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(54) **METHOD AND SYSTEM FOR CLEANING SAND**

(71) Applicant: **KB Foundry Services, LLC**, Independence, OH (US)

(72) Inventors: **Mark R. Pine**, Burbank, OH (US); **Zachary R. Pine**, Cleveland, OH (US); **Michael L. Lenahan**, South Bend, IN (US)

(73) Assignee: **KB Foundry Services, LLC**, Independence, OH (US)

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CPC ***B03B 5/34*** (2013.01); ***B08B 3/044*** (2013.01); ***B22C 5/185*** (2013.01)

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CPC B03B 5/34; B03B 7/00; B03B 9/04; B08B 3/044; B22C 5/044; B22C 5/185
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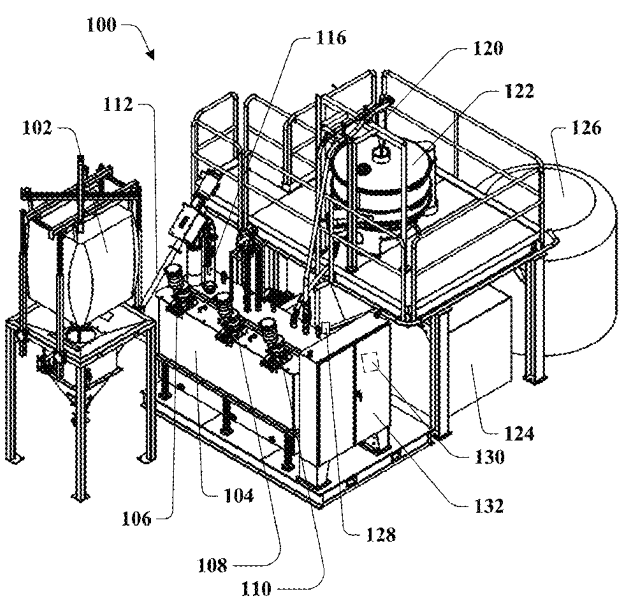
Primary Examiner — Joseph C Rodriguez
(74) *Attorney, Agent, or Firm* — Tucker Ellis LLP; Ross M. Kowalski

(57) **ABSTRACT**

A system for processing a sand product includes a process tank having a first compartment, a second compartment in fluid communication with the first compartment, and a third compartment that is isolated from the first compartment and the second compartment. The system also includes a first hydrocyclone configured to receive a sand mixture comprising the sand product and water from the first compartment, and separate the sand mixture into wet sand and a clay mixture. The second compartment is configured to receive the wet sand and clay mixture from the first hydrocyclone. The system also includes a second hydrocyclone configured to receive the wet sand and the clay mixture from the second compartment, and further separate the wet sand from the clay mixture to produce a clay product that can include a fully hydrated clay material. The third compartment is configured to receive the clay product from the second hydrocyclone.

20 Claims, 5 Drawing Sheets



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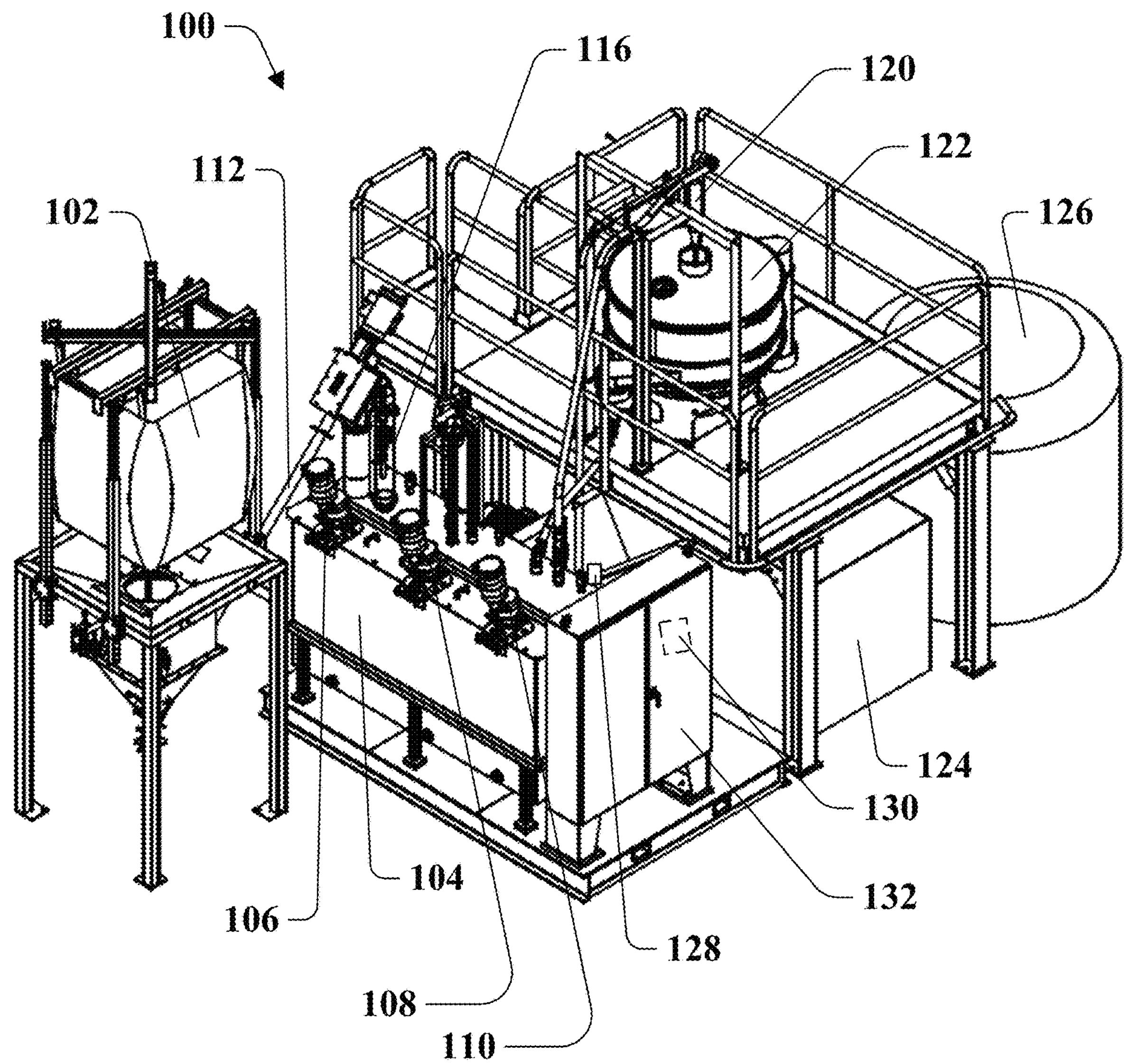

