

2120567

(11)

IMPROVED ROTARY DRUM FILTER

BACKGROUND OF THE INVENTION

This invention relates to an improved continuous rotary drum filter means. More specifically, the subject invention is related to a continuous rotary drum filter for the separation of petroleum liquids, such as lube oils, from solids, such as paraffins.

The separation of mixtures of compounds can be accomplished by various unit operations including distillation, solvent extraction and fractional crystallization. Fractional crystallization is particularly well-suited to the purification of many mixtures economically in a one-stage operation. Frequently, the crystallization operation is combined with another unit operation to produce an improved separation process. In petroleum processing, operations fractional crystallization is often utilized to separate waxy compounds from the lube oil fraction. Frequently, a solvent is added to the mixture to provide more favorable conditions for crystal growth and to dilute the resultant chilled slurry to thereby permit continuous oil-wax separation.

One type of filter particularly well suited to fractional crystallization, in general, and wax-lube oil separation, in particular, is the rotary drum filter. In this type of filter, a filter drum continuously rotates within a filter vat containing the mixture to be separated. During the

rotation, vacuum is applied to the sector of the filter drum which is immersed in the mixture in the vat causing a major portion of filtrate to be drawn through the filter cloth and fluid conduits within the drum, while the solids and a minor amount of filtrate are trapped by the filter cloth and build up to form a cake. A liquid solvent wash liquid is often then sprayed over the cake and drawn through the filter cloth and conduits to remove additional quantities of filtrate from the cake. At a subsequent sector of the drum, during rotation thereof, high velocity gas is passed outwardly through the fluid conduits within the drum to purge the liquid filtrate and/or solvent and break the filter cake away from the cloth. During this purge stage, liquid adhering to the walls of the conduits may be directed against sections of the filter cloth by the high velocity gas, thereby causing erosion of the filter cloth. Filter cloth replacement necessitates complete shutdown of the filter and is relatively expensive, since rotary filters frequently are thirty feet (9.144 m) or more in length.

One method for minimizing the erosive effects of the liquid on the filter cloth has been to have an extended purge stage in which the lead fluid conduit in the direction of movement is evacuated while the lag conduit, or conduit immediately following the lead conduit, is purged with high velocity gas. Liquid purged out of the lag pipe is directed into the lead pipe before it can strike the filter cloth. At a predetermined angle of the drum, the vacuum is discontinued

and the purge gas and any remaining liquid is directed outwardly. Extension of the time period during which the combination of purge and evacuation is accomplished would decrease the amount of liquid remaining in the lag fluid conduit when evacuation of the lead fluid is discontinued. However, this would require a decrease in the other filter drum cycle times. Either of these methods thus would decrease the filtration capacity of the unit.

Yet another method of decreasing the erosive effects of the liquid would be to use a thicker or more erosion-resistant filter cloth. Use of a thicker filter cloth would increase the filter cloth cost and also increase the tendency of the filter cloth to bow while also decreasing the filter capacity. In addition, the thicker the filter cloth, the more difficult it is to remove the wax fines from the cloth. Use of a more erosion-resistant filter cloth may not be advantageous, since a more erosion-resistant cloth may not have desirable filter cake discharge characteristics.

Other methods for decreasing the amount of liquid blown from the fluid conduits within the drum onto the filter cloth have been directed at the addition of liquid storage chambers by the use of a series of capped pipes or the like attached to the fluid conduits to trap the discharged liquid. United States Patents 2,321,120; 3,262,575; and 4,032,442 all are directed at individual liquid chambers attached to each fluid conduit. These devices have several disadvantages.

(15)

- 4 -

Since the volume of residual liquid which may remain in each fluid conduit may be significant, these fluid chambers each should have a large capacity to trap all the liquid discharged. However, entrapping this residual liquid may result in undesirable deflection of the chambers unless relatively complex support mechanisms are provided. In addition, venting of the aforementioned devices may not be sufficient, resulting in incomplete drainage of the chambers during filter drum rotation. In addition, the aforementioned devices may not be easily fitted to rotary drum filters presently in use.

Accordingly, it is desirable to produce a modified rotary filter in which erosion of the filter cloth by entrained liquid is reduced or eliminated without decreasing the filter throughput or increasing the cost of replacement filter cloths.

It is also desirable to have a rotary filter design which effectively traps residual liquid and which is relatively inexpensive and reliable.

It is also desirable to have a rotary filter design which is easily adaptable to rotary filters currently in use for removing entrained liquid.

