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(54) A METHOD AND APPARATUS FOR THE FILTRATION OF A SUSPENSION

(71) We, REDERIAKTIEBOLAGET NORDSTJERNAN, a Swedish joint stock company, of 3, Stureplan, Stockholm, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method for the filtration of a suspension e.g. emulsion. The invention also relates to an apparatus for carrying out the method.

It is for the filtration of a suspension or emulsion previously known to supply the suspension (e.g. emulsion) to a filter bed, consisting of a filter medium of particle size, enclosed in a tank, allow the suspension to flow upwards through the filter bed, and in some appropriate manner allow the filtrated liquid phase obtained by the filtration to discharge from the filter bed through outlet means provided with some appropriate cover means, for instance a jalousie or screen, in order to prevent the filter medium escaping together with the filtrated liquid phase. In one type of such a filtration apparatus it is also known in order to obtain a continuously operating filtration apparatus, i.e. without shutting off the filtration during the cleaning of the filter medium, to allow the filter medium, while the filtration is going on, to flow downwardly through the filtration tank, remove the dirtified (contaminated) filter medium in the course of filtration from the base of the tank to a pipe positioned outside of the tank, allow the dirtified filter medium to pass through a washing device, and return the cleaned filter medium from the washing device to the surface of the filter bed in the tank. In another known filtration apparatus, likewise provided with a washing device positioned outside of the filtration tank but without filtration in counter-current between the filter medium and the suspension, the cleaning of the filter medium takes place during the flow thereof in counter-current to the wash liquid which is taken

out from the pipe for delivering the suspension to be filtrated.

The object of the present invention is to provide a continuously operating filter, which—besides utilizing the advantage of an effective use of the filter bed by counter-current flow, known per se in one filtering apparatus, between the filter medium and the suspension during the filtration together with the advantage of improved washing by counter-current flow between the filter medium and the wash liquid, known per se in another known filtering apparatus—gives with simple means during reliable operation high capacity in relation to required space, always gives substantially the same filtering capacity and at the same time guarantees an increased efficiency in the washing of the filter medium.

The present invention, as mentioned above in connection with the statement of prior art, relates to a method for the filtration of a suspension e.g. emulsion, which is supplied to a zone of filter medium of particle size forming a filter bed, flows during the filtration in the direction upwards through the filter bed and is discharged from the filter bed as filtrated liquid phase, during which filtration the filter medium flows in the direction downwards through the filter bed zone in counter-current to the suspension past the inflow of the suspension into the filter bed and thereafter is transported separated from the filter bed to a wash path for the washing of the dirtified filter medium during flow in counter-current to a wash liquid along the wash path, whereupon the washed filter medium is returned to the filter bed zone to the top surface thereof.

According to the invention, there is provided a method for filtering a dispersion comprising allowing the dispersion to flow upwards through a particulate filter medium in a filtration zone, discharging filtrate from said filtration zone and maintaining a zone of said filtrate above said filtration zone, allowing said filter medium to flow downwards through the filtration zone in counter-

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current to the upward flowing dispersion and downwards below a dispersion inflow point, extracting the used filter medium from a position below the filtration zone and transporting it upwards to a wash path, and washing the used filter medium by allowing it flow along the wash path in counter-current to a flow of a wash liquid, the wash liquid being a portion of said filtrate supplied to the wash path from said filtrate zone, and returning washed filter medium to the top of said filtration zone.

Thus, according to the invention the total filtering and washing process can take place within the filtration apparatus and filtered liquid phase, the clarified liquid, obtained by the filtration is in a simple and advantageous manner utilized as wash liquid.

Within the frame of the present invention and as is evident from the following claims, further improvements are made possible with a view to make the washing as well as the filtration still more effective. Thus, measures can be taken during the washing in order to increase the velocity of the wash liquid momentarily at least once, which creates especially favourable conditions for the washing of the filter medium, and in order to decelerate the filter medium at least once and thereby increase the contact time between the filter medium and the wash liquid, which results in an increased effectiveness of the washing, and further in order to break up possible caked aggregates of filter medium caused by the dirtying. Moreover according to the invention, the quantity of the wash liquid flowing along the wash path can be controlled. As to the quantity of filter medium transported to the wash path this quantity can according to the invention also be automatically controlled in order to constantly achieve an appropriately adapted flow of filter medium to the wash path and this control can be made by sensing quantity or pressure of the suspension before its supply to the filter bed zone. Finally, by a method according to the invention, air introduced into the dirtified filter medium for transporting such medium can be prevented from entering the filter bed zone by being previously trapped and discharged, whereby risk for local fluidizing of the filter bed, which could result in substantial reduction of the filtering capacity of the filter bed, is eliminated.