FIG. 1

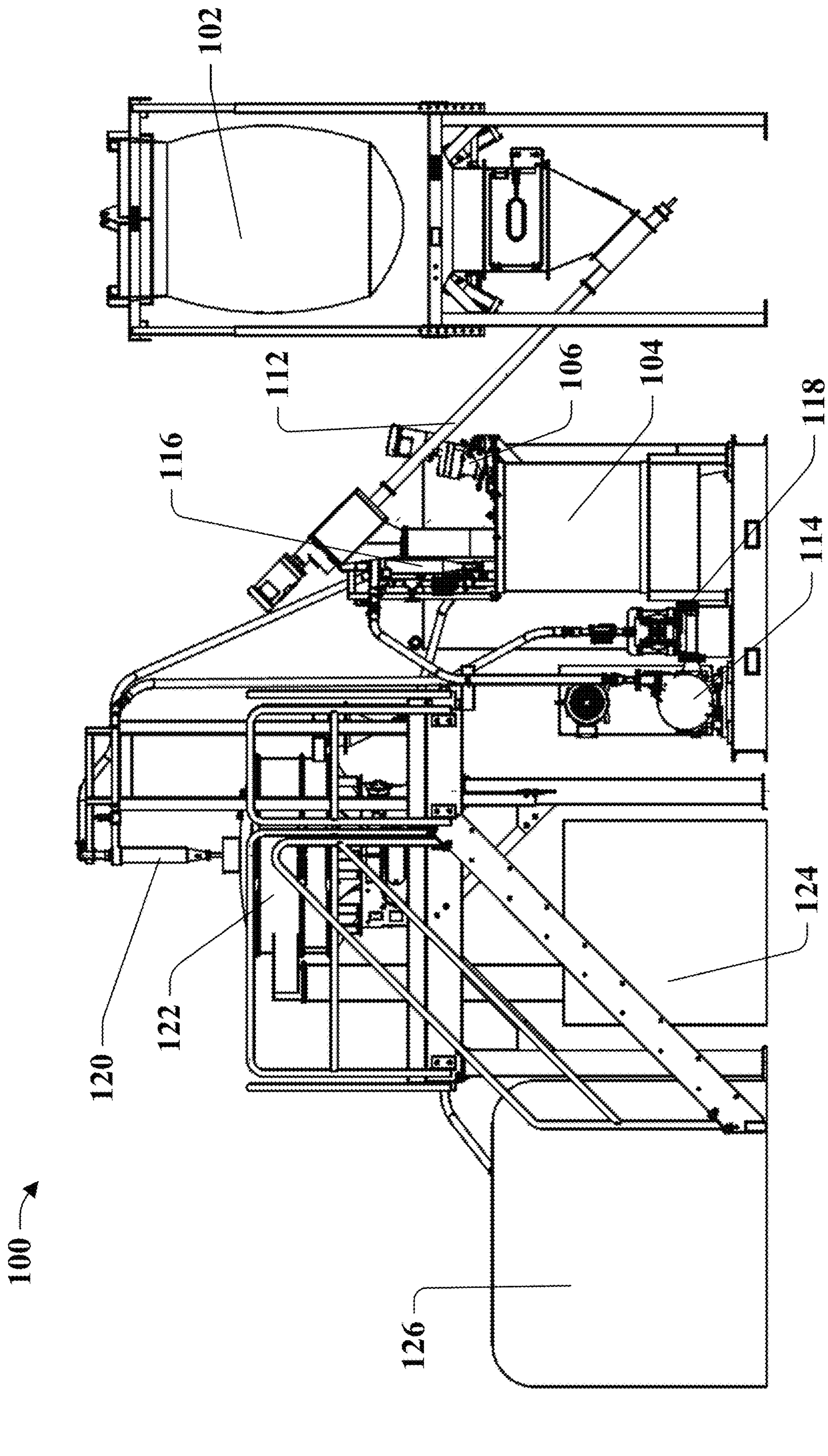

FIG. 2

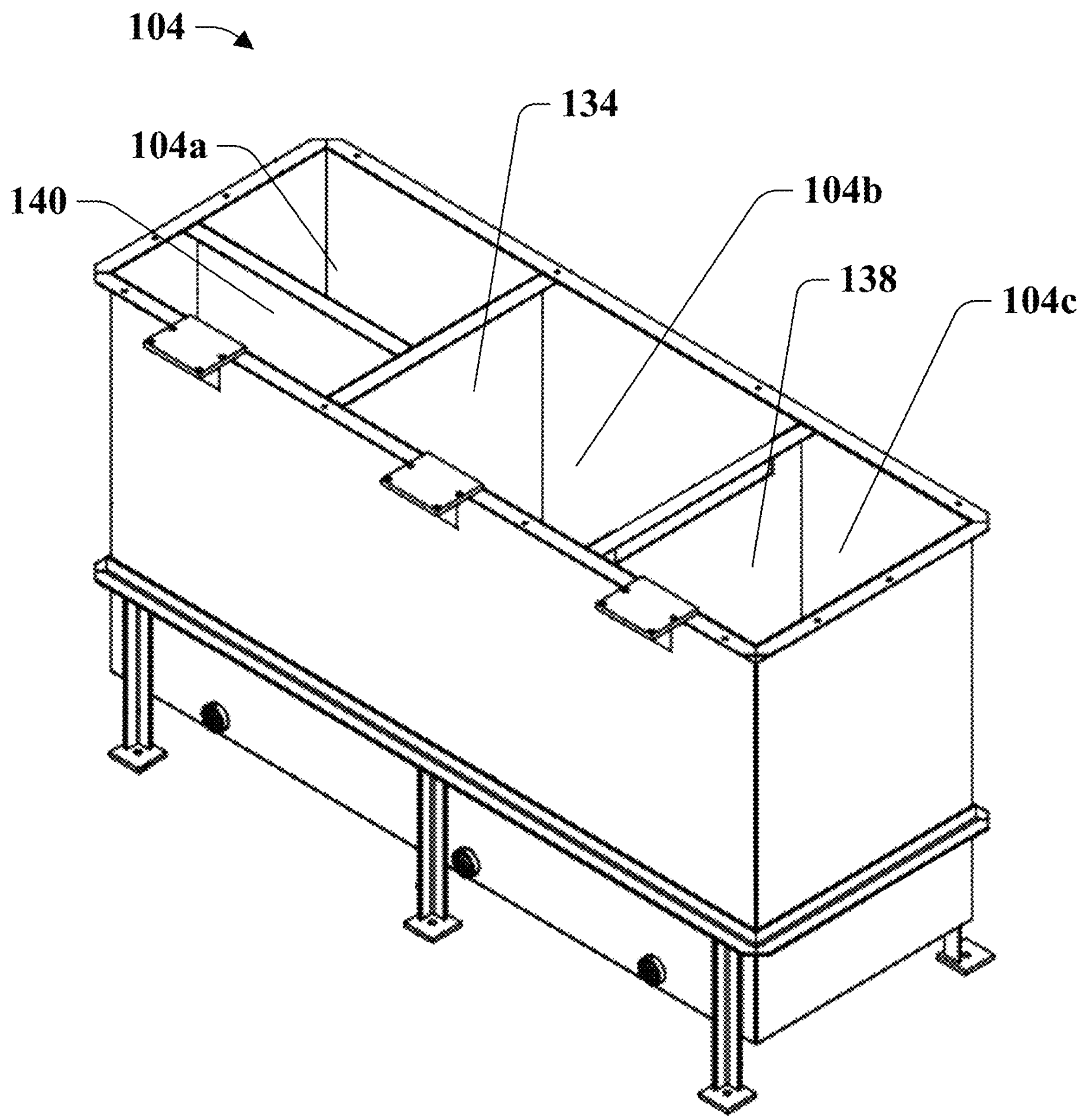

FIG. 3

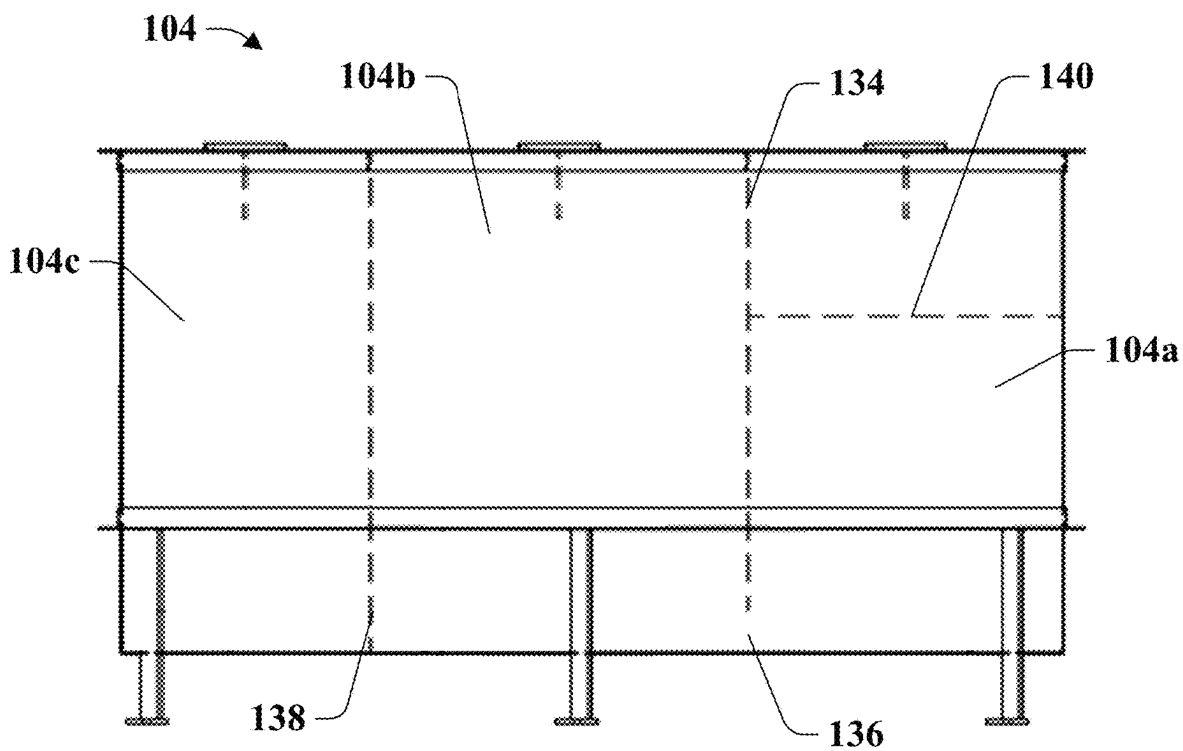

FIG. 4

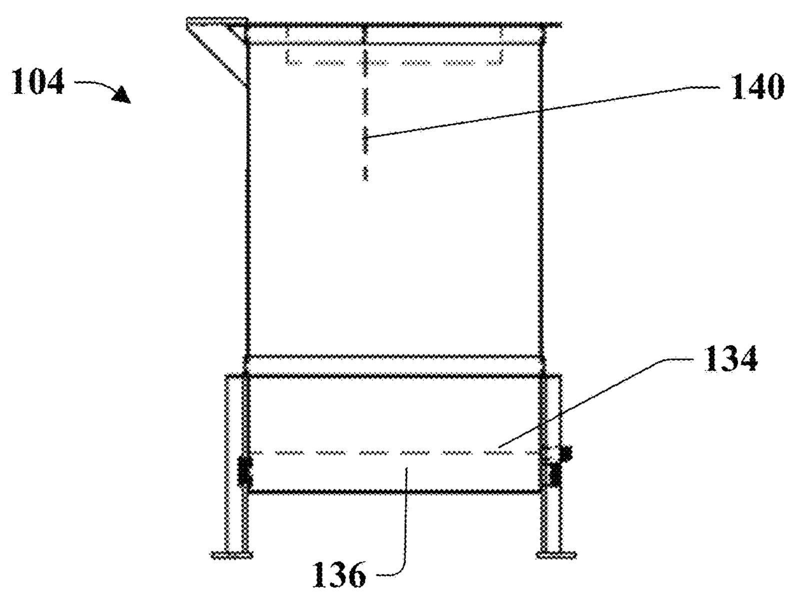

FIG. 5

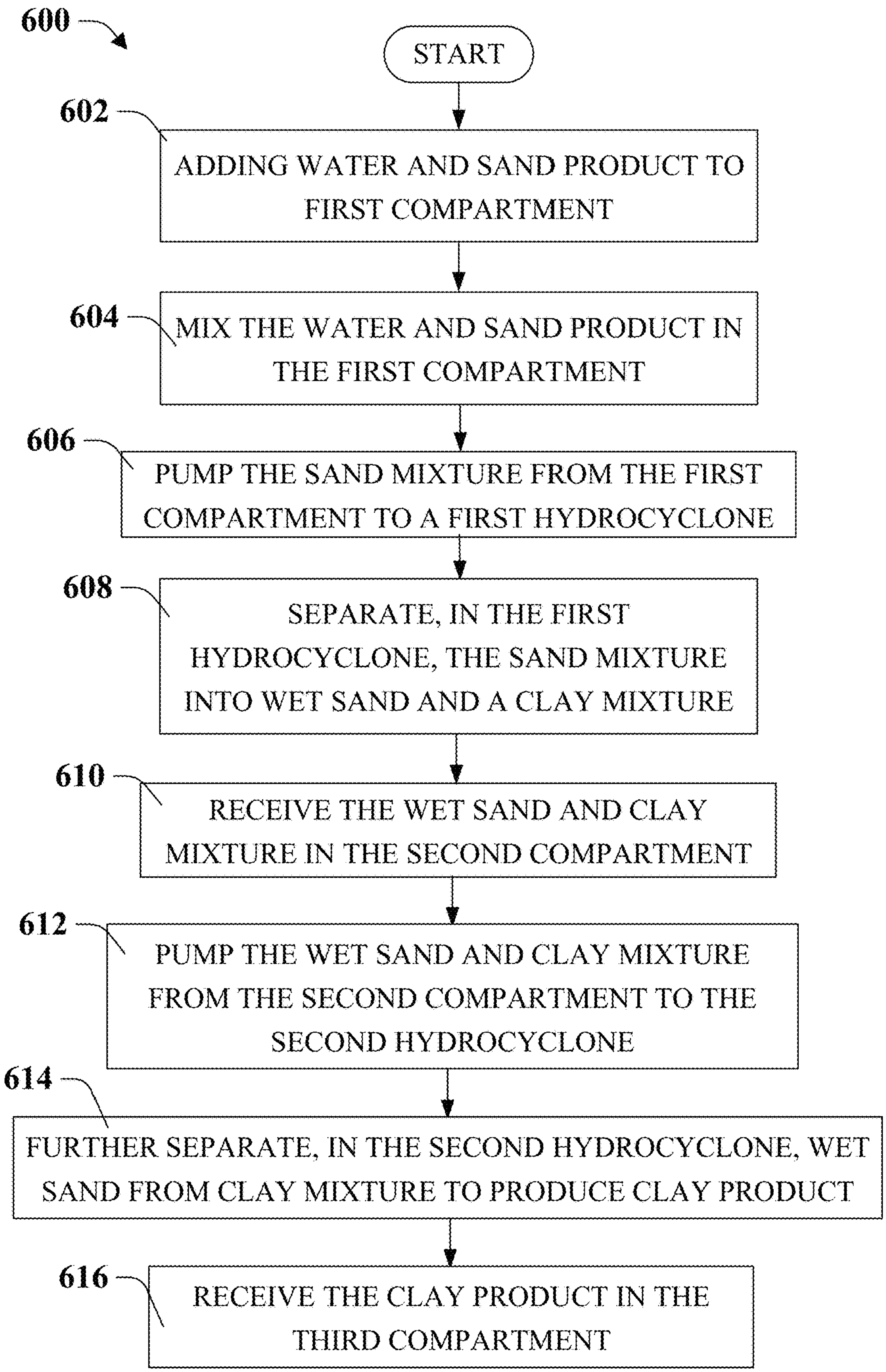
600
START
602
ADDING WATER AND SAND PRODUCT TO FIRST COMPARTMENT
604
MIX THE WATER AND SAND PRODUCT IN THE FIRST COMPARTMENT
606
PUMP THE SAND MIXTURE FROM THE FIRST COMPARTMENT TO A FIRST HYDROCYCLONE
608
SEPARATE, IN THE FIRST HYDROCYCLONE, THE SAND MIXTURE INTO WET SAND AND A CLAY MIXTURE
610
RECEIVE THE WET SAND AND CLAY MIXTURE IN THE SECOND COMPARTMENT
612
PUMP THE WET SAND AND CLAY MIXTURE FROM THE SECOND COMPARTMENT TO THE SECOND HYDROCYCLONE
614
FURTHER SEPARATE, IN THE SECOND HYDROCYCLONE, WET SAND FROM CLAY MIXTURE TO PRODUCE CLAY PRODUCT
616
RECEIVE THE CLAY PRODUCT IN THE THIRD COMPARTMENT

FIG. 6

METHOD AND SYSTEM FOR CLEANING SAND

TECHNICAL FIELD

In general, the present invention relates to a system and method for processing foundry waste products to create a reusable clay product.

BACKGROUND OF THE INVENTION

Foundry operations utilize green sand to create molds for casting metal products. The green sand typically comprises a mixture of sand, a binder material (e.g., clay and carbon mix), and water. The molds are formed, the casting is made, and the used sand is removed from the casting. The resulting used sand can be disposed of, or portions may be re-used after being subjected to specialized treatment. Re-using sand products from a foundry can potentially save resources for a foundry. However, the effective collection and treatment of high-quality re-use sand often utilizes specialized processes and systems.

SUMMARY OF THE INVENTION

As provided herein, one or more methods and systems for cleaning a sand product from a foundry sand handling operation is provided. A sand product such as foundry sand can be collected from a variety of places in a foundry, including a mold making operation, and/or a casting removal and cleaning process. The collected sand product can be cleaned and separated into a clay material such as a material that includes a clay and carbon mixture, and a beneficial re-use sand. The clay and carbon mixture may be re-used in the foundry, and the beneficial re-use sand can be used offsite.

