A mixing apparatus for forming a slurry includes a dispenser for dispensing a measured amount of alkali material to a predetermined volume of liquid. The volume of liquid in the apparatus as well as the quantity of alkali material added to the liquid is controlled by a ball float. The liquid and alkali materials are mixed together to form a slurry by continuously withdrawing and readmitting to the apparatus a portion of previously formed slurry. The extraction and readmission of slurry creates a mixing action of the alkali and liquid components within the apparatus. A predetermined amount of the withdrawn slurry is continuously exhausted from the apparatus for use elsewhere. When the amount of exhausted slurry causes the ball float to recede to a lower limit level a liquid inlet valve is activated to an open condition to replenish the exhausted volume of slurry.

37 Claims, 4 Drawing Figures
MIXING APPARATUS FOR FORMING A SLURRY

This invention is directed to new and useful improvements in water treatment apparatus and more particularly to a mixing apparatus for continuously forming a slurry of uniform consistency.

Most known apparatus for forming a slurry generally include a rotatable casing having stirring members or paddles which move within the slurry components to achieve an intermixing thereof. Since the rotatable casing is a moving part it is usually subject to repairs and maintenance due to wear and tear. Furthermore the stirring member often requires a separate mounting structure in the mixing apparatus and the surface thereof generally attracts a buildup of the components being mixed. The stirrers or paddles must therefore be periodically cleaned.

Among the several objects of the present invention may be noted the provision of a novel mixing apparatus for forming a slurry; a novel mixing apparatus for mixing slurry forming components together in predeterminated proportions; a novel mixing apparatus that eliminates the stirring member; a novel mixing apparatus that withdraws and readmits a portion of the slurry to achieve a circulating mixing action; and a novel method for mixing a slurry. Other objects and features will be in part apparent and in part pointed out hereinafter.

The present invention relates to a novel mixing apparatus for forming a slurry. In one embodiment of the invention the mixing apparatus comprises a tank having an accumulation chamber at the lower portion thereof and a dispenser of dry chemicals at the upper portion thereof. The tank also includes a primary water inlet pipe having an inlet valve that is arranged to close and stop further accumulation of water within the tank when the water therein reaches a first predetermined level. The dispenser is arranged to dispense a predetermined amount of alkaline material to the accumulated water when the water has reached its first predetermined level. Dispensation of the alkaline material is over a timed duration, the interval of which can be varied to vary the quantity of chemicals dispensed.

The tank also includes an outlet pipe arranged to communicate with an exhaust pipe and a secondary inlet pipe that feeds back into the tank. Slurry removed from the tank through the outlet pipe is thus partially exhausted and the remaining non-exhausted portion readmitted to the tank through the secondary inlet pipe. The flow of slurry through the outlet pipe and secondary inlet pipe sets up a circulating action that mixes the accumulated water with the dispensed alkaline material. When the mixture is reduced to a second predetermined level in the tank due to exhaustion of slurry through the exhaust pipe the primary inlet pipe valve opens and the accumulation and dispensation cycles begin again.

The invention accordingly comprises the constructions and methods hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

FIG. 1 is a perspective view of a mixing apparatus incorporating one embodiment of the present invention;

FIG. 2 is a sectional view taken on the line 2—2 of FIG. 1;
FIG. 3 is a sectional view taken on the line 3—3 of FIG. 2; and
FIG. 4 is a sectional view taken on the line 4—4 of FIG. 2.

Corresponding reference characters indicate corresponding parts thought the several views of the drawings.

Referring to the drawings for a detailed description of the present invention, a mixing apparatus incorporating one embodiment thereof is generally indicated at 10. Mixing apparatus 10 is generally shaped in the form of a box-like tank having side walls 12, 14, 16, 18, a base 20 and an inclined lid 22 opposite base 20. Lid 22 is hinged to side wall 18 in any suitable known manner permitting upward movement thereof away from wall 14 as indicated in FIG. 4. A swingable prop rod 24 depending from lid 22 engages any suitable known catch piece (not shown) on wall 16 to maintain lid 22 in an open position when desired.