The invention also provides filtration apparatus for filtering a dispersion, said apparatus comprising a particulate filter medium in a filtration zone, a dispersion inlet port positioned to allow the dispersion to flow upwards through said filtration zone into a filtrate-receiving zone above said filtration zone, a used filter medium extraction zone positioned below said inlet port to receive the filter medium which in use

of the apparatus flows downwards through said filtration zone into said used filter medium extraction zone, and a transport conduit for extracting said used filter medium from said extraction zone and transporting it upwards to a counter-current wash device in which in use, the filter medium flows through the wash device along a wash path in counter-current with a wash liquid, said wash device having an inlet communicating with said filtrate-receiving zone to supply a portion of said filtrate as said wash liquid, and the apparatus being constructed such that washed filter medium is returned to the top of said filtration zone.

Specific features and advantages of this invention will be apparent from the following description of a typical embodiment thereof which is given by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a vertical section of a filtration apparatus in accordance with this invention.

Fig. 2 shows in larger scale the same vertical section of the upper portion of the filtration apparatus of Fig. 1 in order to illustrate more clearly the wash device of the filtration apparatus.

Fig. 3 is a somewhat schematic view from above showing a number of filtration apparatus embodying the invention located to provide a filtration plant.

In the apparatus illustrated in Fig. 1 a particle filter medium 1 is enclosed in a tank having a cylindrical wall 2 or a plurality of walls 2 and a funnel-shaped bottom 3. The base of the cone or pyramid 3 should preferably coincide to the form of the tank as defined by the wall or walls 2.

Sand is a suitable filter medium. However, other materials, such as plastics, can be used or mixtures of several materials. A mixture of several grainsize fractions can be used in a continuously operating filter according to the invention contrary to conventional technics, however depending on what shall be filtrated and how effective the filtration shall be carried out. A man skilled in the art will find after tests the most suitable material and grain size in each particular case.

The suspension or emulsion to be filtered is supplied, as shown by arrow A, to the tank through inlet 4. The flow of the suspension into the filter bed takes place in the lower part of the filter bed via a number of pipes 5 having pipe mouths 6. A roof 7 is arranged above each pipe mouth in order to prevent the filter medium being in direct contact with the pipe mouths and in order to expose a larger surface of the filter medium to the supplied suspension. By this, the risk of clogging of the filter owing to substantial momentary dirtying of the filter medium close to the pipe mouths is reduced.

The roofs have a V-shaped cross section and owing to this by suitable arrangement of the pipe mouths in relation to the undersides of the roofs the movement of the filter medium downwards is considerably reduced. The arrangement of the inlet pipe mouths 6 in the lower part of the filter bed involves the advantage that the most dirty filter medium, i.e. the filter medium passing the roofs and the pipe mouths, continues downwards and is no more utilized for the filtration. Clogging at the inlets is thereby prevented and fresh filter medium is always exposed to the incoming suspension. The incoming suspension flows in counter-current to the filter medium upwards through a zone of the filter bed towards more and more clean filter medium. The filtrated liquid phase obtained during the flow of the suspension upwards through the filter bed zone is kept as a zone 8 of filtrated liquid phase above the filter bed and its surface level is in the shown embodiment fixed by discharging the filtrated liquid phase from the filtration apparatus via a weir 9 to an outlet (arrow B).

In the tank bottom 3, down into which the dirty filter medium flows, the mouth of a transport device 10 is located. As appears from the illustrated embodiment the transport device extends centrally through the apparatus and can for instance consist of a mammoth pump, which is an air pump. Such a pump operates with air as transport medium and the air is supplied from above downwards along a pipe 11 extending alongside a transport pipe 12 forming a part of the transport device. The air is supplied to the transport pipe 12 through holes (not shown) in the lower part of the pipe. The filter medium is transported (arrow C) by the air through the pipe 12 up to a wash device 13 positioned above the filter bed. The wash device shall be described below more in detail.

