HYDRAULIC CLASSIFYING PROCEDURE AND MEANS.

Priority: 03.05.85 FI 851763

Date of publication of application: 27.05.87 Bulletin 87/22

Publication of the grant of the patent: 04.10.89 Bulletin 89/40

Designated Contracting States: AT DE FR GB SE

References cited:

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Description

A hydraulic classifying procedure wherein particulate material transported by a liquid is divided in a centrifugal field established in a cylindrical, substantially vertical classifying space into a fines product consisting of lighter particles, this product becoming separated in the centre of the centrifugal field, and a coarse product consisting of heavier particles, which is separated on the outer margin of the centrifugal field and descends in a spiralling flow conforming to the margin of the field, to the lower end of the classifying space.

The commonest means employed towards hydraulic classification of particulate material is the hydrocyclone, usually consisting of a cylindrical upper part and a conical lower part. The hydrocyclone divides the material to be classified into a fines product, which is removed through the top end of the cyclone, and a coarse product, which is removed from the lower end of the cyclone, i.e. through an aperture at the tip of the conical lower part. In addition to the partly conical hydrocyclones mentioned, cyclones with level bottom have been used, in which separation of the fines and coarse products and their departure take place in substantially like manner. Moreover, such classifying means are known in which the coarse product is removed tangentially with the aid of a passage commencing on the periphery or at the bottom of the means.

The classifying carried out with said means of prior art is encumbered by the drawback that the coarse product is removed by a liquid classifying fluid among which there is also finely divided matter contained in the material that is being classified and which, ideally should end up among the fines product. Finely divided matter is removed along with the coarse product in at least equal proportion as classifying fluid is removed, in other words, the more such matter is removed the higher is thus the ratio of coarse and fine product quantities. When the classification constitutes part of a wet grinding process, where optimally said ratio is about 100 to 300%, the separation sharpness of classification carried out with means of prior art, that is the proportion of particles smaller than a given limit size contained in the material being classified which are successfully separated to form the fines product, is typically only about 50%, and occasionally it is even less than 40%.

The most commonly employed hydrocyclones have the further drawback that regulation of said limit size during operation is nearly impossible. Hardly any ways of regulation are known other than regulating the size of the coarse product removal aperture on the lower end of the cyclone; even this is rarely applied, owing to practical difficulties.

A specific reference is made to two prior art separators which have been described in the US patents Nos 2 799 208 and 2 927 693. The separator according to the US patent No 2 799 208 comprises a circumferential, gradually deepening groove which leads to a transfer passage forming an outlet channel for the slurry which is being separate. An extra liquid flow is fed through a nozzle to one point in the circumferential groove, so that the extra liquid is mixed with the slurry travelling along the groove to the outlet channel. The US patent No 2 927 693 shows a separating apparatus which is provided with an inlet to supply water which is used to elutriate the material under separation. The material is then passed through an annular gap to an outlet.

The object of the present invention is to devise a hydraulic classifying procedure in which the abovementioned drawbacks of the state of art are avoided and by which is obtained better separation sharpness than before, and controllability of the classifying process. The procedure of the invention is characterized in that the coarse product is transported through an annular through-flow gap surrounding a substantially round closing member positioned at the lower end of the classifying space, and in that a separate liquid flow is introduced tangentially in relation to the centrifugal field to said gap, the coarse product as passed through said annular gap being removed by said separate liquid flow.

By using a pure liquid flow conducted tangentially in relation to the centrifugal field, one gains the effect that with the coarse product are entrained fewer, if any, finely divided particles having a size below the fines limit size, than before. The amount of liquid flow can be adjusted to be such that the liquid fluid supplied into the classifying process together with the material to be classified does not participate at all in the removal of coarse product, and instead, in its entirety departs together with the fines. It is also possible to increase said liquid flow even further, whereby it can be applied in adjusting the limit size between the fines and coarse products. When necessary, the centrifugal field can be boosted with said liquid flow so that the coarse product is caused to separate at a sufficient rate even in those instances in which the limiting size between the fines and coarse products is small.

