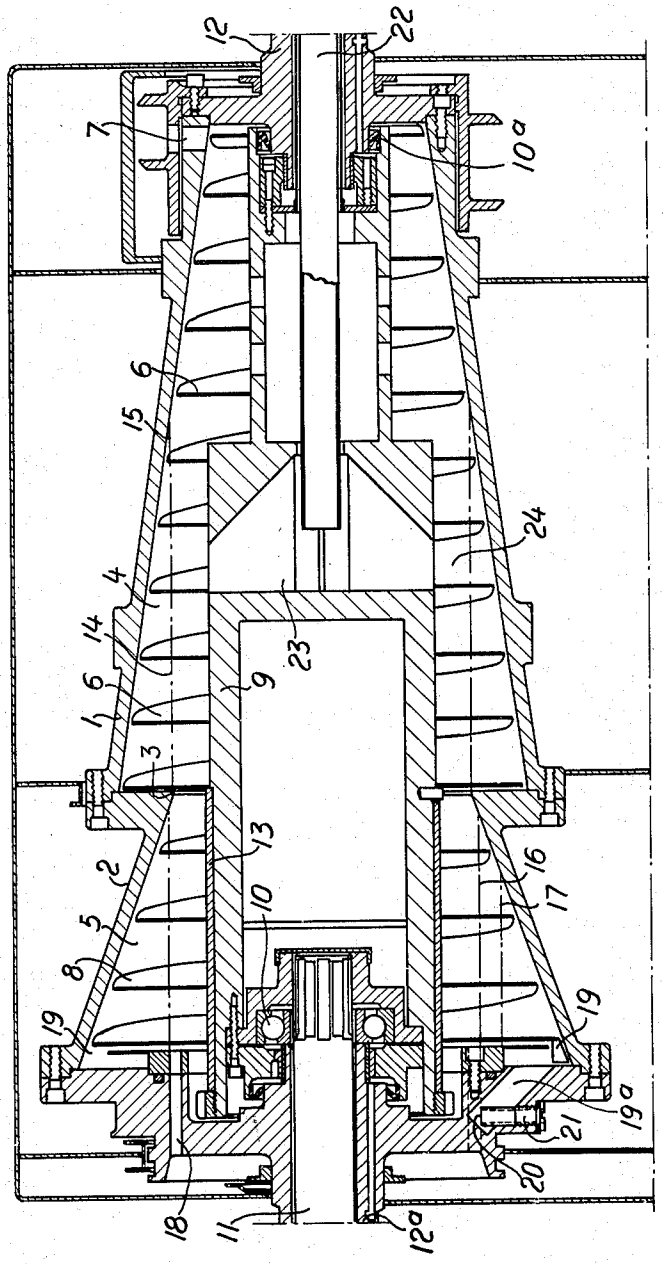
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SLUDGE CENTRIFUGE

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SLUDGE CENTRIFUGE

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This invention relates to sludge centrifuges of the type in which the rotor consists of a hollow conical bowl containing a conveyor screw rotatable relative to the bowl to feed the separated sludge mass along the conical walls to the sludge outlet, the latter being located in the end of the conical bowl which has the smaller diameter.

Such centrifuges are usually designed solely for removal of the sludge particles from a sludge-containing liquid. The liquid outlet of the conical bowl is placed in the end having the greater diameter. The distance of this liquid outlet from the rotation axis is so chosen that the outer part of the bowl is filled with liquid, whereas the inner part is free from liquid. Thus, during operation, there is formed a free liquid surface of cylindrical shape which intersects the peripheral wall of the conical bowl somewhere between the two ends. The screw conveys the sludge mass out of the liquid mass at this point of intersection and thence along the bowl wall to the outlet. The distance through which the sludge mass is thus forced along the conical wall, inside the liquid level, serves as a drying zone for the sludge. Also, within this zone the centrifugal force acts upon the liquid held by the sludge mass, so that the liquid is forced out of the sludge mass and flows back to the liquid body in that part of the bowl which has the greater diameter. Consequently, at the sludge outlet in the opposite or smaller-diameter end of the bowl, a relatively dry sludge is discharged.

