(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 712 289 B2**

(12) **NEW EUROPEAN PATENT SPECIFICATION**
After opposition procedure

(45) Date of publication and mention of the opposition decision:
14.11.2012 Bulletin 2012/46

(45) Mention of the grant of the patent:
16.01.2008 Bulletin 2008/03

(21) Application number: **06425212.5**

(22) Date of filing: **29.03.2006**

(51) Int Cl.:
B04B 15/06 *(2006.01)*

(54) Washing method for centrifugal separators of mixtures composed of two liquid phases and solid and non-solid sediments

Verfahren zur Reinigung eines Zentrifugalseparators für Gemische aus zwei Flüssigkeitsphasen und Feststoffpartikeln sowie nicht festen Ablagerungen

Procédé de lavage de séparateur centrifugeuse pour la séparation de mélanges de deux phases liquides et de corps solides et non-solides

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL HR

(30) Priority: **14.04.2005 IT MC20050031**

(43) Date of publication of application:
18.10.2006 Bulletin 2006/42

(73) Proprietor: **Nuova Maip Macchine Agricole Industriali Pieralisi S.p.A.**
60035 Jesi (AN) (IT)

(72) Inventor: **Pieralisi, Gennaro**
60035 Jesi (AN) (IT)

(74) Representative: **Baldi, Claudio**
Viale Cavallotti, 13
60035 Jesi (AN) (IT)

(56) References cited:
WO-A1-89/03251 **US-A- 1 749 291**
US-A- 5 735 789

- **PATENT ABSTRACTS OF JAPAN vol. 015, no. 431 (C-0881), 5 November 1991 (1991-11-05) -& JP 03 181348 A (KYOTO KIKAI KK), 7 August 1991 (1991-08-07)**
- **'Instruction book MAPX 207S-00', 1984, ALFA LAVAL**

EP 1 712 289 B2

Description

[0001] The present patent application for industrial invention refers to a washing method for centrifugal separators, known as "disk centrifugal separators" for separation of mixtures composed of two liquid phases and solid and non-solid sediments according the pre-characterising portion of claim 1.

[0002] The said separators are normally used to separate mixtures composed of two liquids with different specific weight, which are respectively the "light phase" and the "heavy phase"; the heavy phase is sometimes the residual product obtained from processing with respect to the more valuable light phase.

[0003] A typical application of the said separators is found in oil industry, where the liquid to be separated, normally known as "oil wort", is centrifugated to extract the valuable oil component depurated from aqueous phase and solid sediments.

[0004] Separation takes place because of the different specific gravity of the two liquid phases that, because of centrifugal acceleration, tend to be positioned on two radial layers, whose interface theoretically coincides with a cylindrical surface on which the heavy phase is collected externally, and the light phase is concentrated internally.

[0005] In order to understand the solutions and advantages offered by the washing method of the invention, this description continues illustrating the operating principles of centrifugal separators with vertical axis, which are basically composed of a feed conduit with vertical axis ending into a column distributor, being an integral part of a drum that rotates around the said conduit and supports a stack of diaphragms with spacers, consisting in a closed and overlapped series of lamellar disks with truncated-conical profile, which make separation of the two liquid phases easier, favouring the formation of a laminar flow through the spaces of the stack of diaphragms.

[0006] During processing a preferably constant amount of mixture is dropped or introduced continuously in the feed conduit by means of a feed pump, goes through the distribution column and inundates the drum, including the area with lamellar disks.

[0007] The solid sediments and the heavy phase stratify in the peripheral area of the drum because of centrifugation and the light phase occupies the internal area.

[0008] The product continues phase separation while passing through the area with lamellar disks.

[0009] More precisely, the heavy phase and the solid sediments migrate towards the peripheral area, sliding on the lower surface of the lamellar disks, and the light phase occupies the centre of the drum, sliding on the upper surface of the lamellar disk, thus forming three layers inside the rotating drum: one external layer made of solid sediments, one intermediate layer made of the heavy phase and one internal layer made of the light phase, being the three phases separated by two interfaces, theoretically composed of two vertical cylindrical surfaces coaxial with the drum.

[0010] The two liquid phases formed inside the drum are divided by a partition positioned on the opposite side with respect to the side where the product is introduced in the drum from the bottom of the distribution column and basically composed of a bell that rotates with the drum, whose peripheral border creates a reverse overflow with is overridden by the heavy phase directed towards the annular area formed by the bell.