By the design of the invention, a secondary classification step has been created in the region of the annular gap, its operation being based on the fact that the velocity and direction, in the gap, of the separate liquid flow supplied tangentially in relation to the centrifugal field determine that particle size of which the removal as coarse product, enforced by the centrifugal field, is possible. Since the coarse product has not yet, at this stage, finally departed from the first classifying step taking place in the classifying space proper, said secondary classification influences the separation limit in such way that particles finer than the limit size which have been entrained will return to the classifying space, and by this route further to join the fines product. If the coarse product were brought into contact with the separate liquid flow removing it, only after it
has departed from the classifying space proper, the result would merely be dilution of the coarse product flow.

With reference to the two US patents specifically cited in the above, the difference between the invention and the separators described in these patents is that in the latter the extra liquid flows are not fed to the spot of an annular gap tangentially in relation to a centrifugal field but at a distance from the spot where the material as separated is leaving the field. According to the US patent No 2 927 693 the inlet for the extra water is at a considerable distance above the material outlet, which means that the extra water, instead of contributing to the removal of the material, does little more than dilutes the material that is being separated. In the separator described in the US patent No 2 799 208 there is no annular gap that would be defined by a circular closing member, but only the circumferential groove as mentioned before. The location of the nozzle which provides the extra liquid is such that the mixing takes place only after the slurry has left the classification area, so that the extra liquid has no effect on the separation but only dilutes the slurry which is passed to the outlet channel.

An embodiment of the invention is characterized in that the coarse product is separated from said liquid flow in a hydrocyclone where after the liquid is returned to the classifying process to serve as fluid medium in the classification taking place in the centrifugal field.

The invention also concerns a means for hydraulic classification of particulate material by the procedure described above. The means comprises, as elements known in themselves a cylindrical, substantially vertical classifying space in which a centrifugal field can be established; a supply passage for conducting the material to be classified and the liquid serving as fluid medium into the classifying space; and removal apertures for removing the fines product consisting of lighter particles, which separate to the centre of the classifying space, and the coarse product consisting of heavier particles, which separate on the outer margin of the classifying space and further in the form of a spiralling, descending flow in the lower part of the classifying space. The means is characterized in that the coarse product removal aperture consists of an annular gap at the lower end of the classifying space, said gap being defined by a substantially round closing member positioned so that the gap is surrounding the closing member, and that said means further comprise a fluid in-feed passage tangential to the centrifugal field and connected to a chamber below to said annular gap and for the removal of the coarse product with the use of a separate liquid flow conducted through said passage and running tangentially in relation to said gap.

The invention is described in detail in the following with the aid of examples, referring to the attached drawing, wherein:

Fig. 1 presents a hydraulic classifying apparatus according to the invention.

Fig. 2 shows the lower part of the cylindrical classifying space belonging to the apparatus of Fig. 1, in section II - II as indicated in Fig. 1.

Fig. 3 presents part of the classifying space of the apparatus in accordance with another embodiment of the invention, and

Fig. 4 shows the classifying apparatus of the invention, installed as a component in a grinding circuit.

In figs 1 and 2 is depicted a hydraulic classifying apparatus which divides particulate material composed of various-sized particles and transported by a liquid, such as water for instance, into a fines product consisting of lighter particles and a coarse product consisting of heavier particles. This classification takes place in a vertical, cylindrical classifying space 1 in a centrifugal field created by the tangential supply of material to be classified and of liquid serving as fluid medium, this centrifugal field separating the fines product to reside in the centre of the classifying space and the coarse product to its outer margin. The material to be classified and the fluid are in spiralling rotary motion in the classifying space 1, this motion lifting in the centre of the space the fines product to the removal aperture 2 located close to the upper end of said space, and on the outer margin of the space by gravity action urging the coarse product to the coarse product removal aperture 3 in the lower part of said space.