In many cases, the liquid separated from the sludge consists of a mixture of two components, e. g., an aqueous phase and an oil phase, as in the case of recovering fish oil. These two liquids leave the liquid outlet as a mixture and must be subjected to re-treatment, if it is desired to separate them.

The present invention has for its principal object the provision of an improved centrifuge which not only desludges the liquid but also separates the de-sludged liquid into two liquid components which are discharged separately from the rotor.

According to the invention, the outer part of the rotor chamber is connected with an outlet for the heavier liquid component, which outlet is located nearer the rotor axis than is this outer part of the rotor; while the lighter liquid is discharged through an outlet, preferably an overflow outlet, located at the region of the free liquid level in the rotor. Thus, the outlet for the lighter liquid component is positioned at a somewhat shorter radius than the outlet for the heavier liquid component. By regulating the relative radial positions of these two outlets, the boundary level formed between the two liquid components within the rotor chamber is disposed in the desired radial position between the free liquid level and the outer wall of the chamber.

In the new centrifuge, the sludge can be separated from the sludge-containing liquid in the usual manner, that is, in a chamber where the liquid phase is homogeneous and is withdrawn from the free liquid level. However, to separate the liquids from each other as completely as possible, it is necessary to have a boundary level within the liquid mass so that it is divided into an inner layer containing the lighter liquid component and an outer layer containing the heavier liquid component.

According to the present invention, these desiderata are met by making a part of the conical bowl as a clarifier, in which the sludge particles are separated from a homogeneous liquid mixture, and making another part as a purifier in which, during operation, a boundary level is formed in the liquid mass. In the preferred form of the invention, the clarifier part is provided at the end having the larger diameter with an end wall which extends close to the free liquid level, where it forms an overflow over which the liquid mixture flows into the purifier part. The latter has its free liquid level positioned radially at or somewhat outside the free liquid level in the clarifier part. In this way, the liquid mixture is caused to flow from the clarifier part to the purifier part without any possible formation of different layers in the clarifier part.

The purifier part, like the clarifier part, forms a conical bowl, but its conical angle may be greater. The purifier part also may be provided with a conveyor screw for forcing fine sludge, separated in this rotor part, along the conical wall to the overflow edge between the purifier part and the clarifier part.

In the accompanying drawing, the single illustration is a longitudinal sectional view of a preferred embodiment of the invention.

The rotor has two conical shell or bowl parts 1 and 2 joined endwise, as by means of screws, so that an end wall of the part 2 forms an overflow 3 between the enlarged end of clarifier chamber 4 and the reduced end of purifier chamber 5. In the part 1 is a conical conveyor screw 6 adapted to force separated sludge along the adjacent conical wall towards the sludge outlet 7. In the purifier part 5 is a similar conveyor screw 8 adapted to force sludge along the adjacent conical wall towards the overflow edge 3 and over this edge into the chamber 4. The conveyor screw 6 is supported and driven by a cylinder 9 which surrounds, the cylinder 9 being rotatably mounted axially of the bowl by means of bearing assemblies 10 and 10*a* at opposite ends. The part 9 is rotated relative to the shell 1—2 by a shaft 11 which projects centrally into one end of the rotor and rotates relative to the driving shaft 12 of the rotor at its opposite end. The shaft 12 and a journal 12*a* at the opposite end of the bowl are mounted in suitable bearings in the centrifuge frame (not shown).

The conveyor screw 8 is supported by a thin-walled cylindrical member 13 which is removably secured to the cylinder 9 and rotates with it relative to the conical walls of the rotor.