Apparatus 10 further comprises a dispensing hopper 26 supported at side walls 12, 14, 16 and 18 in any suitable known manner. A duct 30 joined to hopper 26 communicates therewith through an opening 28. Duct 30 includes a duct outlet portion 32 at one end thereof and any suitable known low-speed motor 34 at an opposite end thereof. A worm screw 36 disposed in duct 30 is drivably connected to motor 34. A timing device 37 of any suitable known construction is electrically connected to motor 34 and any suitable power source (not shown).

A support plate 38 is fastened to side walls 12, 14, 16 and 18 in any suitable known manner and supports timer 37 and a bracket 40 connected to motor 34. Support plate 38 also includes an opening 42 communicating with duct outlet portion 32.

Apparatus 10 further comprises an accumulation chamber 44 bounded by side walls 12, 14, 16 and 18 below support plate 38. A pair of inclined intersecting trapezoidal plates 46, 48 and a corner zone 50 of base 20 form one floor portion of accumulation chamber 44, the remaining floor portion being defined by an intermediate plate 52 spaced above base 20 and intersecting trapezoidal plate 48. Accumulation chamber 44 is provided with a pair of spaced box-like watertight enclosures 49, 51 joined to walls 18, 16 and 14, 16 respectively. Enclosures 49 and 51 extend between support plate 38 and intermediate plate 52.

Plates 46, 48, 52, side walls 14, 16, 18 and base 20 define a pump chamber 54 containing any suitable known pump 56 mounted on base 20. A first pipe 58 is connected at one end to pump 56, and has an opposite end 60 intersecting plate 48 near zone 50 of base 20. A second pipe 62 is connected at one end to pump 56 and extends outwardly of pump chamber 54 at side wall 16. Second pipe 62 is connected at its opposite end to a T-fitting 64 which extends an exhaustage 66 having a throttle valve 68 connected thereto. T-fitting 64 also joins a secondary inlet pipe 70 which feeds back into accumulation chamber 44 through wall 16.

Apparatus 10 further includes a primary water inlet pipe 72 that feeds into accumulation chamber 44 at wall 12. Pipe 72 is connected to a water source (not shown) at a supply pipe 74. A solenoid valve 76 provided on pipe 72 is arranged in any suitable known manner to shut off flow in pipe 72 when solenoid 76 is
deenergized. An auxiliary inlet pipe 78 supported at wall 12 is also connected to supply pipe 74 and is provided with a manually operable flow control valve 80 for controlling flow through pipe 78 into accumulation chamber 44.

Accumulation chamber 44 further includes a ball float 82 having a shaft 84 extending therefrom through support plate 38 and through a guide member 86 on support plate 38. A disc 88 is keyed to shaft 84 for disposition between spaced jaws 90 and 92 of a yoke switch 94 pivoted at 96 in any suitable known manner. Yoke switch 94 includes a contact arm 98 disposed below a contact rod 100 secured to yet suitably insulated from side wall 12. Yoke switch 94 and contact rod 100 are electrically connected to solenoid valve 76 and any suitable power source (not shown). An overflow pipe 102 is provided in side wall 18 and leads to any suitable known overflow tank (not shown).

In using apparatus 10 hopper 26 is supplied with any suitable alkali material such as lime, and accumulation chamber 44 is filled with water through either pipe 72 or pipe 78. In normal use of apparatus 10 valve 80 remains in a shut off condition to prevent flow through pipe 78.

Pump 56 draws liquid from accumulation chamber 44 into pipe 58 pumping it through pipe 62. A portion of liquid pumped through pipe 62 passes through T-fitting 64 into exhaust pipe 66 for transmission to another stage (not shown) of the water purification system of which apparatus 10 is a part. Another portion of liquid pumped through pipe 62 passes through T-fitting 64 into secondary inlet pipe 70 for readmission into accumulation chamber 44. The amount of liquid pumped back into accumulation chamber 44 through pipe 70 can be varied depending upon the throttle position of valve 68 on exhaust pipe 66. Pipes 66 and 70 have smaller internal diameters than pipe 62 such that the flow velocity in pipes 66 and 70 exceeds the flow velocity through pipe 62.

