

Description

This invention relates to centrifugal separators.

In Patent specification GB—A—1359157 there is disclosed a centrifugal separator having a rotor with an inlet for a mixture of two liquid components to be separated, and two outlets for the respective separated components. The separating chamber of the rotor communicates with an outlet chamber, defined centrally within the rotor, for the heavier component, and in this chamber there is arranged a stationary outlet member comprising at least one channel for conducting liquid from the outlet chamber to a reception place outside the rotor. Valve means actuatable during the operation of the rotor is arranged either to admit, or to prevent, liquid flow from the outlet chamber to said reception place. The separator is intended to be used in connection with separation of oil from water and solid particles. A centrifugal separator of the foregoing form is also disclosed in EP—A—0123491, which falls within the terms of Article 54(3) EPC, and includes a calibrated opening in the connection between the separating chamber and the outlet chamber for restricting the rate of discharge of heavier component from the separator with the aim of maintaining the liquid interface in the separating chamber within predetermined limits.

A problem with centrifugal separators as mentioned above is that a relatively high temperature arises in the central outlet chamber during the time when the valve means is closed so that liquid is prevented from flowing between this chamber and to the reception place for separated heavy liquid component. The reason for this is that during this time the central outlet chamber is filled by the separated light liquid component which reaches such a high level in the outlet chamber that the stationary outlet member therein becomes immersed relatively deeply within the liquid. Thus, a great deal of friction arises between the rotating liquid and the stationary outlet member, the heat thus produced being accumulated in the liquid present in the outlet chamber.

A high temperature in the outlet chamber is especially disadvantageous when the separated liquid component consists of oil.

The present invention resolves this problem by arranging for a reduced level of liquid to be maintained in the outlet chamber so that a temperature may be maintained within the outlet chamber, which does not substantially exceed the temperature of the liquid being treated in the separating chamber of the rotor.

According to the invention there is provided a centrifugal separator comprising a rotor with an inlet for a mixture including two liquid components to be separated, and two outlets for the respective separated liquid components, a separating chamber in the rotor communicating with an outlet chamber defined within the rotor for the heavier liquid component, a stationary outlet member arranged in the outlet chamber and

having at least one channel for conducting the liquid from the outlet chamber to a reception place outside of the rotor, and valve means actuatable during the operation of the rotor either to admit or to prevent flow liquid flow out of the rotor through said channel from the outlet chamber, characterised by a calibrated opening in the connection between the separating chamber and the outlet chamber for limiting the liquid flow into the outlet chamber, and by stationary outlet means extending into the outlet chamber and comprising a calibrated outlet for liquid to leave the outlet chamber while said valve means prevents liquid from flowing through said channel to said reception place, said calibrated opening and said calibrated outlet having such throughflow areas that they let through the same amount of liquid per unit time at a predetermined liquid level in the outlet chamber, as long as said valve means prevents liquid from flowing through the channel to said reception place.

The stationary outlet member of the outlet means for the heavier separated component and the stationary outlet means characterising the invention could be separate devices. However, said calibrated outlet can conveniently and is preferably constituted by an outlet situated in the liquid flow path between the outlet chamber and said valve means.

Thus, by the characteristic features of the invention the liquid level within the outlet chamber can be maintained at such a low level — even when liquid is prevented from flowing therefrom to the reception place for separated heavy liquid component — that a minimum of frictional heat will be generated in the outlet chamber. The throughflow areas of the calibrated opening and the calibrated outlet, respectively, are so chosen with respect to such a liquid level within the outlet chamber that, when the separated heavy liquid component is to be removed from the centrifuge rotor and conducted to the reception place, the pumping pressure required is achieved at the outlet member arranged in the outlet chamber.

It is possible to connect the calibrated outlet to the inlet of the centrifuge rotor or to some separate vessel outside the rotor. However, according to a preferred embodiment of the invention the calibrated outlet is arranged to discharge liquid flowing therethrough to the separating chamber of the rotor. This is preferably achieved by the radially outermost part of the separating chamber being arranged to communicate with a space defined centrally within the rotor, to which space said liquid is conducted through the calibrated outlet.