If the air conducted into the mammoth pump for some reason should pass through the lower part of the transport pipe 12 and infiltrate into the filter bed, there is a risk for local fluidizing of the filter medium resulting in a substantial reduction of the filtering capacity of the filter. In order to prevent such a disturbance a funnel 14 turned upside down is placed around the mammoth pump above the bottom mouth thereof. The funnel catches possible air gone astray and the caught air is discharged through holes (only one shown) in the top end of the funnel to a pipe 15 extending alongside the transport pipe. The funnel also serves as guide means for the flow of the filter medium downwards, so that a uniform flow profile (flow characteristic) is obtained over the cross section of the apparatus.

The above-described roofs 7 positioned above the mouths 6 contribute as well as the funnel 14 to achieve desired flow profile. Such roofs can, although not shown, in order to still more ensure desired flow profile be arranged in the filter bed at other fitting places and without being combined with inlets for the suspension.

The wash device 13 is shown in larger scale in Fig. 2. The filter medium to be washed arrives from the upper end of the transport pipe 12, turns (arrow D) and flows downwards along a wash path formed by the space between the transport pipe 12 and an outer pipe 16. The outer pipe 16 is preferably concentrically arranged relative to the transport pipe 12. The filter medium can, owing to the fact that it is dirty, contain aggregates fused together. Such possible aggregates are broken up when they hit a plate or the like 17 positioned in the flow path of the filter medium; at the same time the velocity of fall of the filter medium is decelerated. The filter medium hits thereafter further down in the wash path an intermediate partition 18 provided with holes 19, preferably followed by a number of additional intermediate partitions of similar shape. In the embodiment shown there are five intermediate partitions. The holes 19 in two adjacent partitions are preferably displaced in relation to each other, so that a vertical free passage for the filter medium is prevented. Owing to this, there is a frequent deceleration of the filter medium during its passage through the wash device. The filter medium meets all the time a wash liquid in counter-current and at the holes in the intermediate partitions the velocity of the wash liquid becomes momentarily higher, which results in especially favourable conditions for the washing of the filter medium.

The filtrated liquid phase in zone 8 positioned above the filter bed is used as wash liquid. The wash device is immersed into the filtrated liquid phase in zone 8 and, as shown with arrow E in the illustrated embodiment, the wash liquid, i.e. the filtration liquid phase, is supplied to the wash path through the opening 20 between the lower end of the outer pipe 16 and the transport pipe 12 and flows upwards along the wash path. The wash liquid which becomes dirty during the washing, i.e. that which is to be rejected, is discharged from the wash path as shown with arrow F, flows over a weir 21 and is discharged from the apparatus as shown with arrow G. This weir can in other embodiments be adjustable as to its height and/or width position, thereby making it possible to control the quantity of wash liquid discharged. For instance, the quantity of wash liquid is increased upon lowering of the weir. The quantity of wash liquid is also automatically increased when the level of

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the filtrated liquid above the filter bed arises, for instance by increased load on the filtration apparatus.

In order to guide the filter medium, discharged from the transport pipe 12, downwardly to the wash path and in order to separate the wash liquid to be rejected from the incoming filter medium, a pipe 22 is arranged between the outer pipe 16 and the transport pipe 12, said pipe 22 being lowered a distance past the top end of the transport pipe.

The pipe 22 projects out of the outer pipe 16, and air supply pipe 11 and air discharge pipe 15 extend through the pipe 22. The pipe 22 also encloses a device 23 for capturing air bubbles from the transport pipe 12 containing filter medium. In the illustrated embodiment this capturing device consists of cones and truncated cones, alternatively arranged.

Although not shown, a part of the filtrated liquid phase can, if desired, be taken out within the filter bed zone below its top surface by arranging outlet pipe mouths for filtrated liquid phase, preferably substantially vertically above the inlet pipe mouths 6. Moreover, these outlet pipe mouths can preferably be provided with roofs in conformity with the roofs 7 above the inlet pipe mouths 6. By taking out the filtrated liquid phase through such outlet pipe mouths positioned within the filter bed zone below the top surface thereof a satisfactory filtrated liquid phase is ensured even during possible shutdowns of the wash device, when the liquid phase contained above the filter bed could be dirty.

Below the bottom end of the wash device a cone 24 is arranged for spreading the filter material coming from the wash device out over the top surface of the filter bed. Moreover, the cone 24 is provided with a suitable number of holes 25 in order to obtain a supply of filter medium particles to the surface of the filter bed positioned below the cone.