The present invention provides a continuous rotary drum filter means comprising:

16

- (a) a filter vat for containing a filterable slurry of liquids and solids up to a selected level;
- (b) a rotatable filter drum mounted with its axis horizontal for rotation about its axis with its upper part above the selected level, the drum comprising a plurality of circumferentially-spaced filtering sectors each having a plurality of openings at the periphery of the drum;
- (c) means to rotate the drum about its axis in a selected sense;
- (d) each filtering sector of the drum having lead and lag conduits connected to respective sets of openings such that during rotation of the drum in the selected sense, the openings connected to a lead conduit of a sector arrive at a given point before the openings connected to the next successive lag conduit;
- (e) valve means for regulating the sequence and duration of the connection of the lead and lag conduits with a source of reduced pressure, a source of raised pressure, and with atmospheric pressure at respective angular intervals during the rotation of the drum; and
- (f) a plurality of liquid collection means, there being one liquid collection means adjacent to each axial end of the filter drum communicating with at least a majority of said lag fluid conduits for receiving liquid from said lag fluid conduits when gas at a raised pressure is admitted to the lag fluid conduits at one selected rotational position or interval of the drum, the liquid being

(17)

- 6 -

dischargeable via a discharge vent in the liquid collection means under the influence of the gas at a raised pressure at the said one selected rotational position or interval of the drum.

Each liquid collection means preferably comprises a series of circumferentially-adjacent chambers, and each chamber preferably communicates with a lag fluid conduit. Preferably, each chamber has a discharge vent for the discharge of liquid therefrom.

The invention is now further described with reference to some non-limitative examples thereof and to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an exploded isometric drawing of a typical rotary filter according to the present invention;

Figure 2 is an enlarged simplified isometric view of the filter of Figure 1 showing fluid conduits and the liquid collection means; and

Figure 3 is a simplified cross-sectional view of a rotary filter indicating the operations performed at different locations of the drum of the rotary filter during operation thereof.

(18)

DETAILED DESCRIPTION OF THE INVENTION

Referring to Figure 1, an exploded, simplified isometric assembly drawing of a typical rotary drum filter is shown. The filter includes a filter vat, generally indicated as 10 and a filter drum generally indicated as 20. Vat 10, having a substantially semicylindrical shape is supported by columns 12 above base 14. An inlet 16 communicates with vat 10 and with the source of the slurry to be separated (not shown). A level controller (not shown) usually is added to control the level of slurry in vat 10 by regulating valve 18 in inlet 16. A filter hood 90 having an overall semicylindrical shape has a plurality of perforated spray headers or drip pipes 92 disposed therein parallel to the axis of rotation of drum 20 to wash the wax cake formed in the drum as hereinafter described. Filter drum 20 is of a generally overall cylindrical shape having a diameter slightly less than that of the diameter of vat 10, such that drum 20 is rotatable about its axis in vat 10 on a pair of trunnions 22 located at each axial end thereof. A series of uniformly spaced sections 40 extends outwardly from the curvilinear surface of drum 20 parallel to the axis of rotation. Terminal sections 42 disposed near the ends of drum 20 connect each section 40 to an adjacent section, thereby to define a series of segments 44 circumferentially disposed around the drum 20. Each segment 44 has two series of openings through drum 20 evenly spaced along substantially the entire axial length of each segment to form circumferential rows with one series of openings 32

19

- 8 -

connected to, and in general alignment with, respective fluid conduits 30 located within the drum 20 and with the other series of openings 34 connected to, and in general alignment with, respective fluid conduits 31 located within the drum 20. In each segment 44, the leading openings 32 in the direction of rotation hereinafter are referred to as the lead openings while the immediately adjacent trailing openings 34 are referred to as the lag openings. Similarly, a fluid conduit 30, communicating with openings 32, is referred to as a lead fluid conduit, while a fluid conduit 31 communicating with lag openings 34 is referred to as a lag fluid conduit. The lead and lag conduits extend substantially parallel to the axis of the drum 20 for substantially the entire axial length of the drum.

One of the pair of trunnions (the right-hand trunnion of Figure 1, which is not visible) communicates with a conventional drum rotation means (not shown) to rotate the drum 20 about its longitudinal horizontal axis in a selected sense (e.g. clockwise as viewed from the left-hand end of drum 20).