In accordance with an embodiment of the present invention a system for processing a sand product includes a process tank that has a first compartment, a second compartment in fluid communication with the first compartment, and a third compartment that is isolated from the first compartment and the second compartment. The system also includes a first hydrocyclone configured to receive a sand mixture comprising the sand product and water from the first compartment, and separate the sand mixture into wet sand and a clay mixture. The second compartment is configured to receive the wet sand and clay mixture from the first hydrocyclone. The system also includes a second hydrocyclone configured to receive the wet sand and the clay mixture from the second compartment, and further separate the wet sand from the clay mixture to produce a clay product that can contain a fully hydrated clay material. The third compartment is configured to receive the clay product from the second hydrocyclone.

In one aspect, the process tank further includes a first wall separating the first compartment from the second compartment. The first wall extends partially towards a bottom of the process tank, defining a gap that provides the fluid communication between the first compartment and the second compartment. The process tank also includes a second wall separating and providing isolation between the second compartment and the third compartment.

In one aspect, the process tank further includes a first mixer configured to mix the sand mixture within the first compartment, a second mixer configured to mix the wet sand and the clay mixture in the second compartment, and a third mixer configured to mix the clay product in the third compartment.

In one aspect, the system includes a first pump configured to pump the sand mixture from the first compartment to the first hydrocyclone, and a second pump configured to pump the wet sand and the clay mixture from the second compartment to the second hydrocyclone.