A full understanding of the invention will be had from the following detailed description, reference being made to the accompanying drawing, in which:—

Figure 1 shows a cross section of a centrifugal separator embodying the invention; and

Figure 2 shows an enlarged portion thereof.

The centrifugal separator in Fig. 1 comprises a rotor consisting of two parts 1 and 2, which are

held together by means of a lock ring 3. The rotor is supported by a driving shaft 4.

Within the rotor there is a slide member 5 movable axially into and out of sealing abutment against an annular sealing gasket 6. Between the slide member 5 and the upper rotor part 1 there is formed a separating chamber 7, and between the slide member 5 and the lower rotor part 2 there is formed a chamber 8 intended to contain a so-called operating liquid.

Means 9 is arranged for the supply of operating liquid to a space 10 defined by the rotor part 2, from where a channel 11 leads to the chamber 8. A throttle channel 12 leads from the radially outermost part of the chamber 8 through the rotor part 2 to the outside of the rotor.

Within the separating chamber 7 there is arranged a set of conical separating discs 13. These rest on a so-called distributor 14 which in the lower part of the rotor forms together with a conical plate 15 an inlet 16 to the separating chamber 7.

The upper part of the distributor 14 surrounds a central space within the rotor, into which there extends a stationary pipe 17 for the supply of a fluid mixture of components to be separated within the rotor.

On the upper side of the disc set within the separating chamber (only a few discs 13 are shown in the drawing) rests an upper conical plate 18 which is thicker than the discs 13 and which extends somewhat further radially outwards in the separating chamber than the discs. The plate 18 forms together with the upper rotor part 1 a channel 19 and has at substantially the level of the outer edges of the separating discs a through hole 20.

In the upper part of the rotor the upper plate 18 has two radially inwardly directed annular flanges 21 and 22, which between themselves form a chamber 23. The upper flange 22 extends further radially inwards than the flange 21. Above the upper flange 22 the upper rotor part 1 supports an annular inwardly directed flange 24, which extends somewhat further radially inwards than the lowermost flange 21. Between the flanges 24 and 22 there is a space 25 which communicates with the separating chamber 7 through the channel 19.

Between the uppermost portion of the rotor part 1 and the flange 24 supported thereby there is formed a chamber 26 which communicates with said space 25 through a calibrated opening 27 in the flange 24.

The previously described inlet pipe 17 carries a coaxially surrounding pipe 28 which at its lower end carries a so-called paring disc 29. The paring disc 29 is arranged within the previously mentioned chamber 23.

The pipe 28 in turn carries a coaxially surrounding pipe 30 which at its lower end carries a paring disc 31. The paring disc 31 is arranged within the previously mentioned chamber 26 and has several channels 32 — distributed around the paring disc — which through an annular channel 33 communi-

cate with an outlet conduit 34. In the outlet conduit 34 there is arranged a shut off valve 35.

In one or some of its channels 32 the paring disc 31 has a calibrated opening 36, which thus constitutes a calibrated outlet from the connection extending between the chamber 26 and the valve 35.

The paring disc 29 has paring channels 37 which communicate with a conduit 39 through an annular channel 38. In the conduit 39 there is arranged sensing means 40 of any conventional kind, arranged for sensing whether liquid flowing within the conduit 39 contains fractions of another liquid.

Control equipment 41 is connected through lines 42 and 43 to the sensing means 40 and the valve 35, respectively.

The above described centrifugal separator may be used for purifying oil, for instance heavy fuel oil, from water and solid particles. A mixture of these components, heated to about 100°C, is supplied into the centrifuge rotor through the conduit 17, from where it flows through the channel 16 into the separating chamber 7.

At this stage the chamber 8 between the slide member 5 and the rotor part 2 is filled with operating water, so that the slide member 5 is kept pressed against the gasket 6. A small amount of operating water constantly leaves the chamber 8 through the hole 12, but the corresponding amount of new operating water is continuously supplied through the means 9.

In the separating chamber 7 separated oil moves towards the centre of the rotor and flows into the chamber 23, from where it is pumped by the paring disc 29 through the channels 37 and 38 to the outlet conduit 39. The radially inwardly directed annular flange 21 forms an overflow outlet from the separating chamber for the separated oil, and the liquid level in the separating chamber is therefore determined by the position of the inner edge of the flange 21.