In the operation of the centrifuge, there is formed in the clarifier part 1 a free liquid level 14 in the form of a cylinder, which at 15 intersects the inner conical surface of the part 1. Thus, the conical surface between this part 15 of the rotor and the sludge outlet 7 is free from the liquid so that the sludge during its passage from 15 to 7, under the influence of the centrifugal force, is more or less dried before leaving the rotor.

In the purifier part 2 there is formed a free liquid surface 16 and a boundary level 17 between the lighter and heavier liquid components, e. g., oil and water. The lighter liquid is discharged through an outlet 18 placed on the radius of the free liquid level 16, whereas the heavier liquid passes through an annular slot 19 located in the outer part of the liquid chamber through an inwardly extending passage 19*a* to an outlet 20 in the form of a radially directed hollow screw 21. The

hollow screw 21 forms a discharge opening located nearer the bowl axis than is the outer part 19 of the bowl chamber. By radially displacing the inner free edge of the screw 21, which may be effected by screwing it either in or out, or by substituting screws having inner parts projecting inwardly at different lengths, the position of the boundary level 17 is regulated according to the nature of the two liquid components, so that the boundary level may be located on that radius which is most favorable to the separation.

The sludge-containing liquid is introduced through a fixed tube 22 projecting through the drive shaft 12 into the rotatable bowl and opening within the bowl into a chamber 23 provided with radial vanes, from which the liquid enters the clarifier part at 24. In the clarifier part 1, the centrifugally separated sludge is discharged through the drying zone and the outlet 7 by conveyor screw 6, while the de-sludged liquid (the components of which still form a homogeneous mixture) is discharged over the overflow 3 into the purifier part 2. There the liquid is centrifugally separated into its lighter and heavier components, which are discharged at 18 and 21, respectively, while the sludge separated in chamber 5 and accumulating at the outer conical wall thereof is returned by screw 8 over the overflow 3 to the clarifier chamber 4, countercurrently to the liquid passing to the purifier chamber 5.

The division of the liquid chamber of the rotor into a clarifier part 4 and a purifier part 5 is highly important. In the purifier chamber 5, there is unavoidably a boundary level 17 between the two kinds of liquids separated from each other. If it is desired to free the lighter liquid (which usually is oil) as far as possible from the other liquid component (which usually is more or less pure water and thus in most cases valueless, whereas the oil constitutes a marketable product), then the boundary level 17 must be located at a relatively large radius in the purifier chamber. If there were only one liquid chamber in the bowl, this would mean that the sludge mass deposited on the shell wall would be forced by the conveyor screw a rather long distance along the shell wall through the oil layer. On arriving in the drying zone, the sludge mass would then be mingled with oil instead of a mixture of oil and water. As only part of the liquid is removed from the sludge in the drying zone, the remainder adhering to the sludge mass, this means that the sludge carries with it a relatively great portion of the oil. By arranging a special clarifier part 4 in which no separation of liquids from each other occurs, the sludge mass arriving at the drying zone is mingled with a mixture of oil and water. As in most cases the water constitutes by far the greatest portion of the liquid mixture, a relatively small quantity of oil is contained in the sludge mass when the latter enters the drying zone. In this zone, an approximately equal percentage of oil and water is forced out because of the centrifugal force, for which reason the oil quantity left in the sludge at the outlet of the drying zone becomes much smaller than it would be if the sludge had been forced through an oil layer.

It is true that in the purifier part 5 of the bowl some remaining fine sludge particles are separated from the liquid and form on the shell wall a sludge mass which will be forced through the oil layer. However, this sludge quantity constitutes only a small part of the total sludge quantity in the untreated liquid and, moreover, it can be returned from the purifier part 5 over the overflow 3 into the clarifier part 4 where, being the heavier constituent, it travels at once through the liquid to the shell wall. During this travel, and as it moves along the shell wall to the drying zone, this returned sludge is freed, by washing, from the main part of the oil.