There may also be provided an automatic control of the quantity of filter medium supplied to the wash device, although not shown. By placing a quantity sensing or pressure sensing means in the supply pipe for the suspension (in Fig. 1 indicated with the arrow A) a signal indicating a change, for instance a pressure increase owing to accumulation of suspended material in the filter bed, is obtained. This signal can in a manner known per se be used for the control of the capacity of the transport device 10, so that the transported quantity of filter medium to the wash device is adjusted accordingly.

In the embodiment described above and shown on the drawings the wash device is immersed in the zone 8 of filtrated liquid

phase and the filtrated liquid phase is from this zone admitted as wash liquid into the wash device through the opening 20. The filtrated liquid phase utilized for the washing can, however, alternatively be laterally admitted through one or several openings in the outer pipe 16 at the lower portion thereof. In another alternative embodiment, not shown, in which likewise filtrated liquid phase from the zone 8 is utilized as wash liquid, at least a part of the wash device is separately arranged relative to the filter bed and one or several pipes are drawn from the zone 8 to the lower portion of the wash device for the supply of the wash liquid to the wash device so positioned.

A filtration apparatus according to the invention, for instance the preferred embodiment described above and shown in Figs. 1 and 2, makes a construction with comparatively small dimensions possible and thereby the advantage is achieved that the apparatus is easy to handle and easy to attend in operation. Moreover, owing to the fact that all elements required for the continuously operating apparatus are positioned within the filtering unit and furthermore that certain devices, for instance the wash device and the transport device, can be formed as units, the apparatus is well adapted to be built as module. When greater filtration capacities than one single apparatus can produce are required it is owing to this possible to build together in a simple and advantageous way several apparatuses into one large filtration plant. Such a filtration plant may comprise at least two rows of filtration apparatuses, one embodiment being exemplified and somewhat schematically shown in Fig. 3 and comprising a group of eight module-built filtration apparatuses joined together. All devices and elements required for the operation of a filtration apparatus according to the invention, for instance a filtration apparatus as shown in Figs. 1 and 2, are embodied in each module. However, the walls 2, which border against each other in the group, are removed (the dashed lines in Fig. 3 are intended to illustrate the upper edge of the bottoms 3). Furthermore, for each row of filtration apparatuses there is a common outlet 26 for the filtrated liquid phase discharged from each filtration apparatus (arrow B in Figs. 1 and 2), and for both rows there is a common outlet 27 for the wash liquid to be rejected from the wash device (arrow G in Figs. 1 and 2). It is apparently not necessary to arrange these common outlets 26 and/or 27 as shown but such an arrangement obviously simplifies the construction. The outer wall 28 enclosing the filtration apparatus can consist of walls 2 in each filtration apparatus, but alternatively the walls 2 of each filtration apparatus can

be replaced by a single outer wall extending around the perimeter of the filtration plant.

As is also evident from Fig. 3, each apparatus module has a hexagonal form in cross section. This form allows simple joining together of modules to form larger filtration plants. Other forms are, however, possible to use, for instance square, which also allows simple joining. A square form can, however, compared with for instance hexagonal form be less suitable owing to the fact that the filter medium situated in the corners is decelerated in its movement downwards and therefore takes a less active part in the filtration.

WHAT WE CLAIM IS:—

1. A method for filtering a dispersion comprising allowing the dispersion to flow upwards through a particulate filter medium in a filtration zone, discharging filtrate from said filtration zone and maintaining a zone of said filtrate above said filtration zone, allowing said filter medium to flow downwards through the filtration zone in counter-current to the upward flowing dispersion and downwards below a dispersion inflow point, extracting the used filter medium from a position below the filtration zone and transporting it upwards to a wash path, and washing the used filter medium by allowing it flow along the wash path in counter-current to a flow of a wash liquid, the wash liquid being a portion of said filtrate supplied to the wash path from said filtrate zone, and returning washed filter medium to the top of said filtration zone.

2. A method according to claim 1, wherein during the washing the velocity of the wash liquid is momentarily increased at least once.

3. A method according to claim 1 or 2, wherein during the washing the flow velocity of the filter medium is decelerated at least once.

4. A method according to any one of the preceding claims, wherein caked aggregates of used filter medium are broken up during the washing.

5. A method according to any one of the preceding claims, including controlling the quantity of wash liquid flowing along the wash path.

6. A method according to claim 5, wherein the wash liquid flow is controlled by adjustment of the rate of outflow of used wash liquid from said wash path.

7. A method according to claim 5, wherein the wash liquid flow is controlled by changing the surface level of said filtrate zone.