Separated oil will flow towards the rotor centre even within the channel 19 between the upper plate 18 and the rotor part 1. From the channel 19 the oil enters the central space 25, where a surface is formed at the same level as in the separating chamber 7.

A certain amount of oil flows through the calibrated opening 27 in the flange 24 into the chamber 26. From there oil is pumped by the paring disc 31 through the channels 32 and 33 into the conduit 34 to the valve 35. In a starting condition the valve 35 is closed and, therefore, there is no further flow of oil through the conduit 34, after the channels 32 and 33 and the conduit 34 have been filled. However, the paring disc 31 continues to pump oil out of the chamber 26, and this oil is discharged through the calibrated outlet 36 (Fig. 2) positioned some distance within one of the channels 32 of the paring disc. The oil flowing out through the outlet 36 is collected in the space 25, where it can not influence the liquid level and from where it can again flow into the chamber 26 through the opening 27.

The openings 27 and 36 are so dimensioned that



the same amount of oil per unit time will flow therethrough, whereby the liquid level in the chamber 26 can be maintained as far radially outwards as is acceptable for a satisfactory outflow of separated water, as will be described later.

If the outlet 36 and/or the perforated flange 24 had not existed, the liquid level in the chamber 26 — at the stage now in question — would have been the same as in the separating chamber 7. This would have meant that a relatively large part of the surface of the paring disc 31 would be in contact with oil rotating within the chamber 26, and the temperature in this chamber would have become undesirably high.

In operation of a centrifuge rotor having no outlet 36 and no perforated flange 24, a temperature of about 150°C has been measured in the chamber 26. With the arrangement described and shown in the drawing this temperature could be lowered to about 105°C.

After some time of operation, when so much separated water has been accumulated in the radially outermost part of the separating chamber that the interface layer between oil and water is situated at a level A in the separating chamber, fractions of water start to be entrained by the separated oil leaving through the conduit 39. This is sensed by the means 40 which emit a signal to the control equipment 41. The control equipment 41 in turn opens the valve 35 and keeps it open for a predetermined period of time. During this time so much separated water is allowed to leave the separating chamber 7 through the channel 19 and pass through the flow determining opening 27 in the flange 24, that the interface layer in the separating chamber between oil and water is moved to a level B.

After the valve 35 has been closed, the water which at this stage is present in the chamber 26, the space 25 and the channel 19, will flow back to the separating chamber, oil then flowing through the hole 20 in the upper plate 18 and refilling said spaces to the levels as shown in the drawing.

In the manner described above separated water is intermittently led away from the separating chamber 7. Solid particles separated in the separating chamber are as a rule removed more seldom. This is accomplished by temporary interruption of the supply of operating water through the supply means 9. The control equipment 41 may be programmed such that for instance every fourth time a signal is emitted thereto, indicating that the interface layer between oil and water in the separating chamber has reached the level A, the valve 35 is kept closed and, instead, the supply of operating liquid to the means 9 is temporarily interrupted. The slide member 5 in this way is caused to move axially downwards to leave an open slot between itself and the gasket 6. Separated solid particles and a desired amount of water then leaves the separating chamber 7 through this slot and the ports situated radially outside the slot in the rotor part 2.

For determining the sizes of the calibrated openings 27 and 36 one can start from a certain

desired liquid level in the chamber 26 and a certain desired size of the opening 27. (These desiderata to a certain extent depend on the conditions desired during the periods of time when separated water shall be removed from the rotor through the chamber 26.)

By considering the pressure difference that will prevail between the liquid bodies on both sides of the flange 24 in the area of the opening 27 the flow through the opening 27 may be determined.

To maintain the chosen liquid level for oil in the chamber 26 it is necessary for exactly the same flow that passes through the opening 27 to pass also through the outlet 36, as long as the valve 35 in the outlet conduit 34 is closed. Empirically it then has to be measured which pressure is prevailing in the channel 32 of the paring disc 31 at the place of the outlet 36, when the liquid level in the chamber 26 is situated at the desired level. After that the size of the outlet 36 may be determined, so that the two said flows will be equal. In a practical embodiment of the invention it has proved suitable to arrange an opening 27 with a diameter of 4 mm and four openings 36 each with a diameter of 3,5 mm.

