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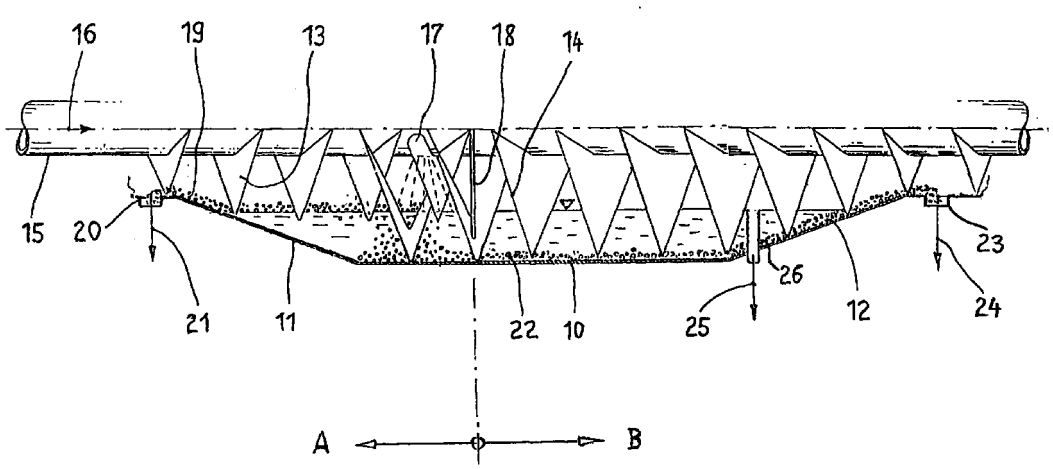
(54) Centrifuge for the wet mechanical separation of solid mixtures

(57) The present invention discloses a centrifuge that is not only suitable for a highly selective classification of fine-grained solids in very small increments, but can also be used for carrying out a sorting process and a classifying process simultaneously in one and the same machine so as to separate solid impurities from the fine grain to be obtained. According to the invention, a sorting zone (A) and a classifying zone (B) are integrated into this centrifuge, wherein the sorting zone (A) extends from the immersion disk (18) to the floats discharge (20) at one end of the centrifuge, and the adjacent classifying zone (B) extends from the immersion disk (18) to the sinks discharge (23) at the other end of the centrifuge. In this case, the coarse-grained solid (24) is discharged at the sinks discharge (23 or 26), while the fine-grained solid (25) is discharged from the centrifuge with the suspension fluid as a third phase.



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Description

[0001] This invention pertains to a centrifuge for the wet mechanical separation of a solids mixture in a fluid suspension into heavy phase sinks, light phase floats, and a third phase, said centrifuge including a cylindrical basket shell part that connects on at least one end to a conical basket shell part, an axial feed for the suspension, a discharge for the heavy phase sinks, a discharge for the light phase floats and a discharge for a third phase that contains the suspension fluid, said centrifuge further including an immersion disk for preventing the floats from remixing with the suspension.

BACKGROUND OF THE INVENTION

[0002] The separating/sorting of solid mixtures, in particular, the separating/sorting of comminuted and contaminated used plastic mixtures into fractions of different density in a separating fluid of such a density that floats and sinks are obtained, is known from, for example, U.S. Patent No. 5,342,281 and DE-A 195 16 636. In this case, the separating fluid as well as the solid particles suspended in the fluid rotate in the centrifugal field of a biconical solid basket screw-type centrifuge. The solid particles, e.g., mineral impurities, PVC, etc., whose density is greater than that of the fluid, e.g., water, are forced radially outward toward the centrifuge shell and transported to the discharge openings at one end of the centrifuge via the sinks cone and by means of the helical screw part for sinks. The distinctly lighter components, e.g. the polyolefins PE, PP, etc., float inward and are transported to the discharge openings at the other end of the centrifuge via the floats cone and by means of the oppositely rotating helical screw part for floats. The separating fluid which no longer contains sinks and floats is discharged from the centrifuge via an overflow system and can be recirculated into the axial centrifuge inlet. This known biconical solid basket screw-type centrifuge represents a sorting centrifuge that is not suitable for separating fine-grained materials into grain classes in a highly selective fashion, in particular, a precise grain classification in small increments on the order of, for example, a few μm.

[0003] DE-A 31 34 935 describes a three-phase decanting centrifuge or screw-type centrifuge that is, for example, able to separate an olive oil/fruit pulp/water mixture into olive oil as the distinctly light liquid phase, water as the heavy liquid phase and solids as the heaviest phase. However, a precise grain classification is not possible with this decanting centrifuge.

[0004] U.S. Patent No. 5,234,400 describes a solid basket screw-type centrifuge that is suitable for a precise grain classification in small increments of a few μm. This centrifuge is used, for example, for colloidal suspensions of kaolin, pigments, etc., namely for obtaining certain grain classes from a grain spectrum. In this case, the suspension is axially fed into the cylindrical basket shell part at one end of the centrifuge, and the heavy (coarse grain) phase as well as the light (fine grain) phase flow in a co-current flow to the product discharge at the other end of the centrifuge with the conical basket shell part. The coarse grain product is discharged by means of nozzle-shaped discharge openings in the basket shell, and the fine grain product is discharged farther radially inward at the end of the conical basket shell part. In this case, the discharge openings for the fine grain product are, viewed in the flow direction of the suspension, arranged at a distance behind the discharge openings for the coarse grain product. The discharge of a third phase does not take place with this known classifying centrifuge.