8. A method according to any one of the preceding claims, including controlling the quantity of filter medium transported to the wash path in response to quantity sens-

ing or pressure sensing of the dispersion prior to the supply thereof to the filtration zone.

9. A method according to any one of the preceding claims, wherein air is used for said transport of the used filter medium, and wherein any air escaping from the transport system is collected substantially to prevent such air infiltrating into said filtration zone.

10. Filtration apparatus for filtering a dispersion, said apparatus comprising a particulate filter medium in a filtration zone, a dispersion inlet port positioned to allow the dispersion to flow upwards through said filtration zone into a filtrate-receiving zone above said filtration zone, a used filter medium extraction zone positioned below said inlet port to receive the filter medium which in use of the apparatus flows downwards through said filtration zone into said used filter medium extraction zone, and a transport conduit for extracting said used filter medium from said extraction zone and transporting it upwards to a counter-current wash device in which in use, the filter medium flows through the wash device along a wash path in counter-current with a wash liquid, said wash device having an inlet communicating with said filtrate-receiving zone to supply a portion of said filtrate as said wash liquid, and the apparatus being constructed such that washed filter medium is returned to the top of said filtration zone.

11. Filtration apparatus according to claim 10, wherein the wash device is located in said filtrate-receiving zone and has its wash liquid inlet positioned above the filtration zone.

12. Filtration apparatus according to claim 10 or 11, wherein the transport conduit and the wash device are positioned substantially on a central vertical axis of the filtration zone.

13. Filtration apparatus according to claim 11 or 12, wherein the wash device comprises a vertical tube and the wash liquid inlet consists of the open bottom end of said tube.

14. Filtration apparatus according to claim 13, wherein the wash tube is concentrically arranged around the upper part of the transport conduit.

15. Filtration apparatus according to any one of claims 10 to 14, wherein the wash device is provided with means for momentary increase of the velocity of the wash liquid and for decelerating the filter medium.

16. Filtration apparatus according to claim 15, wherein said velocity-increasing and decelerating means comprises a perforated disc extending over the cross-section of the wash path of the wash device.

17. Filtration apparatus according to claim 16, wherein at least two said discs



be replaced by a single outer wall extending around the perimeter of the filtration plant.

As is also evident from Fig. 3, each apparatus module has a hexagonal form in cross section. This form allows simple joining together of modules to form larger filtration plants. Other forms are, however, possible to use, for instance square, which also allows simple joining. A square form can, however, compared with for instance hexagonal form be less suitable owing to the fact that the filter medium situated in the corners is decelerated in its movement downwards and therefore takes a less active part in the filtration.

WHAT WE CLAIM IS:—

1. A method for filtering a dispersion comprising allowing the dispersion to flow upwards through a particulate filter medium in a filtration zone, discharging filtrate from said filtration zone and maintaining a zone of said filtrate above said filtration zone, allowing said filter medium to flow downwards through the filtration zone in counter-current to the upward flowing dispersion and downwards below a dispersion inflow point, extracting the used filter medium from a position below the filtration zone and transporting it upwards to a wash path, and washing the used filter medium by allowing it flow along the wash path in counter-current to a flow of a wash liquid, the wash liquid being a portion of said filtrate supplied to the wash path from said filtrate zone, and returning washed filter medium to the top of said filtration zone.

2. A method according to claim 1, wherein during the washing the velocity of the wash liquid is momentarily increased at least once.

3. A method according to claim 1 or 2, wherein during the washing the flow velocity of the filter medium is decelerated at least once.

4. A method according to any one of the preceding claims, wherein caked aggregates of used filter medium are broken up during the washing.

5. A method according to any one of the preceding claims, including controlling the quantity of wash liquid flowing along the wash path.

6. A method according to claim 5, wherein the wash liquid flow is controlled by adjustment of the rate of outflow of used wash liquid from said wash path.

7. A method according to claim 5, wherein the wash liquid flow is controlled by changing the surface level of said filtrate zone.

8. A method according to any one of the preceding claims, including controlling the quantity of filter medium transported to the wash path in response to quantity sens-

ing or pressure sensing of the dispersion prior to the supply thereof to the filtration zone.

9. A method according to any one of the preceding claims, wherein air is used for said transport of the used filter medium, and wherein any air escaping from the transport system is collected substantially to prevent such air infiltrating into said filtration zone.