In one aspect, the system further includes a holding tank configured to receive the clay product from the third compartment.

In one aspect, the system further includes a third pump configured to pump the clay product from the third compartment to the holding tank.

In one aspect, the first hydrocyclone is larger than the second hydrocyclone.

In one aspect, the system further includes a conveyor configured to transport the sand product from a hopper into the first compartment.

In another embodiment, a method of processing a sand product includes adding water and the sand product to a first compartment of a process tank, mixing the water and the sand product in the first compartment to create a sand mixture, pumping the sand mixture from the first compartment to a first hydrocyclone, separating, in the first hydrocyclone, the sand mixture into wet sand and a clay mixture, receiving, from the first hydrocyclone, the wet sand and the clay mixture in a second compartment of the process tank, pumping the wet sand and the clay mixture from the second compartment to a second hydrocyclone, further separating, in the second hydrocyclone, the wet sand from the clay mixture to produce a clay product; and receiving, from the second hydrocyclone, the clay product in a third compartment of the process tank that is isolated from the first compartment and the second compartment.

In one aspect, the first compartment is in fluid communication with the second compartment.

In one aspect, adding the water and the sand product to the first compartment includes continuously adding the water at a fixed water rate and the sand product at a fixed sand product rate such that a constant level is maintained in the first compartment while pumping the sand mixture from the first compartment to the first hydrocyclone.

In one aspect, the method further includes pumping the clay product from the third compartment to a holding tank when a threshold level is reached within the third compartment.