The apparatus of Figs 1 and 2 comprises on the side of the cylindrical classifying space 1, as essential components, a feed passage 4 for material to be classified and for fluid medium, tangentially connecting with the upper end of the classifying space; a passage 5 for removing fines product and fluid conducting same, commencing at the removal aperture 2; a round closing plate 6 in the lower part of the classifying space, this plate confining the coarse product removal aperture to be an annular gap 3 between this plate and the cylindrical wall of the classifying space; and horizontal passages 7a, 7b connecting tangentially with the lower end of the classifying space for removal of the coarse product that has passed through the gap, with the aid of a separate liquid flow which runs tangentially to said gap. The liquid flow coming through the passage 7a is supplied through the aperture 9a into the lower end of the classifying space, immediately under the annular gap 3, where it is set in spiralling motion conforming to the outer margin of said space, and which is a direct continuation of the spiralling motion present higher up, in the classifying space 1 proper, and it departs by the aperture 9b into the passage 7b. The passage 7a has been provided with a control valve, indicated in Fig. 1 with reference numeral 8. The liquid flow departing by the passage 7b transports the coarse product to a hydrocyclone
10, where the coarse product is separated to go to the removal aperture 11 at the conical end of the cyclone and the liquid, to the vertical removal passage 12 commencing in the upper part of the cyclone.

In Fig. 3 is depicted an embodiment of the classifying apparatus which differs from that of Fig. 1 in the respect that the lower part 13 of the cylindrical classifying space 1 has been enlarged and on the boundary 15 between the wider lower part of the space and the narrower part 14 thereabove has been disposed a conical, vertically movable closing member 16. The size of the annular coarse product removal aperture 3 between the closing member 16 and the classifying space 3 can be regulated in this embodiment with the aid of the positioning of said closing member.

It is essential in the presented classifying apparatus of the invention that the removal of the coarse product through the passage 7 with the aid of a liquid flow conducted tangentially in relation to the classifying space 1 and not participating in the classifying process prevents any finely divided material, which belongs to the fines product, from being entrained with the coarse product. The liquid flow can be regulated by means of the control valve 8 in said passage, and the flow can be arranged to be such, for instance, that it takes care alone by itself of the coarse product removal, whereby the fluid coming into the classifying space 1 together with the material to be classified will in its entirety depart along with the fines product and there will be no fluid medium flow in one direction nor in the other at the coarse product removal aperture 3. It is also possible to adjust the flow coming through the passage 7 into the classifying space 1 to be greater than the flow departing along with the coarse product, in which case part of said liquid will go along with the fines product. It is possible by such regulation to enlarge or diminish the limit size of the fines and coarse product particles.

In Fig. 4 is presented a solid material grinding circuit comprising a classifying space 1 and a separator cyclone 10, which may both be as illustrated in Fig. 1. The material, consisting in part of not previously processed material (reference numeral 17) and in part of coarse product separated by the hydrocyclone 10 (reference numeral 11) is ground in the mill 18, and after grinding, the material is mixed together with water obtained from the cyclone 10 and it is fed by the aid of the pump 19, tangentially, into the centrifugal field in the classifying space 1. The fines product separated by the classification departs from the process, while the water departing at the same time is replaced with a water flow introduced through the passage 7, this flow carrying the coarse product to the separator cyclone 10, and, as has been stated, thereafter returning to serve as fluid medium in the classification taking place in the classifying space 1. The solid matter content of each particular flow has been entered in Fig. 4 as a percentage figure.

Claims

1. A hydraulic classifying procedure wherein particulate material transported by a liquid is divided in a centrifugal field established in a cylindrical, substantially vertical classifying space (1) into a fines product consisting of lighter particles, this product becoming separated in the centre of the centrifugal field, and a coarse product consisting of heavier particles, which is separated on the outer margin of the centrifugal field and descends in a spiralling flow conforming to the margin of the field, to the lower end of the classifying space, characterized in that the coarse product is transported through an annular throughflow gap (3) surrounding a substantially round closing member (6, 16) positioned at the lower end of the classifying space (1), and in that a separate liquid flow is introduced tangentially in relation to the centrifugal field to said gap, the coarse product as passed through said annular gap being removed by said separate liquid flow.