[0011] The bell divides the drum in two sections, thus creating two communicating vessels: the heavy phase on one side, the heavy phase on the other side and the light phase inside.

[0012] The solid sediments stratify on the bottom of the vessels, which corresponds to the peripheral area of the drum.

[0013] Because of radial stratification of the two liquid phases, the liquid phases can be extracted from the drum by means of annular openings, with straight and free overflow, separated and positioned on top of the drum in external position with respect to the feed conduit with vertical axis; more precisely, the heavy phase is extracted continuously through a first opening and the light phase is extracted continuously through a second opening situated at a lower distance from the drum rotation axis with respect to the first opening.

[0014] In other words, it can be said that the two overflow openings are situated at two different radial levels to intercept the free surfaces of the two liquid phases that are positioned on completely different radial levels due to a more intense centrifugal field than the gravity field.

[0015] The drum is normally provided with peripheral openings with sub-radial direction that are normally closed and opened during the rotation of the drum in order to eject the solid sediments with the liquid mass inside the drum by centrifugation.

[0016] This structure of the drum is particularly used in applications where the product to be separated contains a considerable quantity of solid sediments; this version of the drum is defined as "automatic discharge" drum.

[0017] When the drum is not provided with the said openings, the drum is defined as "manual discharge" drum, meaning that sediments can be only removed by stopping the separator and dismounting the drum.

[0018] In both types of drums, before performing the automatic ejection or manual removal of sediments, the valuable liquid phase must be extracted from the drum, in order not to waste it.

[0019] In particular, during manual discharge (i.e. drum without openings), manual cleaning is completely performed on the drum and on each lamellar disk.

[0020] The automatic discharge (i.e. drum with openings) is performed to restore the best operating conditions of the separator. Therefore, once sediments are ejected, periodical cleaning is required to remove all sediments (normally dirtying agents) that are not automati-

cally discharged and are trapped in the small gaps of the drum and of the stack of lamellar disks.

[0021] In order to ensure complete cleaning, the "automatic discharge" drum is periodically opened (at the and of working day or week, according to the dirtying characteristics of the product being processed) to clean each disk manually, as in the case of drums without openings.

[0022] This operation requires considerable labour and machine shutdown.

[0023] The need to periodically perform complete cleaning of the drum has no other solution, with the type of disk centrifugal separators in which the liquid phases (or the heavy phase only) are ejected by means of free overflow openings.

[0024] This type of machine does not permit the washing procedure known as CIP (cleaning in place), which allows to wash the drum without dismounting it, while the machine is in operation, because the lamellar disks are not subjected to the washing flow.

[0025] The CIP of the drum, either of automatic or manual discharge type, is a complete cleaning operation of the drum, with special reference to the lamellar disks, performed introducing a washing liquid flow, possibly with added detergent, or an alkaline or acid solution into the feed conduit.

[0026] The mechanical washing action because of hydraulic turbulence is possibly associated with a chemical action based on the agents used.

[0027] Normally, It is performed with recirculation of the washing liquid, with final cleansing in order to guarantee a good result.

[0028] The essential condition for CIP is that the washing flow goes through the lamellar pack; this condition, however, cannot be achieved if the overflow opening of the heavy phase, that is to say the furthest one from the drum axis, is open, thus creating a preferential exit for the washing liquid, which cannot raise to wash the lamellar disks.

[0029] An increase of the inlet capacity in order to wash the disks would also cause an Increase of capacity through the preferential exit, with great energy waste and no success.

[0030] Moreover, it must be noted that the capacity of the inlet flow is limited because of the reduced "radial jump" between the feed conduit and the position of the light phase opening; the said jump needs to be considerable to compensate the inevitable great load losses associated with a considerable flow through the drum, which would be however small and insufficient through the lamellar disks.

[0031] Javanese patent No. JP03181348 A describes a method cleaning of the drum by switching a high-flow-rate cleaning in which a cleaning solution discharged from a water outlet is directly returned to a raw liquid inlet and a low-flow-rate cleaning in which the cleaning solution is circulated between a centrifugal separator and a cleaning solution tank.

[0032] WO 89/0325 discloses a cleaning method of a centrifugal separator similar to the one of the JP03181348.