In another embodiment, a system for processing a sand product includes a process tank including a first compartment, a second compartment in fluid communication with the first compartment, and a third compartment that is isolated from the first compartment and the second compartment. The system further includes a first hydrocyclone, a second hydrocyclone, a first pump, a second pump, and a controller configured to: operate the first pump to pump a sand mixture comprising the sand product and water from the first compartment to the first hydrocyclone such that a wet sand and a clay mixture flow from the first hydrocyclone into the second compartment, and operate the second pump to pump the wet sand and the clay mixture from the second compartment to the second hydrocyclone such that a clay product flows from the second hydrocyclone to the third compartment.

In one aspect, the system further includes a third pump and a holding tank, wherein the controller is further configured to receive a level of the clay product in the third compartment, and in response to the level reaching a threshold level, operating the third pump to pump the clay product to the holding tank.

In one aspect, the process tank further includes a first wall separating the first compartment from the second compartment. The first wall extends partially towards a bottom of the process tank, defining a gap that provides the fluid communication between the first compartment and the second compartment. The process tank further includes a second wall separating and providing isolation between the second compartment and the third compartment.

In one aspect, the process tank further includes a first mixer configured to mix the sand mixture within the first compartment, a second mixer configured to mix the wet sand and the clay mixture in the second compartment, and a third mixer configured to mix the clay product in the third compartment.

In one aspect, the first hydrocyclone is larger than the second hydrocyclone.

In one aspect, the system further includes a conveyor configured to transport the sand product from a hopper into the first compartment.

In one aspect, the controller is further configured to operate the conveyor to continuously add the sand product to the first compartment at a fixed sand product rate, and to continuously add water at a fixed water rate.

In one aspect, the fixed sand product rate and the fixed water rate are selected such that a constant level is maintained in the first compartment while the controller operates the first pump to pump the sand mixture to the first hydrocyclone.

These and other objects of this invention will be evident when viewed in light of the drawings, detailed description and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may take physical form in certain parts and arrangements of parts, a preferred embodiment of which will be described in detail in the specification and illustrated in the accompanying drawings which form a part hereof, and wherein:

FIG. **1** is a perspective view of an exemplary system for processing a sand product;

FIG. **2** is an elevation view of the exemplary system for processing a sand product;

FIG. **3** is a perspective view of an exemplary process tank;

FIG. **4** is a rear cross-sectional view of the exemplary process tank;

FIG. **5** is a side cross-sectional view of the exemplary process tank; and

FIG. **6** is a flow diagram depicting an exemplary method for processing a sand product.

DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the invention relate to a system for processing a sand product. An embodiment of the system includes a process tank that has a first compartment, a second compartment in fluid communication with the first compartment, and a third compartment that is isolated from the first compartment and the second compartment. The system also includes a first hydrocyclone configured to receive a sand mixture comprising the sand product and water from the first compartment, and separate the sand mixture into wet sand and a clay mixture. The second compartment is configured to receive the wet sand and clay mixture from the first hydrocyclone. The system also includes a second hydrocyclone configured to receive the wet sand and the clay mixture from the second compartment, and further separate the wet sand from the clay mixture to produce a clay product that contains a fully hydrated clay material. The third compartment is configured to receive the clay product from the second hydrocyclone. The system takes a sand product that is a result of foundry operations and ultimately processes it into a clay product that can be reused in a foundry's operations.

Beneficial re-use foundry sand has found use in a variety of applications and industries. Further, beneficial re-use foundry sand can be a commodity instead of a waste product, potentially saving resources for a foundry. Beneficial re-use foundry sand comprises sand that has been used by the foundry and typically may not be appropriate for re-use by the foundry. Effective collection of high-quality re-use sand may utilize specialized processes and systems.

The best mode for carrying out the invention will now be described for the purposes of illustrating the best mode known to the applicant at the time of the filing of this patent application. The examples and figures are illustrative only and not meant to limit the invention, which is measured by the scope and spirit of the claims.

A system can be devised that can produce a high-quality clay material from a sand product from a foundry. Referring now to the drawings, wherein the drawings are for the purpose of illustrating an exemplary embodiment of the invention only and not for the purpose of limiting same, FIG. **1** and FIG. **2** illustrate an exemplary system **100** for processing a sand product. The system **100** can include a sand hopper **102** that can be supported by or coupled to a support structure. The sand hopper **102** can be a fixed unit, or it can be a collection bag or baghouse transported from a foundry. The system **100** further includes a process tank **104**. The process tank **104** can include a first compartment **104**_a_, a second compartment **104**_b_, and a third compartment **104**_c_ (as shown in FIG. **3** and described in greater detail below). The process tank **104** can further include a first mixer **106** that extends into the first compartment **104**_a_, a second mixer **108** that extends into the second compartment **104**_b_, and a third mixer **110** that extends into the third compartment **104**_c_. The first mixer **106**, second mixer **108**, and the third mixer **110** can include rotating blades designed to push solids down and then up the sides of the respective compartment to keep the solids in suspension. In certain embodiments, the first mixer **106**, second mixer **108**, and the third mixer **110** can be made of a metal or an alloy, such as bronze, or any other metal/alloy chosen using sound engineering judgment.

A conveyor **112** can extend from the hopper **102** to an entrance to the first compartment **104**_a_. By way of example and not limitation, the conveyor **112** can be a screw conveyor, a belt conveyor, or a bucket elevator, among others. The conveyor **112** is configured to transport the contents of the hopper **102**, such as a sand product, into the first compartment **104**_a_. The system **100** further includes a first pump **114** and a first hydrocyclone **116**. The first pump **114** can be configured to pump the contents of the first compartment **104**_a_, such as a sand mixture of the sand product and water, to the first hydrocyclone **116** via one or more pipes, tubes, or hoses. In one embodiment, the first hydrocyclone **116** is mounted at a position above the process tank **104**, specifically above the first compartment **104**_a_ and/or the second compartment **104**_b_. The system **100** further includes a second pump **118** and a second hydrocyclone **120**. The second pump **118** can be configured to pump the contents of the second compartment **104***b*, such as wet sand and a clay mixture, to the second hydrocyclone **120** via one or more pipes, tubes, or hoses. In one embodiment, the second hydrocyclone **120** can be mounted on a platform or scaffolding, at a position higher than the process tank **104**. In certain embodiments, the first hydrocyclone **116** is larger than the second hydrocyclone **120**. For example, the first hydrocyclone **116** can be a three-inch hydrocyclone and the second hydrocyclone **120** can be a two-inch hydrocyclone. The three-inch hydrocyclone has a three-inch diameter inlet and the two-inch hydrocyclone has a two-inch diameter inlet.

In certain embodiments, the first pump **114** and/or the second pump **118** is a slurry pump. The first pump **114** and/or the second pump **118** can be constructed from any material chosen using sound engineering judgment. In one example, the first pump **114** and/or the second pump **118** is made at least partially of chrome to withstand the silica sand that is abrasive. In one embodiment, the first pump **114** and/or the second pump **118** is constructed of 27% chrome.