The other trunnion 22 (i.e. the left-hand trunnion 22 as shown in Figure 1) has a plurality of holes on its axially-outer radial face which communicate either with the lead or the lag conduits 30, 31 within the drum 20. The axially outermost radial face of the (left-hand) trunnion 22 contacts an opposed surface of a non-rotating trunnion valve

means 24, which is fixed relative to the vat 10. The trunnion valve means 24 has holes therethrough which, during rotation of the drum 20 and the trunnion 22, periodically register with the holes in the axially outermost face of the trunnion 22. Some of the holes in the trunnion valve means 24 are connected to a source of reduced pressure (not shown) and to a filtrate storage facility (not shown), other holes to a source of air (or other gas), not shown, under superatmospheric pressure to serve as the so-called "blow gas", while other holes are connected to atmosphere. As a result of this arrangement, during each operating cycle of the rotary drum filter of the drawings, the lead and lag conduits 30, 31 are connected in turn to the source of reduced pressure and the filtrate storage facility, the source of pressurized air or other gas serving as the blow gas, and to atmosphere for the purposes described herein. The construction, arrangement and resultant operation of the filter of the drawings, as so far described, is substantially conventional and well-known in the art.

Each lag conduit 31 extends substantially the entire axial length of the drum 20 and is connected at each end with a chamber 82 of a liquid collection means 80, more specific details of which are given below, in connection with the description of Figure 2.

A means for removing the filter cake from filter cloth 60, such as doctor knife 140 disposed in a compartment in vat 10, is shown discharging the filter cake into a screw

21

- 10 -

conveyor 102 which directs the filter cake out of vat 10 through outlet 104. Within each segment 44 is disposed a filter grid 50 to maintain a filter cloth 60 spaced apart from drum 20. The filter cloth 60 is stretched over sections 40 and grids 50 and is retained in position by caulking bars 70 (of which only one is shown in Figure 1) compressingly inserted between the sections 40 and by circumferential wires (not shown).

It has been found that the liquid remaining in lag conduit 31 tends to be blown to the ends of the conduit when blow gas is passed through the conduit 31 while flow to lead conduit 30 is simultaneously blocked by means of trunnion valve 24. Accordingly, liquid collection means 80 at each end of the drum 20, as shown in Figure 2, somewhat simplified for clarity, should be in communication with at least a plurality of lag conduits 31, and more preferably in communication with all lag conduits 31, to decrease the erosive effects of residual liquid from the lag conduits 31 impacting on the filter cloth 60 and to prevent residual liquid from being blown back into the filter cake. The collection means 80 are disposed within the drum 20 in communication with the termini of lag fluid conduits 31. The collection means 80 preferably have a substantially annular configuration. In the preferred embodiment described herein, a pair of collection means 80 having an overall annular configuration are utilized, one disposed in drum 20 adjacent to each drum wall 26. Each collection means 80 may be a separate body mounted in drum 20,

or it may be formed by partitioning the internal area adjacent to wall 26 of drum 20. Where existing filters are to be adapted to be in accordance with the present invention, there may not be sufficient room between the outermost circumferential rows of openings 32, 34 and the drum walls 26 for the collection means 80. In that event, a sufficient number of rows of circumferential openings adjacent to each end of the drum may be blocked off to provide sufficient room for the installation or accommodation of collection means 80, and the lag conduits 31 may be modified to communicate with the collection means 80 as hereinafter described.

The overall configuration of the collection means 80 will be dependent upon the design of the filter means, the required liquid storage capacity in the collection means, and the space available within the filter drum 20 for installing or accommodating the collection means. To simplify construction, each collection means 80 is preferably of an overall annular shape.

Figure 2 shows a liquid collection means 80 comprising a generally annular vessel 81 having individual chambers 82, each chamber separated from the adjacent chamber by a partition 86. Each chamber 82 communicates on one hand with a terminus of a lag fluid conduit 31 through chamber opening 88 and on the other hand with a discharge vent means, such as discharge vent conduit 84, to permit alternate gas and liquid residence in, and discharge from, each chamber 82.

during each revolution of the drum 20. The chambers 82 should be sized such that each chamber will contain all the residual liquid discharged through the respective terminus of lag fluid conduit 31 by the blow gas during each revolution of the drum 20. It may be desirable to brace each vessel 81 to drum 20 by radially-extending supports 100 connecting the vessels 81 and the drum 20.