[0033] The centrifugal separators disclosed in WO 89/0325 and JP03181348 comprise a first opening for the exit of heavy phase and a second opening for the exit of light phase. Both the first and second openings are connected to respective output devices which are centripetal pumps.

[0034] The purpose of the present invention is to provide a solution to all aforementioned disadvantages, introducing a new effective washing method of CIP type.

[0035] In order to achieve the object above, a method according to the invention is defined by the features of claim 1.

[0036] According to the method of the invention, washing is performed in two phases, regardless of their sequence, a first washing phase dedicated to clean the internal peripheral areas of the drum, where sediment and heavy phase are stratified, and a second washing phase dedicated to clean the central areas, and particularly the lamellar disks.

[0037] According to the method of the invention, the washing phase dedicated to clean the internal peripheral areas of the drum is performed keeping both overflow openings open; evidently, the washing liquid flows off from the overflow opening situated at the furthest distance from the rotation axis of the drum.

[0038] According to the new method of the invention, the washing phase dedicated to clean the central areas of the drum is performed keeping the overflow opening situated at the furthest distance from the rotation axis of the drum closed and keeping the overflow opening situated at the closest distance from the rotation axis open, in such a way that the washing liquid is forced to go through the small spaces of the lamellar disks in centripetal direction and exit from the second overflow opening.

[0039] Evidently, the washing method of the invention requires the introduction of means used to Intercept the flow exiting the overflow opening situated at the furthest distance from the rotation axis of the drum while the machine is in operation.

[0040] Any interception means can be used, such as cocks, gates or obturating disks of the type used in some models of centrifugal separators to favour the correct emptying of the drum and recuperate the light phase contained in the drum, before the periodical removal of the sediments laid against the walls of the drum.

[0041] In order to understand the solutions and advantages offered by the washing method of the invention, the following description of a preferred embodiment continues Illustrating the operating principles of a centrifugal separator with vertical axis, which is basically composed of a feed conduit with vertical axis ending Into a column distributor, being an integral part of a drum that rotates around the said conduit and supports a stack of diaphragms with spacers, consisting in a closed and overlapped series of lamellar disks with truncated-conical pro-

file, which make separation of the two liquid phases easier, favouring the formation of a laminar flow through the spaces of the stack of diaphragms.

[0042] During processing a preferably constant amount of mixture is dropped or introduced continuously in the feed conduit by means of a feed pump, goes through the distribution column and inundates the drum, including the area with lamellar disks.

[0043] The solid sediments and the heavy phase stratify in the peripheral area of the drum because of centrifugation and the light phase occupies the internal area.

[0044] The product continues phase separation while passing through the area with lamellar disks.

[0045] More precisely, the heavy phase and the solid sediments migrate towards the peripheral area, sliding on the lower surface of the lamellar disks, and the light phase occupies the centre of the drum, sliding on the upper surface of the lamellar disk, thus forming three layers inside the rotating drum: one external layer made of solid sediments, one intermediate layer made of the heavy phase and one internal layer made of the light phase, being the three phases separated by two interfaces, theoretically composed of two vertical cylindrical surfaces coaxial with the drum.

[0046] The two liquid phases formed inside the drum are divided by a partition positioned on the opposite side with respect to the side where the product is introduced in the drum from the bottom of the distribution column and basically composed of a bell that rotates with the drum, whose peripheral border creates a reverse overflow with is overridden by the heavy phase directed towards the annular area formed by the bell.

[0047] The bell divides the drum in two sections, thus creating two communicating vessels: the heavy phase on one side, the heavy phase on the other side and the light phase inside.

[0048] The solid sediments stratify on the bottom of the vessels, which corresponds to the peripheral area of the drum.

[0049] Because of radial stratification of the two liquid phases, the liquid phases can be extracted from the drum by means of annular openings, with straight and free overflow, separated and positioned on top of the drum in external position with respect to the feed conduit with vertical axis; more precisely, the heavy phase is extracted continuously through a first opening and the light phase is extracted continuously through a second opening situated at a lower distance from the drum rotation axis with respect to the first opening.

[0050] In other words, it can be said that the two overflow openings are situated at two different radial levels to intercept the free surfaces of the two liquid phases that are positioned on completely different radial levels due to a more intense centrifugal field than the gravity field.