A separator **122** can be positioned beneath the second hydrocyclone **120** to collect wet sand and further separate remnant water from the wet sand. A sand bin **124** can be coupled to the separator **122** such that sand separated out in the separator **122** can fall into the sand bin **124** for containment and storage. The system **100** can also include a holding tank **126**. The holding tank **126** can be configured to store the clay product resulting from the second hydrocyclone **120**. A third pump **128** can be configured to pump the clay product from the third compartment **104***c* to the holding tank **126** via one or more pipes, tubes, or hoses. In one embodiment, the third pump **128** is a diaphragm pump.

The system **100** and its components (e.g. the conveyor **112**, the first pump **114**, and the second pump **118**) can be controlled by a controller **130** located within a control cabinet **132**. The controller **130** can be, for example, a programmable logic controller (PLC). In other embodiments, the controller **130** can be implemented with a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. The controller **130** may be a microprocessor, but in the alternative, the controller **130** may be any processor, controller, microcontroller, or state machine. The controller **130** may also be implemented as a combination of computing devices, for example a combination of a DSP and a microprocessor, a plurality of microprocessors, multi-core processors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. The controller **130** can be configured by way of software code such as ladder logic, among others, to perform the methods disclosed herein.

Turning now to FIGS. **3**-**5**, a process tank **104** is shown. The process tank **104** can include a first compartment **104***a*, a second compartment **104***b*, and a third compartment **104***c*. The first compartment **104***a* is separated from the second compartment **104***b* by a first wall **134**. The first wall **134** extends partially towards the bottom of the process tank **104** and defines a gap **136** below a bottom of the first wall **134** that provides fluid communication between the first compartment **104***a* and the second compartment **104***b*. In other words, the first compartment **104***a* and the second compartment **104***b* are not isolated from one another, and a portion of the contents of the first compartment **104***a* may flow into

the second compartment **104***b* through the gap **136** and a portion of the contents of the second compartment **104***b* may flow into the first compartment **104***a* through the gap **136**.

The second compartment **104***b* and the third compartment **104***c* are separated by a second wall **138**. The second wall **138** can extend the entire depth of the process tank **104** and provides fluid isolation of the third compartment **104***c* from the second compartment **104***b*. In this manner, the third compartment **104***c* is isolated from both the first compartment **104***a* and the second compartment **104***b* such that none of the contents from the first compartment **104***a* or second compartment **104***b* can flow into the third compartment **104***c* and none of the contents from the third compartment **104***c* can flow into the first compartment **104***a* or the second compartment **104***b*. In certain embodiments, there may be a third wall **140** arranged within the first compartment **104***a* and perpendicular to the first wall **134**. The third wall **140** extends only a portion of the depth of the first compartment **104***a* and acts as a self levelling system.

Turning now to FIG. **6**, a flow chart of a method for processing a sand product **600** is depicted. At reference numeral **602**, water and a sand product are added to the first compartment **104***a* of the process tank **104**. In one implementation, the sand product may comprise a material that is collected from a foundry bag-house collection system. That is, for example, during foundry sand handling procedures, such as separation of the castings from the molds, handling and reconditioning of the used sand during shake-out or knock-out, mechanical and pneumatic conveying, bucket elevators, mixers and sand coolers, as well as cast cleaning, foundries often employ dust collection equipment to collect the airborne particulate released during these procedures. In this implementation, the collected sand product, which may comprise dust and other collected material, can be used as the sand product in the example methods and systems described herein. As one example, the sand product collected from the dust collection systems may comprise approximately fifty percent (50%) sand and approximately fifty percent (50%) clay and carbon mixture. In one non-limiting example, the clay may be a bentonite clay.

In another implementation, the sand product may comprise used sand that is collected from spent foundry sand. As an example, green sand is used to create the molds for cast products, and after the casting is created, the mold sand can be collected as used or spent foundry sand. Further, during the mold creation process, excess sand may be generated during the mold creation process, which can also be collected. In this example, these types of used foundry sand can comprise the sand product in the example methods and systems described herein. As one example, the sand product collected from the used or spent foundry sand may comprise approximately the same constituent make-up as green sand used to make the molds.

The sand product can be provided in the hopper **102**, which can be taken directly from a foundry baghouse system. The sand product can be transported from the hopper **102** to the first compartment **104***a* by way of the conveyor **112**. The water can be added from a water source (e.g. utility water hookup or on-site water storage) to the first compartment **104***a* through pipes, tubes, or hoses that are opened or closed by way of one or more valves that can be controlled by the controller **130**. The controller **130** can control the amount and/or rate of addition of the sand product by, for example, controlling the speed of the conveyor **112**. Similarly, the controller **130** can control the amount and/or rate of addition of the water to the first compartment **104***a* by, for example, operating a water valve.

Accordingly, the controller **130** can adjust the ratio of additions of the sand product and the water into the first compartment **104***a* and also the flow rate of each the sand product and the water into the first compartment **104***a*.

In one implementation, the water and sand product may be introduced to the first compartment **104***a* at an approximate ratio of about three-parts water to one part sand product or less. The ratio may be about two-parts water to one part sand product. As another example, the specific ratio of water to sand product may be altered to provide a desired sand product/water mix, depending on the type of sand product that is used, and the type and specifications of the first mixer **106** used, along with the specifications for the other parts of the system, including the first pump **114**, the first hydrocyclone **116**, the second pump **118**, and the second hydrocyclone **120**. In one embodiment, the controller **130** operates the water input (e.g. water valve) so that the water is added at a fixed water rate and the controller **130** operates the conveyor **112** so that the sand product is added at a fixed sand product rate, such that a constant volume level is maintained in the first compartment **104***a*.

At reference numeral **604**, the first mixer **106** mixes the water and the sand product in the first compartment **104***a* to create a sand mixture. The first mixer **106** can be configured to mix water and the sand product, resulting in a sand mixture comprising the sand product and water that have been added to the first compartment **104***a*. As an example, the first compartment **104***a* may be configured to continuously receive a supply of water and a supply of sand product, and the first mixer **106** can continually mix these ingredients to produce a continual flow of the sand product/water mix. In one example, the water and sand product may be received at a top area of the first compartment **104***a*, and the sand mixture may be discharged from a bottom portion of the first compartment **104***a*.

At reference numeral **606**, the sand mixture is pumped from the first compartment **104***a* to the first hydrocyclone **116**, by way of the first pump **114**. The first pump **114** can pump out the sand mixture from the first compartment **104***a* continuously while the water and the sand product are continuously being added to the first compartment **104***a*. In one example, the water and the sand product are added through the top of the first compartment **104***a* and the first pump **114** pumps the sand mixture out of the first compartment **104***a* from the bottom of the first compartment **104***a*. As discussed above, the controller **130** can operate the water input (e.g. water valve) so that the water is added at a fixed water rate and the controller **130** operates the conveyor **112** so that the sand product is added at a fixed sand product rate, such that a constant volume level is maintained in the first compartment **104***a*, taking into account the exiting flow rate of the sand mixture being pumped out of the first compartment **104***a* by the first pump **114**. In other words, the fixed sand product rate and the fixed water rate can be selected such that the volume of the sand mixture in the first compartment **104***a* remains constant due to the volume of the water and sand product entering the first compartment **104***a* being equal to the volume of the sand mixture being pumped out of the first compartment **104***a* by the first pump **114**. In this manner, the system **100** can operate in a continuous mode that does not require intervention by an operator during operation.