After said openings 26 and 36 have been correctly dimensioned and the described arrangement has been put in operation, the liquid surface in the chamber 26 will automatically be set at the desired level. The arrangement is thus self-controlling.

When the valve 35 is opened intermittently, and liquid flows up through the channels 32 of the paring disc 31, the static liquid pressure in the channels 32 will be lowered, which results in a reduced liquid flow through the calibrated outlet 36.

Claims

1. A centrifugal separator comprising a rotor with an inlet (17) for a mixture including two liquid components to be separated, and two outlets (34, 39) for the respective separated liquid components, a separating chamber (7) in the rotor communicating with an outlet chamber (26) defined within the rotor for the heavier liquid component, a stationary outlet member (31) arranged in the outlet chamber and having at least one channel (32—34) for conducting liquid from the outlet chamber (26) to a reception place outside of the rotor, and valve means (35) actuable during the operation of the rotor either to admit or to prevent liquid flow out of the rotor through said channel (32—34) from the outlet chamber (26) characterised by a calibrated opening (27) in the connection between the separating chamber (7) and the outlet chamber (26) for limiting the liquid flow into the outlet chamber (26), and by stationary outlet means extending into the outlet chamber and comprising a calibrated outlet (36) for liquid to leave the outlet chamber while said valve means (35) prevents liquid from flowing through said channel to said reception place, said calibrated opening (27) and



the same amount of oil per unit time will flow therethrough, whereby the liquid level in the chamber 26 can be maintained as far radially outwards as is acceptable for a satisfactory outflow of separated water, as will be described later.

If the outlet 36 and/or the perforated flange 24 had not existed, the liquid level in the chamber 26 — at the stage now in question — would have been the same as in the separating chamber 7. This would have meant that a relatively large part of the surface of the paring disc 31 would be in contact with oil rotating within the chamber 26, and the temperature in this chamber would have become undesirably high.

In operation of a centrifuge rotor having no outlet 36 and no perforated flange 24, a temperature of about 150°C has been measured in the chamber 26. With the arrangement described and shown in the drawing this temperature could be lowered to about 105°C.

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After the valve 35 has been closed, the water which at this stage is present in the chamber 26, the space 25 and the channel 19, will flow back to the separating chamber, oil then flowing through the hole 20 in the upper plate 18 and refilling said spaces to the levels as shown in the drawing.

In the manner described above separated water is intermittently led away from the separating chamber 7. Solid particles separated in the separating chamber are as a rule removed more seldom. This is accomplished by temporary interruption of the supply of operating water through the supply means 9. The control equipment 41 may be programmed such that for instance every fourth time a signal is emitted thereto, indicating that the interface layer between oil and water in the separating chamber has reached the level A, the valve 35 is kept closed and, instead, the supply of operating liquid to the means 9 is temporarily interrupted. The slide member 5 in this way is caused to move axially downwards to leave an open slot between itself and the gasket 6. Separated solid particles and a desired amount of water then leaves the separating chamber 7 through this slot and the ports situated radially outside the slot in the rotor part 2.

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desired liquid level in the chamber 26 and a certain desired size of the opening 27. (These desiderata to a certain extent depend on the conditions desired during the periods of time when separated water shall be removed from the rotor through the chamber 26.)

By considering the pressure difference that will prevail between the liquid bodies on both sides of the flange 24 in the area of the opening 27 the flow through the opening 27 may be determined.

To maintain the chosen liquid level for oil in the chamber 26 it is necessary for exactly the same flow that passes through the opening 27 to pass also through the outlet 36, as long as the valve 35 in the outlet conduit 34 is closed. Empirically it then has to be measured which pressure is prevailing in the channel 32 of the paring disc 31 at the place of the outlet 36, when the liquid level in the chamber 26 is situated at the desired level. After that the size of the outlet 36 may be determined, so that the two said flows will be equal. In a practical embodiment of the invention it has proved suitable to arrange an opening 27 with a diameter of 4 mm and four openings 36 each with a diameter of 3,5 mm.