The invention has important advantages over the sludge centrifuges used heretofore. With easily separable components, the oil thus can often be finely separated in a subsequent clarifier, whereas in methods used heretofore it is necessary first to separate off water and oil in a purifier before finely purifying the oil in a clarifier. Further, in the processing of fish oil, for example, at least the major part of the water, which often constitutes the greatest proportion of the supplied liquid, is separated in the present centrifuge at an early stage of the process, whereby the load on the succeeding machines is considerably reduced. Finally, the troublesome emulsion-formation is avoided, this being unavoidable when oil and water leave the bowl jointly. This emulsion renders the subsequent separation of the oil and the water much more difficult.

It will be understood that the parts 1 and 2 of the centrifugal bowl define a chamber which is divided into sub-chambers 4 and 5 by the wall defining the liquid overflow 3 between these sub-chambers. As shown, the overflow 3 is located nearer the rotation axis of the bowl than is the outlet 18 for the lighter liquid, the outer confine of this outlet being at a greater radius than the edge of the overflow 3. The liquid outlets 18 and 20 and the sludge outlet 7 are located at opposite ends of the bowl, the larger end wall constituting a means forming the lighter liquid outlet 18.

I claim:

1. In a centrifuge for separating sludge-containing liquids of the type having a centrifugal bowl forming a chamber provided with a generally conical portion and a sludge outlet located in the conical portion at a relatively small radius from the rotation axis of the bowl as compared with the free liquid level in the bowl chamber, and a conveyor screw in the bowl mounted for rotation relative thereto for conveying separated sludge inward through the liquid and along a drying zone of the conical wall of said portion to the sludge outlet, the improvement which comprises a discharge passage for a heavier liquid component leading from the outer part of said chamber and terminating in a discharge opening located nearer said axis than is said outer part, means forming a lighter liquid outlet leading from the inner part of said chamber, and a wall in the bowl dividing the chamber into two sub-chambers extending from each other in the axial direction of the bowl, said dividing wall extending inward from the bowl periphery and forming a liquid overflow between the sub-chambers, the sludge outlet leading from one sub-chamber, and said discharge passage and outlet for the liquids leading from the other sub-chamber.

2. The improvement according to claim 1, comprising also a hollow screw forming said discharge opening for the heavier liquid component, the screw extending generally radially of the bowl and having an inner edge defining the radius of said discharge opening.

3. The improvement according to claim 1, in which the bowl comprises two conical shells interconnected at adjacent ends to form said chamber and each defining a sub-chamber, one of the shells forming a clarifier section having the sludge outlet and the other shell forming a purifier section having said discharge passage and outlet for the liquids, said last shell forming said dividing wall.

4. The improvement according to claim 1, in which the bowl comprises two conical shells interconnected at adjacent ends to form said chamber and each defining a sub-chamber, one of the shells forming a clarifier section having the sludge outlet and the other shell forming a purifier section having said discharge passage and outlet for the liquids, said last shell forming said dividing wall over which liquid may pass from the clarifier section to the purifier section, and a second screw conveyor in the purifier section mounted for rotation relative thereto for conveying residual sludge inward along the conical wall of the purifier section and into the clarifier section via said overflow.

5. The improvement according to claim 1, in which

said liquid overflow is located nearer said axis than is said lighter liquid outlet.

6. The improvement according to claim 1, in which said liquid overflow is located nearer said axis than are said lighter liquid outlet and said discharge passage.

7. The improvement according to claim 1, comprising also a feed tube leading into said sub-chamber from which the sludge outlet leads, the feed tube being adapted to deliver a sludge-containing liquid into said last sub-chamber.

8. The improvement according to claim 1, comprising also a feed tube leading into said sub-chamber from which the sludge outlet leads, the feed tube being adapted

to deliver a sludge-containing liquid into said last sub-chamber, said sludge outlet being located at one end of the bowl and said liquid discharge passage and liquid outlet being located at the opposite end of the bowl, said liquid overflow being located nearer said axis than is said lighter liquid outlet.

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