At reference numeral **608**, the first hydrocyclone **116** separates the sand mixture into wet sand and a clay mixture. For example, the first hydrocyclone **116** can be used to separate or sort particles in a liquid based on their fluid resistance. In this example, denser or courser particles such as sand typically have a higher fluid resistance to a generated centripetal force than the less dense or finer particles such as clay and carbon, as well as water. That is, for example, the sand mixture containing the sand product and water can be pumped from the first compartment **104***a* into the first hydrocyclone **116** at a desired pressure (e.g., thirty pounds of pressure per square inch (PSI) or more) to generate a desired centripetal force inside the first hydrocyclone **116**. In this example, because the sand is courser and denser than the clay and or carbon found in recovered sand product, wet sand can be separated from a clay mixture that can include one or more of clay, carbon, and water. Typically, the denser and/or courser material is retrieved from a bottom of the first hydrocyclone **116**, and the lighter and/or finer material can be drawn from a top portion of the first hydrocyclone **116**.

In one implementation, the clay mixture containing clay, carbon, and water that is collected from the first hydrocyclone **116** contains approximately ten to twenty-two percent (10-22%) solids, with the remaining portion comprising water. Further, in one implementation, typical makeup of the collected solids can comprise approximately seventy-five percent (75%) clay and twenty-five percent (25%) carbon; however, this makeup will be dependent upon the sand product input to the first compartment **104***a* of the example method or system, along with the setup of the first hydrocyclone **116**.

The wet sand and the clay mixture from the first hydrocyclone **116** flow into the second compartment **104***b* of the process container **104**. At reference numeral **610**, the second compartment **104***b* receives the wet sand and clay mixture from the first hydrocyclone **116**. The pressure of the sand mixture flowing into the first hydrocyclone **116**, which is produced by the first pump **114**, causes the outputs of the first hydrocyclone **116**, namely the wet sand and the clay mixture, to flow through pipes, tubes, or hoses into the second compartment **104***b*. In certain embodiments, the second mixer **108** can further mix the wet sand and clay mixture to homogenize distribution of the contents within the second container **104***b*. It should be appreciated that due to the gap **136** and the resulting fluid communication between the first container **104***a* and the second container **104***b*, the level of the contents of the first container **104***a* and the second container **104***b* is homogeneous. The fluid level of the contents of the first container **104***a* is substantially the same as the fluid level in the second container **104***b*. A portion of the sand mixture within the first container **104***a* may flow into the second container **104***b* through the gap **136**, and similarly, a portion of the wet sand and clay mixture within the second container **104***b* may flow into the first container **104***a* through the gap **136**.

At reference numeral **612**, the wet sand and clay mixture is pumped from the second compartment **104***b* to the second hydrocyclone **120**, by way of the second pump **118**. The rate at which the second pump **118** pumps the wet sand and clay mixture out of the second compartment **104***b* can be selected such that the level of contents within the second compartment **104***b* and the first compartment **104***a* remains constant, or within a level range defined by a minimum level and a maximum level, during operation as to support the continuous nature of the process.

At reference numeral **614**, the second hydrocyclone **120** further separates wet sand from the clay mixture. For example, similar to operation of the first hydrocyclone **116**, the second hydrocyclone **120** can be used to separate or sort particles in a liquid based on their fluid resistance. In this example, denser or courser particles such as sand typically have a higher fluid resistance to a generated centripetal force than the less dense or finer particles such as clay and carbon, as well as water. That is, for example, the wet sand and clay mixture (and any sand mixture that has made its way into the second compartment **104***b*) can be pumped from the second compartment **104***b* into the second hydrocyclone **120** at a desired pressure (e.g., thirty pounds of pressure per square inch (PSI) or more) to generate a desired centripetal force inside the second hydrocyclone **120**. In this example, because the sand is courser and denser than the clay mixture, wet sand can be further separated from the clay mixture that can include one or more of clay, carbon, and water. Typically, the denser and/or courser material is retrieved from a bottom of the second hydrocyclone **120**, and the lighter and/or finer material can be drawn from a top portion of the second hydrocyclone **120**. The second hydrocyclone **120** is smaller than the first hydrocyclone **116**. As a result, the first hydrocyclone **116** provides a course level of separation of wet sand from the clay mixture and the second hydrocyclone **120** provides a finer level of separation of wet sand from the clay mixture to result in a clay product that can include fully hydrated clay material, carbon, and/or water.

In one implementation, the clay product containing fully hydrated clay material, carbon, and water that is collected from the second hydrocyclone **120** contains approximately ten to twenty-two percent (10-22%) solids, with the remaining portion comprising water. Further, in one implementation, typical makeup of the collected solids can comprise approximately seventy-five percent (75%) clay and twenty-five percent (25%) carbon; however, this makeup will be dependent upon the sand product input to the first compartment **104***a* of the example method or system, along with the setup of the second hydrocyclone **120**.

In one implementation, the wet sand drawn from the second hydrocyclone **120** may be introduced to a separator **122** that is configured to further separate remnant water from the wet sand. That is, for example, the second hydrocyclone **120** separates most of the water from the sand, as the water can be included with the clay product. As an example, the separator can comprise any system suitable for performing the function of separating water from the wet sand, such as those that are commercially available. Further, as an example, depending on an amount of moisture content desired for a resulting beneficial re-use sand, a dryer may be utilized to bring the moisture content to a desired level.

In one implementation, the water separated from the wet sand may be introduced into the first compartment **104***a* along with the sand product as part of the step described by reference numeral **602**. As an example, at least a portion of the water used in the addition step of **602** and the mixing step of **604** may comprise water collected from the separator **122**. Further, as an example, beneficial re-use sand can be collected from the separator **122** and stored in the sand bin **124**. For example, beneficial re-use sand can find other uses that may not be related to foundry operations. In this example, the beneficial re-use sand can be collected and transported (e.g., or stored) off-site, or alternatively, disposed of by other methods.

At reference numeral **616**, the third compartment **104***c* receives the clay product from the second hydrocyclone **120**. The pressure of the wet sand and clay mixture flowing into the second hydrocyclone **120**, which is produced by the second pump **118**, causes the clay product output from the second hydrocyclone **120** to flow through pipes, tubes, or hoses into the third compartment **104***c*. The clay product within the third compartment **104***c* is isolated from the contents of the first compartment **104***a* and second compartment **104***b* to avoid mixing or contaminating the desired clay product with additional water, sand product, wet sand, clay mixture, or any combination of these process materials. It should be appreciated that the method **600** can be operated in a continuous manner until the third compartment **104***c* reaches a desired fill level or maximum level of the third compartment **104***c*. When the controller **130** detects that a level threshold is reached within the third compartment **104***c* (e.g. from a level sensor in the third compartment **104***c*), the controller **130** can cease operation of the process by, for example, stopping the first pump **114**, the second pump **118**, the conveyor **112**, and the water input.