2. Procedure according to claim 1, characterized in that the coarse product is separated from said liquid flow in a hydrocyclone (10) whereafter the liquid is returned to the classifying process to serve as fluid medium in the classification taking place in the centrifugal field.

3. A means for classifying particulate material by a procedure according to claim 1 or 2, said means comprising a cylindrical, substantially vertical classifying space (1), in which a centrifugal field can be established; a supply passage (4) for conducting the material to be classified and the liquid serving as fluid medium into the classifying space; and removal apertures (2,3) for removing the fines product consisting of lighter particles, which separate to the centre of the classifying space, and the coarse product consisting of heavier particles, which separate on the outer margin of the classifying space and further in the form of a spiralling, descending flow in the lower part of the classifying space, characterized in that the coarse product removal aperture consists of an annular gap (3) at the lower end of the classifying space (1), said gap being defined by a substantially round closing member (6, 16) positioned so that the gap is surrounding the closing member, and that said means further comprises a fluid in-feed passage (7) tangential to the centrifugal field and connected to a chamber below to said annular gap and for the removal of the coarse product with the use of a separate liquid flow conducted through said passage (7) and running tangentially in relation to said gap.

4. Means according to claim 3, characterized in that the lower end (13) of the classifying space (1) is widening and that the closing member (16)
is vertically displaceable so that the width of the annular gap (13) can be varied.

Patentansprüche

1. Verfahren für das hydraulische Klassieren, bei welchem von einer Flüssigkeit getragenes körniges Material in einem zentrifugalem Feld, welches in einem zylindrischen, im wesentlichen vertikalen angeordneten Klasserraum (1) erzeugt wird, aufgeteilt wird in ein feines Produkt, welches aus leichteren Körnern besteht und sich im Zentrum des zentrifugalen Feldes ansammelt, und ein grobes Produkt, welches aus schwereren Körnern besteht, sich an der äußeren Begrenzung des zentrifugalen Feldes ansammelt und in einer spiralförmig entlang der äußeren Begrenzung des Feldes verlaufenden Strömung zum unteren Ende des Klasserraumes (1) absinkt, dadurch gekennzeichnet, daß das grobe Produkt durch einen ringförmigen Durchtrittspalt (3) hindurchtritt, der im wesentlichen rund ausgebildetes Abschlußorgan (6, 16) umgibt, welches am unteren Ende des Klasserraumes (1) angeordnet ist, und daß im Bereich des Durchtrittspaltes (3) ein separater Flüssigkeitsstrom eingeleitet wird, der in bezug auf das zentrifugale Feld tangential verläuft und daß durch den Durchtrittspalt (3) durchtretende grobe Produkt ausströmt.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß das grobe Produkt von dem separaten Flüssigkeitsstrom in einem Hydrozyklon (10) abgetrennt wird, wonach die Flüssigkeit in das Klassierverfahren zurückgeführt wird und dort als Flüssigkeit für das Klassieren in dem zentrifugalen Feld dient.

3. Vorrichtung für das Klassieren von körnigem Material in einem Verfahren nach den Ansprüchen 1 oder 2, mit einem zylindrischen, im wesentlichen vertikalen angeordneten Klasserraum (1), in welchem ein zentrifugales Feld hergestellt werden kann, einer Zuführungleitung (4) für die Zuführung des zu klassifizierenden Materials und der zum Klassieren dienenden Flüssigkeit in dem Klasserraum und Abführungsoffnungen (2, 3) für das Abführen des aus den leichteren Körnern bestehenden feinen Produktes, welches sich im Zentrum des Klasserraumes ansammelt, und des groben Produktes aus den schwereren Körnern, welches sich an der äußeren Begrenzung des Klasserraumes (1) ansammelt und als spiralförmig absteigender Strom in den Unterteil des Klasserraumes gelangt, dadurch gekennzeichnet, daß die Abführungsoffnung für das grobe Produkt aus einem am unteren Ende des Klasserraumes (1) befindlichen Durchtrittspalt (3) besteht, der durch ein im wesentlichen runder Abschlußorgan (6, 16) begrenzt wird, welches so angeordnet ist, daß der Durchtrittspalt (3) das Abschlußorgan (6, 16) umgibt, und daß eine tangential zu dem zentrifugalen Feld verlaufende Flüssigkeitzführung (7) vorgesehen ist, die an eine Kammer unterhalb des ringförmigen Durchtrittspaltes (3) angeschlossen ist und durch die ein in Bezug auf den Durchtrittspalt tangential verlaufender, separater Flüssigkeitsstrom geleitet wird, der zum Austrag des groben Produktes dien.