Primary inlet pipe 72 is maintained in a closed condition by solenoid valve 76 as the liquid level in accumulation chamber 44 recedes due to exhaustion of liquid from accumulation chamber 44 through exhaust pipe 68. The receding liquid level causes ball float 82 to descend in chamber 44 enabling disc 88 on shaft 84 to engage jaw 92 of yoke switch 94. Engagement of disc 88 with jaw 92 causes contact arm 98 to pivot in a clockwise direction (as viewed in Fig. 2) toward contact rod 100. When ball float 82 has descended to a predetermined lower limit level disc 88 will have pivoted contact arm 96 into engagement with contact rod 100 thereby completing a circuit between the power source and solenoid valve 76. Solenoid valve 76 thus being energized opens to permit water to flow through pipe 72 into accumulation chamber 44. The rate of flow of water through primary inlet pipe 72 exceeds the flow of liquid through exhaust pipe 66 such that the liquid level in accumulation chamber 44 eventually rises.

As ball float 82 rises with the rising liquid level, disc 88 on shaft 84 will engage jaw 90 of yoke switch 94. When the liquid level in accumulation chamber 44 has risen to a desired predetermined upper limit level, disc 88 will have pivoted contact arm 96 out of engagement with contact rod 100 thereby breaking the circuit between the power source and solenoid 76. Solenoid 76 thus being deenergized closes to prevent any more water from flowing into accumulation chamber 44 through pipe 72. Overflow pipe 102 accommodates any liquid inadvertently rising above the upper limit level in chamber 44.

Although not shown in detail shaft 84 is arranged in any suitable known manner to activate timer 37 when ball float 82 is at the upper limit level. Timer 37 when activated permits motor 34 to operate for a predetermined time interval. Motor 34 rotates worm screw 36 thereby transmitting chemicals from hopper 26 through duct 30, and duct end portion 32 into opening 42 where the chemicals drop into accumulation chamber 44. Worm screw 36 will transmit a given amount of chemicals to opening 42 in a given time interval. Consequently by controlling the operating time of motor 34 with timer 37 the dispensation of chemicals through opening 42 can be metered.

Ball float 82 thus functions as a control means for governing the amount of water admitted into accumulation chamber 44 through pipe 72 and also functions as a control means for governing the amount of chemicals dispensed into accumulation chamber 44 from hopper 26. Since operation of ball float 82 is dependent upon the level of liquid in accumulation chamber 44 the controlled admission of water and chemicals is cyclic.

In contrast to the cyclic control provided by ball float 82, pump 56 remains in continuous operation extracting and readmitting liquid into accumulation chamber 44. This movement of liquid into and out of accumulation chamber 44 provides a circulating action that prevents settling of chemicals and mixes the components to form a slurry of uniform consistency. Yoke switch 94 controls the exhaustion flow rate of slurry through pipe 66, and the slurry readmitted to accumulation chamber 44 through pipe 70 churns and mixes the water and dispensed alkali to form more slurry.

Sealed enclosures 49 and 51 on either side of secondary inlet pipe 70 serve to restrict the flow of slurry from pipe 70 into accumulation chamber 44 thereby creating a venturi effect that further promotes circulation and mixing of the slurry forming components therein. The inclination of plates 46 and 48 toward zone 50 also promotes the mixing action in accumulation chamber 44 due to the draining effect of pipe opening 60 at zone 50.