10. Filtration apparatus for filtering a dispersion, said apparatus comprising a particulate filter medium in a filtration zone, a dispersion inlet port positioned to allow the dispersion to flow upwards through said filtration zone into a filtrate-receiving zone above said filtration zone, a used filter medium extraction zone positioned below said inlet port to receive the filter medium which in use of the apparatus flows downwards through said filtration zone into said used filter medium extraction zone, and a transport conduit for extracting said used filter medium from said extraction zone and transporting it upwards to a counter-current wash device in which in use, the filter medium flows through the wash device along a wash path in counter-current with a wash liquid, said wash device having an inlet communicating with said filtrate-receiving zone to supply a portion of said filtrate as said wash liquid, and the apparatus being constructed such that washed filter medium is returned to the top of said filtration zone.

11. Filtration apparatus according to claim 10, wherein the wash device is located in said filtrate-receiving zone and has its wash liquid inlet positioned above the filtration zone.

12. Filtration apparatus according to claim 10 or 11, wherein the transport conduit and the wash device are positioned substantially on a central vertical axis of the filtration zone.

13. Filtration apparatus according to claim 11 or 12, wherein the wash device comprises a vertical tube and the wash liquid inlet consists of the open bottom end of said tube.

14. Filtration apparatus according to claim 13, wherein the wash tube is concentrically arranged around the upper part of the transport conduit.

15. Filtration apparatus according to any one of claims 10 to 14, wherein the wash device is provided with means for momentary increase of the velocity of the wash liquid and for decelerating the filter medium.

16. Filtration apparatus according to claim 15, wherein said velocity-increasing and decelerating means comprises a perforated disc extending over the cross-section of the wash path of the wash device.

17. Filtration apparatus according to claim 16, wherein at least two said discs

are provided spaced apart along the wash device, the perforations in adjacent discs being displaced relative to each other.

18. Filtration apparatus according to any one of claims 10 to 17, including means in an upper part of the wash device for breaking up any caked aggregates of used filter medium.

19. Filtration apparatus according to any one of claims 10 to 18, wherein the wash device is provided with an outlet for the used wash liquid, said outlet being adjustable as to height and/or width for controlling the flow of wash liquid.

20. Filtration apparatus according to any one of claims 10 to 19, wherein the transport conduit at its extraction inlet end is provided with inlet means for air to lift the used filter medium up to the wash device, said air being supplied through a conduit extending through the wash device and along the transport conduit.

21. Filtration apparatus according to claim 20, including means arranged above said air inlet means to trap any air passing into the used filter medium in the extraction zone.

22. Filtration apparatus according to claim 21, wherein said air trap means serves also as guide means for guiding the used filter medium down into said extraction zone.

23. Filtration apparatus according to claim 21 or 22, wherein said air trap means comprises an inverted funnel having its smaller end in peripheral engagement with the transport conduit, said funnel being provided with an outlet at its upper smaller end for supplying the trapped air to a discharge conduit extending through the filtration zone.

24. Filtration apparatus according to claim 23, wherein said discharge conduit extends upwards within the transport conduit and through the wash device.

25. Filtration apparatus according to any one of claims 10 to 24, including a number

of exterior planar walls bounding the filtration zone and the filtrate-receiving zone to form a polygon in plan view.

26. A filtration plant comprising a plurality of filtration apparatuses, each being an apparatus as claimed in claim 25, and disposed in juxtaposed relation, the respective filtration and filtrate-receiving zones of the apparatuses communicating with the corresponding zones in the other apparatuses, and some of the bounding walls of the apparatuses forming a continuous outer wall for the filtration plant.

27. A filtration plant according to claim 26, including a common outlet for the filtrate discharged from the filtrate zones of said filtration zones of said filtration apparatuses.

28. A filtration plant according to claim 26, wherein the filtration apparatuses are arranged in at least two rows, each row having a common filtrate outlet for all the filtration apparatuses in that row.

29. A filtrate plant according to any one of claims 26 to 28, including a common outlet conduit arranged to receive the used wash liquid from several adjacent said filtration apparatuses.

30. A filtration plant according to claim 29, wherein the common outlet conduit for the used wash liquid is arranged to receive used wash liquid from all filtration apparatuses arranged in two adjacent rows.

31. A method as claimed in claim 1 and substantially as described herein.

32. Filtration apparatus substantially as described herein with reference to Figures 1 and 2 of the accompanying drawings.

33. A filtration plant substantially as described herein with reference to Figures 1 to 3 of the accompanying drawings.

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