[0051] The drum is provided with peripheral openings with sub-radial direction that are normally closed and opened during the rotation of the drum in order to eject the solid sediments with the liquid mass inside the drum by centrifugation.

[0052] This structure of the drum is particularly used in applications where the product to be separated contains a considerable quantity of solid sediments; this version of the drum is defined as "automatic discharge" drum.

[0053] Before performing the automatic ejection or manual removal of sediments, the valuable liquid phase must be extracted from the drum, in order not to waste it.

[0054] The automatic discharge (i.e. drum with openings) is performed to restore the best operating conditions of the separator. Therefore, once sediments are ejected, periodical cleaning is required to remove all sediments (normally dirtying agents) that are not automatically discharged and are trapped in the small gaps of the drum and of the stack of lamellar disks.

[0055] In order to ensure complete cleaning, the washing procedure known as CIP (cleaning in place) is a complete cleaning operation of the drum, with special reference to the lamellar disks, performed introducing a washing liquid flow, possibly with added detergent, or an alkaline or acid solution into the feed conduit.

[0056] The mechanical washing action because of hydraulic turbulence is possibly associated with a chemical action based on the agents used.

[0057] Normally, it is performed with recirculation of the washing liquid, with final cleansing in order to guarantee a good result.

[0058] The essential condition for CIP is that the washing flow goes through the lamellar pack; this condition is achieved by the washing method according to the invention by a second washing phase dedicated to clean the internal central areas of the drum, and specifically the stack of lamellar disks, in which the first overflow opening situated at the furthest distance from the rotation axis of the drum is kept closed with ordinary interception means and the second overflow opening situated at the closest distance from the rotation axis of the drum is kept open, in such a way that the washing liquid flow is forced to go through the small spaces of the lamellar disks in centripetal direction and exit from the second overflow opening situated at the closest distance from the rotation axis of the drum.

Claims

1. Washing method for centrifugal separators of mixtures composed of two liquid phases with different specific gravity, and solid and non-solid sediments, of the type comprising a rotating drum with a stack of lamellar disks used to separate the liquid phases, one being a "heavy" phase and one being a "light" phase, which are continuously extracted through a first and a second overflow openings situated respectively at a further and closer distance from the rotation axis of the drum,
   method comprising:

- at least a first washing phase dedicated to clean the internal peripheral areas of the drum in which both overflow openings are kept open,

characterised by the fact that

- a second washing phase is dedicated to clean the internal central areas of the drum, and specifically the stack of lamellar disks,

at least the first overflow opening used for the exit of the heavy phase is a free overflow opening; and in the second washing phase the first overflow opening, situated at the furthest distance from the rotation axis of the drum, is kept closed with ordinary interception means and the second overflow opening situated at the closest distance from the rotation axis of the drum is kept open, in such a way that the washing liquid flow is forced to go through the small spaces of the lamellar disks in centripetal direction and exit from the second overflow opening situated at the closest distance from the rotation axis of the drum.

2. Washing method as defined claim 1, **characterised in that** the interception means are closed during the drum rotation.

3. Washing method as defined in claim1 or claim 2, **characterised in that** during the washing phase illustrated the first claim under b), the overflow opening situated at the furthest distance from the rotation axis of the drum is closed by means of the same obturating disk, normally used in some centrifugal separators of known type to favour the correct emptying of the drum, recuperating the light phase contained in the drum, before performing the "manual discharge" or "automatic discharge" phase of the sediments laid against the internal walls of the drum.

Patentansprüche

1. Reinigungsverfahren für Zentrifugen zur Trennung von Mischungen, die aus zwei flüssigen Phasen mit unterschiedlichem spezifischem Gewicht sowie aus festen und nicht festen Sedimenten bestehen, umfassend eine Drehtrommel, die einen Stapel von Lamellenscheiben zur Trennung der flüssigen Phasen umfasst, wovon eine "schwer" und die andere "leicht" ist, die über eine erste und eine zweite Überlauföffnung kontinuierlich extrahiert werden können, die jeweils näher oder weiter von der Rotationsachse der Trommel entfernt angebracht sind,
Verfahren umfassend:

