **290** may be desired when piping and location are advantageous. For example, if the external sump is located a far distance from the container, but the influent pipe **110**A is located nearby, it may be feasible to make the connection on the pipe in local proximity rather to run a dedicated pipe to the container. FIG. **11**D illustrates that the recycle could be placed in any of the locations.
[0077] In any embodiment attachments at connections/connectors **260**, **290**, **330** are welded, screw on thread to thread, bracket or otherwise.
[0078] The above-described embodiments are merely exemplary illustrations of implementations set forth for a clear understanding of the principles of the invention. Many variations, combinations, modifications or equivalents may be substituted for elements thereof without departing from the scope of the invention. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all the embodiments falling within the scope of the appended claims.

Claims

1. A liquid solid separator has a main container wherein a rotating filter belt receives influent for liquid sold mixture sieve processing. Various recirculation systems are proposed including an external pump sump, internal pump recirculation and dual pumps with one disposed externally in a sump and one internally in the lower basin of the container. Recirculation points include an inflow pipe connection, an influent basin connection located above the influent basin and influent basin connection located underneath the liquid solid mixture influent level.