4. Vorrichtung nach Anspruch 3, dadurch gekennzeichnet, daß das untere Ende (13) des Klasserraumes (1) aufgeweitet ist und daß das Abschlußorgan (16) vertikal verstellbar ist, so daß die Breite des ringförmigen Durchtrittspaltes (3) variabel ist.

Revendications

1. Procédé de tri hydraulique dans lequel la matière particulaire transportée par un liquide est divisée, à l'intérieur d'un champ centrifuge établi dans un espace de tri (1) tout à fait vertical, en un produit fin composé des particules plus légères, ce produit étant séparé et envoyé au centre du champ centrifuge, et en un produit grossier composé des particules les plus lourdes, séparé et envoyé sur le bord extérieur du champ centrifuge et descendant en un flux en spirale suivant le bord du champ, vers la partie inférieure de l'espace de tri, caractérisé par le fait que le produit grossier est transporté par une ouverture d'écoulement de forme annulaire (3) entourant un élément de fermeture de forme circulaire (6) (16) situé au bas de l'espace de tri (1), et par le fait qu'un flux de liquide séparé est introduit tangentielle au champ centrifuge dans la dite ouverture, le produit grossier passant par la dite ouverture de forme annulaire étant évacué à l'aide du dit flux de liquide séparé.

2. Procédé suivant la revendication 1, caractérisé par le fait que le produit grossier est séparé du dit flux de liquide dans un hydrocyclone (10), après quoi le liquide est revoyé dans le processus de tri pour servir de fluide dans l'opération de tri qui a lieu dans le champ centrifuge.

3. Moyen permettant de trier la matière particulaire par un procédé suivant la revendication 1 ou 2, le dit moyen comprenant un espace de tri cylindrique, pratiquement vertical (1), dans lequel peut être établi un champ centrifuge; un conduit d'arrivée (4) pour amener la matière à trier et le liquide servant de fluide dans l'espace de tri; et des ouvertures d'évacuation (2, 3) pour l'évacuation du produit fin composé des particules plus légères, qui se séparent et vont se placer au centre de l'espace de tri, et du produit grossier composé des particules plus lourdes, qui se séparent et vont se placer sur le bord extérieur de l'espace de tri et descendent ensuite sous forme d'un flux en forme de spirale vers le bas de l'espace de tri, caractérisé par le fait que l'ouverture d'évacuation du produit grossier consiste en une ouverture de forme d'annulaire (3) située à l'extrémité inférieure de l'espace de tri (1), la dite ouverture étant définie par un élément de fermeture de forme ronde (6, 16) placé de façon à ce
que l'ouverture se trouve autour de l'élément de fermeture, et par le fait que le dit moyen comprend d'autre part un conduit d'arrivée du fluide (7) tangent au champ centrifuge et relié à une chambre située au-dessous de la dite ouverture de forme annulaire pour l'évacuation du produit grossier à l'aide d'un flux de liquide séparé envoyé par le dit conduit (7) et s'écoulant tangentially à la dite ouverture.

4. Moyen suivant la revendication 3, caractérisé par le fait que la partie inférieure (13) de l'espace de tri (1) est plus large et que l'élément de fermeture (16) peut être déplacé verticalement de façon à pouvoir changer la largeur de l'ouverture en forme d'anneau (13).