The method selected for venting a chamber 82 is not critical provided that the venting is sufficient during all phases of filter operation. Adequate venting is particularly important so that blow gas will displace and thereby discharge liquid from each chamber. The liquid from each chamber 82 is eventually expelled from the lag conduit via a hole in the trunnion 22 and a hole in the trunnion valve means 24, when the holes in the trunnion 22 and trunnion valve means 24 register, and thence to an external filtrate storage facility (not shown) as described in more detail with reference to a preferred arrangement. One particularly effective method for venting individual chambers 82 is to connect each chamber, such as chamber 82A, to the generally diametrically opposite chamber such as chamber 82F, via the vent conduits 84 joined at 85, although other means for venting chambers 82 also may be effective. In Figure 2, the end regions of two lag fluid conduits 31 only, at their connections 88 to the chambers 82 are shown, and all but two vent conduits 84 have been omitted, for clarity.

A typical filter for the separation of wax from lube oil has a filter drum 20, thirty feet (9.144 m) in length and eleven and one-half feet (3.5052 m) in diameter. This drum has an effective filtering area of approximately 1000 square feet (92.9m²) with thirty lag fluid conduits 31, 2.5 inches (6.35 cm) in diameter. In this embodiment, liquid collection means 80 may comprise an annulus approximately nine feet (2.7433 m) in diameter fabricated from pipe of eight inch (20.32 cm) O.D. (outside diameter), suitably of schedule 40 type 316 stainless steel. The rings are partitioned into 30 substantially equivalent chambers 82, each chamber communicating with the terminus of a lag fluid conduit 31 and with the diametrically opposite chamber via vent conduit 84, which may be fabricated from small diameter thin-walled metal tubing, such as half inch (1.27 cm) diameter stainless steel tubing. Preferably tubing which is somewhat flexible should be used, since all vent conduits 84 will pass near the center of vessel 81.

The sectors of Figure 3 illustrate the varying operations performed simultaneously by a typical rotary filter such as that of Figure 1, which is in accordance with the invention. When a selected point on filter cloth 60 is in a position included within sector A, that point is under vacuum. Filtrate is drawn through filter cloth 60, the openings 32 and 34 in the surface of the drum 20 and into the fluid conduits 30 and 31, respectively, and thence, via registering holes in

the trunnion 22 and trunnion valve means 24, into an external filtrate storage facility (not shown). The solid wax crystals are retained on filter cloth 60 and build up to form a wax filter cake. Towards the end of this phase, blow gas is admitted into lag conduits 31 from a pressurized source thereof by registering holes in the trunnion valve means 24 and the trunnion 22. The blow gas passes from chamber 82F through discharge vent conduit 84 into chamber 82A, causing liquid in chamber 82F to be discharged via vent conduit 84 into chamber 82A, and pressurizing chamber 82A momentarily, thereby forcing liquid in chamber 82A out of the chamber through the lag conduit 31 connected thereto and thence via registering holes in the trunnion 22 and the trunnion valve means 24 into the external filtrate storage facility (not shown). As the selected point on the filter cloth 60 rotates to sector B, that point rises out of the slurry. Vacuum continues to be applied from a source of vacuum via registering holes in the trunnion valve means 24 and the trunnion 22 to sector B to continue to draw any remaining filtrate through the openings 32 and 34 in the surface of the drum 20 and the respective fluid conduits 30 and 31, thereby further drying the filter cake. Any remaining liquid in chamber 82A is forced or discharged from the chamber through lag conduit 31 by the combination of the pressure in chamber 82A and the vacuum in the lag conduit. When the said point on the filter cloth 60 rotates still further to a position within sector C, vacuum or reduced pressure applied via valve means 24 and registering holes in the trunnion 22 continues the evacuation of the fluid conduits 30 and 31, while a wash fluid is sprayed through the spray headers 92 in the filter hood 90

to wash filtrate remaining on the wax cake. At least a portion of the filtrate remaining on the cake, as well as wash fluid, passes through the wax cake, filter cloth 60, the openings 32, 34 and the respective fluid conduits 30, 31, for removal from the filter. The wash fluid generally comprises a liquid which is miscible with the filtrate but not with the solids of the filter cake. In the separation of lube oil from wax, this wash liquid frequently is a mixture of ketones or ketone/toluene. When the selected point on filter cloth 60 rotates to a position within Sector D, the filter cake is again dried by discontinuing the external wash flow and continuing to apply vacuum or reduced pressure to sector D, which pulls or sucks wash from the wax cake through the openings 32, 34, and the respective fluid conduits 30, 31. As the said point on the filter cloth 60 rotates still further to sector E, purge gas, typically having a velocity of about 100 feet/second (30.48 m/s), is supplied from a source thereof via registering holes in the valve means 24 and trunnion 22 to lag fluid conduits 31 communicating with lag openings 34 in sector E while the immediately adjacent lead openings 32 continue to be maintained under vacuum by connection to the source of reduced pressure via the valve means 24 and trunnion 22. This serves to cause some of the liquid remaining in lag fluid conduits 31 communicating with lag openings 34 to flow into the fluid conduits 30 communicating with lead openings 32. As the said point on the filter cloth 60 rotates still further to sector F, the lead openings are no longer evacuated. The purge gas, which is called blow gas at this