As will be apparent to those skilled in the art the apparatus disclosed can be used for mixing other components besides those that will form a slurry. Any desired chemical to water ratio can be obtained in accumulation chamber 44 since the running time of motor 34 can be controlled and varied while fixed upper and lower level limits of liquid are maintained in accumulation chamber 44. It is also feasible to obtain any desired chemical to water ratio by varying the upper and lower limit levels of liquid are maintained in accumulation chamber 44. It is also feasible to obtain any desired chemical to water ratio by varying the upper and lower limit levels of chamber 44 while maintaining a fixed running time of motor 34. The upper and lower limit levels can be varied by varying the spacing between jaws 90 and 92 of yoke switch 94. Thus apparatus 10 can be set to automatically provide any desired ratio of components to be mixed in accumulation chamber 44. If desired a throttle valve (not shown) can be provided on secondary inlet pipe 70 to vary the reentry flow velocity of slurry being readmitted to accumulation chamber 44. Although hopper 26 is provided with worm screw 36 to transmit chemicals to accumulation chamber 44, dispensation of chemicals can also be controlled by other suitable mechanisms such as a solenoid
(not shown) arranged to open and close an outlet portion of hopper 26. Although now shown, an extra pump can be provided in pump chamber 54 and connected to pipes 58 and 62. This will permit continuous circulation and mixing of liquid in chamber 44 in the event that pump 56 requires maintenance.

Some advantages of the novel mixing apparatus evident from the foregoing description include a circulating sludge mixing action that eliminates the need for conventional stirring members. Other advantages are a mixing apparatus which can be set to continuously and automatically control the ratio of components mixed and an apparatus that can provide a constant slurry feed pressure from the same pump that is circulating and mixing the slurry.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions and methods without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A mixing apparatus for forming slurry comprising a tank having an accumulation chamber for accumulating slurry-forming components, inlet means on said tank for admitting a first liquid component into said accumulation chamber, dispensing means on said tank for dispensing a second dry component into said accumulation chamber, and liquid circulation means communicating with said accumulation chamber for causing said first and second components to be mixed together, said dispensing means including a holding member for holding said second dry component and second control means for metering the dispensation of said second dry component into said accumulation chamber, said second control means including release means cooperating with said holding member for releasing said second dry component into said accumulation chamber, said release means comprising a motor and a material moving device actuated by said motor to move said second dry component into said accumulation chamber, said holding member comprising a hopper having an opening at the bottom portion thereof, said material moving device comprising a worm member disposed at the bottom of said hopper communicating with said hopper opening such that rotation of said worm member by said motor moves said second material from said hopper into said accumulation chamber, said second control means further comprising timing means cooperating to said motor to limit operation of said motor to a predetermined time period when said timer has been activated.

2. A mixing apparatus for forming a slurry comprising a tank having an accumulation chamber for accumulating slurry-forming components, inlet means on said tank for admitting a first liquid component into said accumulation chamber, dispensing means on said tank for dispensing a second dry component into said accumulation chamber, and liquid circulation means communicating with said accumulation chamber for causing said first and second components to be mixed together, said liquid circulation means comprising liquid outlet means for extracting liquid at one portion of said accumulation chamber and secondary inlet means for admitting liquid at another portion of said accumulation chamber, said outlet means communicating with said secondary inlet means such that liquid extracted from said accumulation chamber is readmitted, said mixing apparatus further including an exhaust pipe connected to said outlet means for exhausting a predetermined amount of fluid pumped through said outlet means.

3. A mixing apparatus as claimed in claim 2 wherein said dispensing means include a holding member for holding said second dry component, said dispensing means further including a second control means for metering the dispensation of said second dry component into said accumulation chamber.

4. A mixing apparatus as claimed in claim 3 wherein said second control means comprise release means cooperating with said holding member for releasing said second dry component into said accumulation chamber.

5. A mixing apparatus as claimed in claim 4 wherein said release means comprise a motor and a material moving device actuated by said motor to move said second dry component into said accumulation chamber.

6. A mixing apparatus as claimed in claim 5 wherein said holding member comprises a hopper having an opening at the bottom portion thereof, said material moving device communicating with said hopper to cause movement of said second material from said hopper opening into said accumulation chamber.

7. A mixing apparatus as claimed in claim 6 wherein said second control means further comprise timing means connected to said motor to limit operation of said motor to a predetermined time period when said timer has been activated.

8. A mixing apparatus as claimed in claim 2 wherein said inlet means include first control means for regulating the input of said first liquid component into said accumulation chamber.