[0005] In the manufacture of a fine pigment material, e.g., fine-grained calcium carbonate, it is not only important to achieve a precise grain classification of a grain spectrum, but to obtain a finest grain class of, for example, <40 μm, which can no longer be sifted further and must not contain any impurities. Processing stages which are carried out before the classification, e.g., grinding processes, as well as abrasion of the transport belt, etc. cause impurities, such as rubber, wood residues, plant residues, etc., to be introduced into the suspension of a classifying centrifuge. Until now, such impurities, whose density is frequently lower than the specific density of the suspension, had to be separated from the material with processes carried out before the classifying stage by means of complicated sorting techniques.

SUMMARY OF THE INVENTION

[0006] The present invention is based on the objective of developing a centrifuge that is not only able to classify fine-grained materials with certain grain spectrums in very small increments, but is also suitable for carrying out a sorting process simultaneously with the classifying process in one and the same machine so as to allow the separation of solid impurities, in particular, from the fine grains to be obtained.

[0007] According to the invention, this objective and others, are attained with a centrifuge including the characteristics disclosed in the present case and claims.

[0008] The centrifuge according to the present invention represents a combination of a sorting centrifuge and a classifying centrifuge. The sorting zone of the centrifuge according to the invention extends from the immersion disk that is immersed into the suspension fluid and rotates with the conveyor screw to the floats discharge at one end of the centrifuge. The classifying zone extends diametrically opposite from the immersion disk to the other end of the centrifuge.

[0009] The supplied material, namely a fine-grained, ground solid with a certain grain spectrum, e.g., calcium carbonate, which is contaminated, e.g., due to the abrasion of rubber on the transport belt, is suspended, e.g., in water and introduced into the sort-

ing zone of the centrifuge according to the invention. The supplied suspension may have a density of, for example, 1.6 g/cm^3. In the sorting zone, the distinctly lighter impurities, e.g., rubber particles with a density of, for example, 1.3 g/cm^3, float to the surface and are transported to the floats discharge openings by a conveying element, e.g., the helical screw of a conveyor screw for floats. The immersion disk prevents the floating impurities from remixing with the classifying suspension. In any case, the suspension that flows into the classifying zone underneath the immersion disk is free of impurities.

[0010] In the classifying zone, the solid suspension, e.g., the calcium carbonate, flows in the direction of the other centrifuge end. The coarse grain can be transported to the coarse grain discharge in the form of sinks by the helical screw of the conveyor screw for sinks, while the classified fine or finest grain remains in the suspension fluid and is discharged with the suspension as a third phase, e.g., by means of a system of overflow pipes, skimming pipes, skimming disks, etc. Alternatively, it would also be possible to discharge the coarse-grained solids in the classifying zone by means of nozzle-shaped openings in the basket shell, and to discharge the fine-grained solids with the suspension fluid at the end of the centrifuge.

[0011] The present invention allows a precise grain classification as well as the separation of interfering impurities in one and the same centrifuge so that prior cleaning stages like screens or other sorting techniques can be eliminated. In this case, the sorting process, in particular, the separation of impurities, does not interfere with the precise grain classification, which simultaneously takes place in the centrifuge.

BRIEF DESCRIPTION OF THE DRAWING

[0012]

Fig. 1 is a schematic, longitudinal, sectional view of a centrifuge as disclosed in the present case.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] The invention and its numerous and additional characteristics and advantages are described in greater detail below with reference to one embodiment that is schematically illustrated in Fig. 1.

[0014] Fig. 1 shows a longitudinal section through the rotor of the centrifuge according to the present invention that, for example, is designed in accordance with a biconical solid basket screw-type centrifuge with a cylindrical basket shell part 10 that connects at each end to a corresponding conical basket shell part 11 and 12, respectively. A rotatable conveyor screw is positioned coaxially in the rotatable centrifuge basket. This conveyor screw rotates in the centrifuge basket with a differential rotational speed and contains a helical screw 13 for floats in the left longitudinal region and a helical screw 14 for sinks that rotates in the opposite direction in the right longitudinal region. The supplied suspension 16, e.g., a fine-grained material, which is contaminated with rubber, plastic, etc. and suspended in water, such as kaolin, calcium carbonate, etc., and has a certain grain spectrum, is introduced through the hollow screw shaft 15. The suspension of the grain spectrum, from which at least one finest grain fraction that is free of contaminants should be obtained, is introduced into the centrifuge basket through at least one hollow shaft opening 17 into the sorting zone A, which is separated from an adjacent classifying zone B by an immersion disk 18 that rotates with the conveyor screw 15 and is immersed in the suspension.