(21)

- 16 -

point, forces at least a portion of the remaining liquid in fluid conduit 31 into a chamber 82F of liquid collection means 80. Blow gas, together with liquid from chamber 82F, also passes through vent conduit 84 to pressurize the diametrically opposite chamber 82A as previously described. Blow gas also contacts filter cloth 60, causing the cloth to billow out slightly, thereby facilitating the subsequent removal of the cake by the doctor knife 110. It should be noted that if the liquid collection means 80 were not installed or provided in the filter of the invention, liquid remaining in conduits 31 would be conveyed by the high velocity purge gas and outwards through the openings 34 to impinge against the filter cloth 60 causing the cloth to erode, particularly at the ends of drum 30 where the liquid tends to collect.

The relative angular widths of the sectors A-F is shown in Figure 3 for a typical filter. It is to be understood that the length of time that any given point or location on filter cloth 60 spends in a particular sector may be adjusted by varying the angular extent of the sector and by varying the rate of rotation of drum 20. In addition to decreasing the erosion rate of the filter cloth, use of the subject invention also may permit a decrease in the time required for the operations performed in sectors E and/or F, thereby permitting an increase in the filtration time in each revolution.



While the invention has been described with respect to a specific embodiment, it will be understood that this disclosure is intended to cover any variations, uses and adaptations of this invention including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains and as fall within the scope of the invention as defined by the claims hereinafter.



CLAIMS:

1. A continuous rotary drum filter means comprising:
 - (a) a filter vat for containing a filterable slurry of liquids and solids up to a selected level;
 - (b) a rotatable filter drum mounted with its axis horizontal for rotation about its axis with its upper part above the selected level, the drum comprising a plurality of circumferentially-spaced filtering sectors each having a plurality of openings at the periphery of the drum;
 - (c) means to rotate the drum about its axis in a selected sense;
 - (d) each filtering sector of the drum having lead and lag conduits connected to respective sets of openings such that during rotation of the drum in the selected sense, the openings connected to a lead conduit of a sector arrive at a given point before the openings connected to the next successive lag conduit;
 - (e) valve means for regulating the sequence and duration of the connection of the lead and lag conduits with a source of reduced pressure, a



source of raised pressure, and with atmospheric pressure at respective angular intervals during the rotation of the drum; and

(f) a plurality of liquid collection means, there being one liquid collection means adjacent to each axial end of the filter drum communicating with at least a majority of said lag fluid conduits for receiving liquid from said lag fluid conduits when gas at a raised pressure is admitted to the lag fluid conduits at one selected rotational position or interval of the drum, the liquid being dischargeable via a discharge vent in the liquid collection means under the influence of the gas at a raised pressure at the said one selected rotational position or interval of the drum.

2. A filter means as in claim 1 in which each liquid collection means comprises a generally annular vessel divided into a plurality of circumferentially-adjacent chambers.

3. A filter means as in claim 2 in which each chamber communicates with a lag conduit.

(2)



4. A filter means as in claim 2 or claim 3 in which each chamber has a discharge vent for the discharge of liquid therefrom.

5. A filter means as in claim 4 in which the discharge vent of one chamber is connected to the discharge vent of another chamber so that liquid from the said one chamber is discharged to the said other chamber.

6. A filter means as in claim 5 in which the said one chamber and the said other chamber are at substantially diametrically opposite sides of a respective annular vessel comprised by a liquid collection means.

7. A filter means of any one of claims 1 to 6 comprising a filter cloth disposed over the circumferential openings on the filter drum, and means for removing filter cake formed on the filter cloth, whereby, over one angular interval of each rotation of the filter drum (during operation), slurry from the vat is drawn onto the filter cloth with at least a portion of the filtrate passing through the openings into the said conduits while filtered solids form a filter cake on the filter cloth, and over another angular interval of each rotation, the filter cake is removed from the cloth.



32

- 21 -

8. A rotary filter means according to any one of claims 1 to 7 substantially as described.

9. A continuous rotary drum filter means substantially as described with reference to the drawings.