9. A mixing apparatus as claimed in claim 8 wherein said first control means comprises valve means for governing the flow of said first liquid component through said inlet means and a float member arranged to float in said accumulation chamber and communicate with said valve means to activate said valve means into an open condition.

10. A mixing apparatus as claimed in claim 9 wherein said float member is arranged to activate said valve means to an open condition to permit said first liquid component to enter said accumulation chamber through said inlet means when said float is at a first predetermined level, said float member activating said valve means to prevent said first liquid component from entering said accumulation chamber through said inlet means when said float is at a second predetermined level.

11. A mixing apparatus as claimed in claim 10 wherein said first control means comprises a switch and said valve means comprises a solenoid valve connected to a power source through said switch, said float member being engageable with said switch and causing said switch to complete the circuit between the power source and said solenoid when said float is at said first predetermined level, said float causing said switch to open the circuit between said power source and said solenoid when said float is at said second predetermined level.
12. A mixing apparatus as claimed in claim 11 wherein said switch is arranged to cause said solenoid valve to maintain said inlet means in an open condition as said float member moves from said first level to said second level, said switch being arranged to cause said solenoid valve to maintain said inlet means in closed condition as said float member moves from said second level to said first level.

13. A mixing apparatus as claimed in claim 2 wherein said outlet means and said secondary inlet means comprise pipes, said outlet pipe having a greater internal diameter than the secondary inlet pipe.

14. A mixing apparatus as claimed in claim 2, said liquid circulation means further comprising pumping means communicating with said outlet means for removing liquid from said accumulation chamber through said outlet means, said pumping means further communicating with said secondary inlet means for pumping said removed liquid back into said accumulation chamber through said secondary inlet means.

15. A mixing apparatus as claimed in claim 2 wherein said outlet means is disposed at one level in said accumulation chamber and said secondary inlet means is disposed at a second level in said accumulation chamber, said first and second levels being spaced from one another such that a mixing action of said liquid in said accumulation chamber occurs when said liquid is removed from said outlet means and admitted into said accumulation chamber through said secondary inlet means.

16. A mixing apparatus as claimed in claim 2 wherein said accumulation chamber includes restriction means at said secondary inlet means for restricting the flow of liquid into said accumulation chamber such that the velocity of liquid entering said accumulation chamber through said secondary inlet means is greater than the velocity of liquid exiting from said accumulation chamber through said outlet means.

17. A mixing apparatus as claimed in claim 2 wherein said accumulation chamber has an inclined floor, said floor having a high level portion at said secondary inlet means and a low level portion at said outlet means, such that liquid entering said accumulation chamber through said secondary inlet means produces a general liquid movement in said accumulation chamber from said secondary inlet means to said outlet means.

18. A mixing apparatus as claimed in claim 2 wherein said exhaust pipe includes valve means for regulating the flow of liquid through said exhaust pipe.

19. A method for continuously forming a slurry comprising adding a first predetermined amount of water to an accumulation chamber containing slurry, adding a predetermined amount of alkaline material to the predetermined amount of water, mixing the predetermined amounts of water and alkaline material by removing a portion of slurry from one part of the tank and simultaneously admitting removed slurry to another part of the tank, the removal and admission of slurry creating a mixing action in the water and alkaline materials to form a slurry, and exhausting a portion of the removed slurry.

20. The method of claim 19 wherein the step of adding alkaline material further includes the step of limiting the time during which the alkaline material is added to the tank.

21. The method of claim 19 further including the step of cycling the step of adding water such that the exhausted slurry is periodically replaced by an equivalent volume of the added water.

22. The method of claim 21 wherein the step of adding alkaline material further includes the step of introducing the alkaline material to the equivalent volume of added water during a given time interval after the equivalent volume of added water has been accumulated in the tank.