- mindestens ein erstes Reinigungsstadium, das für die Innenreinigung der Trommel in den peripheren Bereichen bestimmt ist, während dem alle beiden Überlauföffnungen offen gelassen werden,

dadurch gekennzeichnet, dass
ein zweites Reinigungsstadium für die Innenreinigung der Trommel in den zentralen Bereichen und insbesondere im Bereich des Stapels der Lamellenscheiben bestimmt ist,
mindestens die erste Überlauföffnung, die für den Auslass der schweren Phase verwendet wird, eine freie Überlauföffnung ist, und
während des zweiten Reinigungsstadiums die erste, weiter von der Rotationsachse der Trommel entfernte Überlauföffnung mittels üblicher Verschlussmittel geschlossen gehalten wird, während die zweite, näher bei der Rotationsachse der Trommel befindliche Überlauföffnung offen gelassen wird, damit die gesamte Reinigungsflüssigkeit gezwungen wird, durch sämtliche Spalte des Scheibenstapels in Zentripetalrichtung hindurchzufließen, um anschließend aus der zweiten, näher an der Rotationsachse der Trommel befindlichen Überlauföffnung herauszufließen.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** es vorsieht, dass die Verschlussmittel während der Rotation der Trommel in Verschlussstellung gebracht werden.

3. Reinigungsverfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** während des Reinigungsstadiums gemäß Punkt b) des ersten Anspruchs der Verschluss der weiter von der Rotationsachse der Trommel entfernten Überlauföffnung unter Verwendung derselben Verschlussscheibe erfolg, die bereits in einigen Zentrifugenmodellen bekannten Typs vorhanden ist und verwendet wird, um eine richtige Entleerung der Trommel unter Rückgewinnung der gesamten darin enthaltenen, leichten Phase zu ermöglichen, bevor die Phase der "manuellen Entleerung" oder die Phase der "automatischen Entleerung" der im Innern der Trommel angesammelten Sedimente durchgeführt wird.

Revendications

1. Méthode de lavage pour appareils centrifuges pour la séparation de mélanges composés de deux phases liquides, ayant un poids spécifique différent, et de sédiments solides et non, du type comprenant un tambour rotatif, contenant une pile de disques lamellaires (ou scourtins) de séparation des dites phases liquides, l'une ainsi dite "lourde", l'autre ainsi dite "légère", qui peuvent être extraites en continu à travers une première et une seconde ouverture à débordement, étant respectivement la première et la seconde ouverture positionnées plus loin et plus près par

rapport à l'axe de rotation du tambour,
cette méthode comprenant

- au moins un premier stade de lavage dédié au nettoyage interne des zones les plus périphériques du tambour, pendant lequel les deux dites ouvertures à débordement sont maintenues ouvertes ;

caractérisée en ce que

- un second stade de lavage est dédié au nettoyage interne des zones les plus centrales et, dans notre cas spécifiquement, à la dite pile de disques lamellaires (ou scourtins),

au moins la première ouverture à débordement utilisée pour la sortie de la phase ainsi dite lourde est une ouverture à débordement libre; et
pendant le second stade de lavage, la première ouverture à débordement, celle en position la plus éloignée par rapport à l'axe de rotation du tambour, est maintenue fermée par le biais de moyens d'obturation habituels et la seconde ouverture à débordement, celle la plus proche par rapport à l'axe de rotation du tambour, est laissée ouverte, de manière à ce que tout le liquide de lavage est obligé de traverser, en direction centripète, tous les interstices de la dite pile de disques lamellaires, pour ensuite sortir de la dite seconde ouverture à débordement, c'est-à-dire celle la plus proche de l'axe de rotation du tambour.

2. Méthode de lavage selon la revendication 1, **caractérisée en ce qu'**elle prévoit que les dits moyens d'obturation sont amenés en position fermée pendant la rotation du tambour.

3. Méthode de lavage selon la revendication 1 ou 2, **caractérisée en ce que** pendant le stade de lavage dont au poste b) de la première revendication, la fermeture de l'ouverture à débordement positionnée le plus loin de l'axe de rotation du tambour s'effectue par le biais du disque obturateur déjà présent et utilisé sur certains modèles de séparateurs centrifuges du type connu, afin de favoriser le vidage correct du tambour, avec la récupération de toute la phase ainsi dite légère contenue dans le tambour même, avant de procéder à la phase de "déchargement manuel" ou à la phase de "déchargement automatique" des sédiments qui se sont accumulés dans le tambour.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 03181348 A **[0031]**
- WO 890325 A **[0032] [0033]**
- JP 03181348 B **[0032] [0033]**