In certain embodiments, a third pump **128** can be configured to pump the clay product from within the third compartment **104***c*, through pipes, tubes, or hoses, into a holding tank **126**. Once the clay product is pumped out of the third compartment **104***c* to free up space within the third compartment **104***c*, the process of method **600** can be started again and run continuously once more. In one embodiment, the controller is configured to receive a level of the clay product in the third compartment **104***c*, and in response to the level reaching a threshold level, operating the third pump **128** to pump the clay product to the holding tank **126**.

The above examples are merely illustrative of several possible embodiments of various aspects of the present invention, wherein equivalent alterations and/or modifications will occur to others skilled in the art upon reading and understanding this specification and the annexed drawings. In particular regard to the various functions performed by the above described components (assemblies, devices, systems, and the like), the terms (including a reference to a "means") used to describe such components are intended to correspond, unless otherwise indicated, to any component, such as hardware, software, or combinations thereof, which performs the specified function of the described component (e.g., that is functionally equivalent), even though not structurally equivalent to the disclosed structure which performs the function in the illustrated implementations of the invention. In addition although a particular feature of the invention may have been disclosed with respect to only one of several implementations, such feature may be combined with one or more other features of the other implementations as may be desired and advantageous for any given or particular application. Also, to the extent that the terms "including", "includes", "having", "has", "with", or variants thereof are used in the detailed description and/or in the claims, such terms are intended to be inclusive in a manner similar to the term "comprising."

This written description uses examples to disclose the invention, including the best mode, and also to enable one of ordinary skill in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that are not different from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

The best mode for carrying out the invention has been described for purposes of illustrating the best mode known to the applicant at the time. The examples are illustrative only and not meant to limit the invention, as measured by the scope and merit of the claims. The invention has been described with reference to preferred and alternate embodiments. Obviously, modifications and alterations will occur to others upon the reading and understanding of the specification. It is intended to include all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

What is claimed is:

1. A system for processing a sand product, comprising:
a process tank comprising:
a first compartment;
a second compartment in fluid communication with the first compartment; and
a third compartment that is isolated from the first compartment and the second compartment;
a first hydrocyclone configured to receive a sand mixture comprising the sand product and water from the first compartment, and separate the sand mixture into wet sand and a clay mixture, wherein the second compartment is configured to receive the wet sand and clay mixture from the first hydrocyclone; and
a second hydrocyclone configured to receive the wet sand and the clay mixture from the second compartment, and further separate the wet sand from the clay mixture to produce a clay product, wherein the third compartment is configured to receive the clay product from the second hydrocyclone.

2. The system of claim **1**, wherein the process tank further comprises:
a first wall separating the first compartment from the second compartment, wherein the first wall extends partially towards a bottom of the process tank, defining a gap that provides the fluid communication between the first compartment and the second compartment; and
a second wall separating and providing isolation between the second compartment and the third compartment.

3. The system of claim **1**, wherein the process tank further comprises:
a first mixer configured to mix the sand mixture within the first compartment;
a second mixer configured to mix the wet sand and the clay mixture in the second compartment; and
a third mixer configured to mix the clay product in the third compartment.

4. The system of claim **1**, further comprising:
a first pump configured to pump the sand mixture from the first compartment to the first hydrocyclone; and
a second pump configured to pump the wet sand and the clay mixture from the second compartment to the second hydrocyclone.

5. The system of claim **4**, further comprising a holding tank configured to receive the clay product from the third compartment.

6. The system of claim **5**, further comprising a third pump configured to pump the clay product from the third compartment to the holding tank.

7. The system of claim **1**, wherein the first hydrocyclone is larger than the second hydrocyclone.

8. The system of claim **1**, further comprising a conveyor configured to transport the sand product from a hopper into the first compartment.

9. A method of processing a sand product, comprising:
adding water and the sand product to a first compartment of a process tank;
mixing the water and the sand product in the first compartment to create a sand mixture;
pumping the sand mixture from the first compartment to a first hydrocyclone;
separating, in the first hydrocyclone, the sand mixture into wet sand and a clay mixture;
receiving, from the first hydrocyclone, the wet sand and the clay mixture in a second compartment of the process tank;
pumping the wet sand and the clay mixture from the second compartment to a second hydrocyclone;
further separating, in the second hydrocyclone, the wet sand from the clay mixture to produce a clay product; and
receiving, from the second hydrocyclone, the clay product in a third compartment of the process tank that is isolated from the first compartment and the second compartment.

10. The method of claim **9**, wherein the first compartment is in fluid communication with the second compartment.

11. The method of claim **9**, wherein adding the water and the sand product to the first compartment includes continuously adding the water at a fixed water rate and the sand product at a fixed sand product rate such that a constant level is maintained in the first compartment while pumping the sand mixture from the first compartment to the first hydrocyclone.

12. The method of claim **9**, further comprising:
pumping the clay product from the third compartment to a holding tank when a threshold level is reached within the third compartment.

13. A system for processing a sand product, comprising:
a process tank comprising:
a first compartment;
a second compartment in fluid communication with the first compartment; and
a third compartment that is isolated from the first compartment and the second compartment;
a first hydrocyclone;
a second hydrocyclone;
a first pump;
a second pump; and
a controller configured to:
operate the first pump to pump a sand mixture comprising the sand product and water from the first compartment to the first hydrocyclone such that a wet sand and a clay mixture flow from the first hydrocyclone into the second compartment; and
operate the second pump to pump the wet sand and the clay mixture from the second compartment to the second hydrocyclone such that a clay product flows from the second hydrocyclone to the third compartment.

14. The system of claim **13**, further comprising a third pump and a holding tank, wherein the controller is further configured to receive a level of the clay product in the third compartment, and in response to the level reaching a threshold level, operating the third pump to pump the clay product to the holding tank.

15. The system of claim **13**, wherein the process tank further comprises:
a first wall separating the first compartment from the second compartment, wherein the first wall extends partially towards a bottom of the process tank, defining a gap that provides the fluid communication between the first compartment and the second compartment; and
a second wall separating and providing isolation between the second compartment and the third compartment.

16. The system of claim **13**, wherein the process tank further comprises:
a first mixer configured to mix the sand mixture within the first compartment;

a second mixer configured to mix the wet sand and the clay mixture in the second compartment; and

a third mixer configured to mix the clay product in the third compartment.

17. The system of claim **13**, wherein the first hydrocyclone is larger than the second hydrocyclone.

18. The system of claim **13**, further comprising a conveyor configured to transport the sand product from a hopper into the first compartment.

19. The system of claim **18**, wherein the controller is further configured to operate the conveyor to continuously add the sand product to the first compartment at a fixed sand product rate, and to continuously add water at a fixed water rate.

20. The system of claim **19**, wherein the fixed sand product rate and the fixed water rate are selected such that a constant level is maintained in the first compartment while the controller operates the first pump to pump the sand mixture to the first hydrocyclone.

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