After said openings 26 and 36 have been correctly dimensioned and the described arrangement has been put in operation, the liquid surface in the chamber 26 will automatically be set at the desired level. The arrangement is thus self-controlling.

When the valve 35 is opened intermittently, and liquid flows up through the channels 32 of the paring disc 31, the static liquid pressure in the channels 32 will be lowered, which results in a reduced liquid flow through the calibrated outlet 36.

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said calibrated outlet (36) having such through-flow areas that they let through the same amount of liquid per unit time at a predetermined liquid level in the outlet chamber (26), as long as said valve means (35) prevents liquid from flowing through the channel (32—34) to said reception place.

2. A centrifugal separator according to claim 1, characterised in that said calibrated outlet (36) constitutes an outlet from said channel (32—34) between the outlet chamber (26) and said valve means (35).

3. A centrifugal separator according to claim 1 or 2, characterised in that said calibrated outlet (36) is arranged to discharge the liquid flowing therethrough to the separating chamber (7) of the rotor.

4. A centrifugal separator according to any one of the preceding claims, wherein the radially outermost part of the separating chamber (7) communicates through a channel (19) with a central space (25) within the rotor and separated from said outlet chamber (26) by means of a partition (24), said calibrated opening (27) is situated in the partition, and said calibrated outlet (36) is arranged to discharge liquid flowing therethrough to the central space (25) defined within the rotor.

5. A centrifugal separator according to any one of the preceding claims, wherein the stationary outlet member (31) comprises a so-called paring disc, and said calibrated outlet (36) is constituted by a hole in the paring disc.

Patentansprüche

1. Zentrifugalseparator, mit einem Rotor mit einem Einlaß (17) für eine Mischung, die zwei flüssige aufzutrennende Komponenten einschließt, mit zwei Auslässen (34, 39) für die jeweiligen abgetrennten flüssigen Komponenten, mit einer in dem Rotor angeordneten Trennkammer (7), die in Verbindung steht mit einer Auslaßkammer (26), welche innerhalb des Rotors für die schwerere Flüssigkeitskomponente definiert ist, mit einem stationären Auslaßteil (31), das in der Auslaßkammer angeordnet ist und wenigstens einen Kanal (32—34) zum Ableiten von Flüssigkeit von der Auslaßkammer (26) zu einer Aufnahmestelle außerhalb des Rotors aufweist, und mit Ventileinrichtungen (35), die während des Betriebes des Rotors betätigbar sind, um eine Flüssigkeitsströmung aus dem Rotor durch den Kanal (32—34) von der Auslaßkammer (26) entweder zuzulassen oder zu unterbinden, gekennzeichnet durch eine kalibrierte Öffnung (27) in der Verbindung zwischen der Trennkammer (7) und der Auslaßkammer (26) zum Begrenzen der Flüssigkeitsströmung in die Auslaßkammer (26), und durch eine stationäre Auslaßeinrichtung, die sich in die Auslaßkammer erstreckt und einen kalibrierten Auslaß (36) umfaßt, damit Flüssigkeit die Auslaßkammer verlassen kann, während die Ventileinrichtung (35) Flüssigkeit daran hindert, durch den Kanal zu der genannten Aufnahme-

stelle zu fließen, wobei die kalibrierte Öffnung (27) und der kalibrierte Auslaß (36) derartige Strömungsquerschnitte haben, daß sie die gleiche Flüssigkeitsmenge pro Zeiteinheit bei einem vorbestimmten Flüssigkeitsniveau in der Auslaßkammer (26) durchlassen, so lange die genannte Ventileinrichtung (35) die Flüssigkeit daran hindert, durch den Kanal (32—34) zu der Aufnahme- stelle zu fließen.

2. Zentrifugalseparator nach Anspruch 1, dadurch gekennzeichnet, daß der kalibrierte Auslaß (36) einen Auslaß aus dem Kanal (32—34) zwischen der Auslaßkammer (26) und der Ventileinrichtung (35) darstellt.