23. A mixing apparatus for forming slurry comprising a tank having an accumulation chamber for accumulating slurry-forming components, inlet means on said tank for admitting a first liquid component into said accumulation chamber, dispensing means on said tank for dispensing a second dry component into said accumulation chamber, and liquid circulation means communicating with said accumulation chamber for causing said first and second components to be mixed together, said dispensing means including a holding member for holding said second dry component and second control means for metering the dispensation of said second dry component into said accumulation chamber, said second control means including release means cooperating with said holding member for releasing said second dry component into said accumulation chamber, said release means comprising a motor and a material moving device actuated by said motor to move said second dry component into said accumulation chamber, said holding member comprising a hopper having an opening at the bottom portion thereof, said material moving device communicating with said hopper to cause movement of said second material from said hopper into said accumulation chamber, said second control means further comprising timing means connected to said motor to limit operation of said motor to a predetermined time period when said timer has been activated.

24. A mixing apparatus as claimed in claim 23 wherein said inlet means include first control means for regulating the input of said first liquid component into said accumulation chamber.

25. A mixing apparatus as claimed in claim 24 wherein said first control means comprise valve means for governing the flow of said first liquid component through said inlet means and a float member arranged to float in said accumulation chamber and communicative with said valve means, to activate said valve means into an open condition when said float is at a first predetermined level, said float member activating said valve means to a closed condition when said float member is at a second predetermined level.

26. A mixing apparatus as claimed in claim 25 wherein said float member is arranged to activate said timer when said float member is at one of said predetermined levels.

27. A mixing apparatus as claimed in claim 25 wherein said first control means further comprises a switch and said valve means comprises a solenoid valve connected to a power source through said switch, said float member being engageable with said switch and causing said switch to complete the circuit between the power source and said solenoid when said float is at said first predetermined level, said float causing said switch to open the circuit between said power source and said solenoid when said float is at said second predetermined level.

28. A mixing apparatus as claimed in claim 27 wherein said switch is arranged to cause said solenoid
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valve to maintain said inlet means in an open condition as said float member moves from said first level to said second level, said switch being arranged to cause said solenoid valve to maintain said inlet means in closed condition as said float member moves from said second level to said first level.

29. A mixing apparatus as claimed in claim 23 wherein said liquid circulation means comprise liquid outlet means for extracting liquid at one portion of said accumulation chamber and secondary inlet means for admitting liquid at another portion of said accumulation chamber.

30. A mixing apparatus as claimed in claim 29 wherein said outlet means and said secondary inlet means comprise pipes, said outlet pipe having a greater internal diameter than the secondary inlet pipe.

31. A mixing apparatus as claimed in claim 29 wherein said liquid outlet means communicate with said secondary inlet means such that liquid extracted from said accumulation chamber is readmitted.

32. A mixing apparatus as claimed in claim 31 further including an exhaust pipe connected to said outlet means for exhausting a predetermined amount of fluid pumped through said outlet means.

33. A mixing apparatus as claimed in claim 32 wherein said exhaust pipe includes valve means for regulating the flow of liquid through said exhaust pipe.

34. A mixing apparatus as claimed in claim 29, said liquid circulation means further comprising pumping means communicating with said outlet means for removing liquid from said accumulation chamber through said outlet means, said pumping means further communicating with said secondary inlet means for pumping said removed liquid back into said accumulation chamber through said secondary inlet means.

35. A mixing apparatus as claimed in claim 29 wherein said outlet means is disposed at one level in said accumulation chamber and said secondary inlet means is disposed at a second level in said accumulation chamber, said first and second levels being spaced from one another such that a mixing action of said liquid in said accumulation chamber occurs when said liquid is removed from said outlet means and admitted into said accumulation chamber through said secondary inlet means.

36. A mixing apparatus as claimed in claim 29 wherein said accumulation chamber includes restriction means at said secondary inlet means for restricting the flow of liquid into said accumulation chamber such that the velocity of liquid entering said accumulation chamber through said secondary inlet means is greater than the velocity of liquid exiting from said accumulation chamber through said outlet means.

37. A mixing apparatus as claimed in claim 29 wherein said accumulation chamber has an inclined floor, said floor having a high level portion at said secondary inlet means and a low level portion at said outlet means, such that liquid entering said accumulation chamber through said secondary inlet means produces a general liquid movement in said accumulation chamber from said secondary inlet means to said outlet means.

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