3. Zentrifugalseparator nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der kalibrierte Auslaß (36) eingerichtet ist, um die dort hindurchfließende Flüssigkeit an die Trennkammer (7) des Rotors ausströmen zu lassen.

4. Zentrifugalseparator nach einem der voranstehenden Ansprüche, bei dem der radial äußerste Teil der Trennkammer (7) über einen Kanal (19) mit einem zentralen Raum (25) innerhalb des Rotors kommuniziert und von der Auslaßkammer (26) mit Hilfe einer Trennwand (24) abgetrennt ist, wobei die kalibrierte Öffnung (27) in der Trennwand angeordnet ist und der kalibrierte Auslaß (36) dazu eingerichtet ist, die dort hindurchfließende Flüssigkeit zu dem zentralen Raum (25) ausströmen zu lassen, der innerhalb des Rotors definiert ist.

5. Zentrifugalseparator nach einem der voranstehenden Ansprüche, bei dem das stationäre Auslaßteil (31) eine sogenannte Schälsscheibe umfaßt, und wobei der kalibrierte Auslaß (36) durch ein Loch in der Schälsscheibe gebildet wird.

Revendications

1. Séparateur centrifuge, muni d'un rotor comprenant une admission (17) d'un mélange renfermant deux composants liquides à séparer, et deux sorties (34, 39) des composants liquides respectifs séparés; d'une chambre séparatrice (7) ménagée dans le rotor et communiquant avec une chambre de sortie (26) du composant liquide le plus lourd, délimitée à l'intérieur du rotor; d'un organe stationnaire de sortie (31), logé dans la chambre de sortie et percé d'au moins un canal (32—34) pour acheminer un liquide de la chambre de sortie (26) jusqu'à une zone réceptrice située à l'extérieur du rotor, et d'une valve (35) actionnable pendant le fonctionnement du rotor, soit pour autoriser, soit pour interdire une circulation de liquide vers l'extérieur du rotor à partir de la chambre de sortie (26), par l'intermédiaire dudit canal (32—34), caractérisé par un perçage calibré (27), ménagé dans la jonction entre la chambre séparatrice (7) et la chambre de sortie (26) pour limiter le flux de liquide pénétrant dans la chambre de sortie (26); et par un moyen stationnaire de sortie, qui s'étend dans la chambre de sortie et comprend une sortie calibrée (36) permettant au liquide de quitter la chambre de sortie lorsque ladite valve (35) empêche ce liquide de circuler



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par l'intermédiaire dudit canal jusqu'à ladite zone réceptrice, ledit perçage calibré (27) et ladite sortie calibrée (36) présentant, des zones de circulation traversante telles qu'ils permettent le passage de la même quantité de liquide par unité de temps pour un niveau prédéterminé de liquide dans la chambre de sortie (26), aussi longtemps que ladite valve (35) empêche le liquide de s'écouler jusqu'à ladite zone réceptrice en empruntant le canal (32—34).

2. Séparateur centrifuge selon la revendication 1, caractérisé par le fait que ladite sortie calibrée (36) est constituée par une sortie provenant dudit canal (32—34), entre la chambre de sortie (26) et ladite valve (35).

3. Séparateur centrifuge selon la revendication 1 ou 2, caractérisé par le fait que ladite sortie calibrée (36) est conçue pour décharger le liquide qui la parcourt, vers la chambre séparatrice (7) du rotor.

4. Séparateur centrifuge selon l'une quelconque des revendications précédentes, dans lequel la partie radialement la plus externe de la chambre séparatrice (7) communique, par l'entremise d'un canal (19), avec un espace central (25) situé à l'intérieur du rotor et séparé de ladite chambre de sortie (26) au moyen d'une cloison (24); ledit perçage calibré (27) se trouve dans la cloison; et ladite sortie calibrée (36) est conçue pour décharger un liquide qui la parcourt, vers l'espace central (25) délimité à l'intérieur du rotor.

5. Séparateur centrifuge selon l'une quelconque des revendications précédentes, dans lequel l'organe stationnaire de sortie (31) consiste en ce qu'on appelle un "disque de pelage"; et ladite sortie calibrée (36) est matérialisée par un trou pratiqué dans le disque de cisaillement.



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