[0015] The distinctly lighter impurities contained in the supplied material float to the surface very rapidly in the sorting zone A due to the difference in density between the supplied suspension and the impurities under the influence of the centrifugal field. These floats 19 are lifted out of the suspension fluid by the conical basket shell part 11 and transported to the floats discharge openings 20 by the helical screw 13. The floats are removed from the centrifuge basket in the form of separately obtained impurities 21 at these discharge openings. Depending on its composition, the product 21 can be transported to additional processing stations.

[0016] In the sorting zone A, the heavy particles of the ground material contained in the suspension, e.g., calcium carbonate with a density of approximately 2.6 g/cm^3, are forced against the wall of the centrifuge basket 10. These sinks 22 flow into the classifying zone B of the centrifuge together with the suspension fluid underneath the immersion disk 18, which prevents the floats 19 from remixing with the classifying suspension. In the classifying zone B, a highly selective precise grain classification in small increments on the order of a few μm takes place in a co-current flow. During this process, the sinks 22 are transported through the classifying zone B by the helical screw 14 for sinks, which transports material in the opposite direction than the helical screw 13 for floats. The coarse grain is lifted out of the suspension fluid on the conical basket shell part 12 and transported to the sinks discharge openings 23, where coarse grain 24 with a grain size of, for example, >40 μm is discharged from the centrifuge basket by the helical screw 14.

[0017] The fine grain with a grain size of, for example, <40 μm or less, which was separated from the coarse grain in the classifying zone B, remains in the suspension and is removed from the centrifuge in the form of a third phase 25, in this case, as a highly pure and valuable finest grain product together with the suspension fluid. In the embodiment shown, this discharge is realized by means of several overflow pipes 26 that are distributed over the periphery. The radially inner openings of these overflow pipes make it possible to

vary and maintain a constant level of the separating fluid in the centrifuge basket. This fine grain discharge 25, 26 is arranged approximately at the transition from the cylindrical basket shell part 10 to the conical basket shell part 12 for the discharge of sinks in the embodiment shown. The classifying effect for the respective grain spectrum to be classified can be influenced, if necessary, by designing the helical screw 14 for sinks in the conical basket shell 12 with a different pitch than in the cylindrical basket shell part 10.

[0018] In an alternative embodiment, the pipes 26 are realized in the form of nozzle-shaped discharge openings for discharging the coarse-grained solid which are arranged in the basket shell, where the fine-grained solid is discharged together with the suspension fluid at the discharge openings 23 in this case.

[0019] In order to maintain a high efficiency of the classifying zone B for the highly selective precise grain classification, the cylindrical basket shell part 10 has a length that is preferably smaller than approximately 5 times the basket shell diameter. In addition, the axial length of the conical basket shell part 12 with the sinks discharge may differ from the axial length of the conical basket shell part 11 with the floats discharge. The cone angle of the conical basket shell parts 11 and 12 can be, for example, <12°.

[0020] In order to favorably influence the separation or removal of the fine grain/finest grain from the grain spectrum in the classifying zone B so as to achieve a highly selective classification of coarse grains, systems for mixing the suspension can be provided within the classifying zone B.

[0021] The biconical solid basket screw-type centrifuge according to the present invention is not only suitable for classifying grain spectrums so as to obtain at least one grain class of a ground solid, but also for dewatering or the separation of solids and liquids in sludges that contain materials that can be separated from the sinks separately as a third phase in the form of floats.

[0022] Although the present invention has been described in terms of particular embodiments and applications, one of ordinary skill in the art, in light of this teaching, can generate additional embodiments and modifications without departing from the spirit of or exceeding the scope of the claimed invention. Accordingly, it is to be understood that the drawings and descriptions herein are proffered by way of example to facilitate comprehension of the invention and should not be construed to limit the scope thereof.

Claims

1. A centrifuge for the wet mechanical separation of a solids mixture in a fluid suspension into heavy phase sinks, light phase floats, and a third phase, said centrifuge including a cylindrical basket shell part that connects on at least one end to a conical basket shell part, an axial feed for the suspension, a discharge for the heavy phase sinks, a discharge for the light phase floats, a discharge for a third phase that contains the suspension fluid, and an immersion disk for preventing the floats from remixing with the suspension, said centrifuge further comprising a separating chamber in the form of a classifying zone for separating the solids into fine-grained solids and coarse-grained solids, said classifying zone extending axially into the basket shell part between the immersion disk and the discharge for the third phase, and a sorting zone, said sorting zone extending from the floats discharge to the immersion disk.

2. A centrifuge according to Claim 1, wherein the distinctly lighter impurities that are floating in the suspension to be classified can be discharged at the float discharge.

3. A centrifuge according to Claim 1, wherein the discharge for the third phase, when viewed in the flow direction of the supplied suspension, for discharging the fine-grained solids is arranged at a distance in front of the sinks discharge for the coarse-grained solids or vice versa.

4. A centrifuge according to Claim 1, wherein the discharge of the third phase for discharging the fine-grained solids is positioned approximately at the transition from the cylindrical basket shell part to the conical basket shell part for discharging the sinks.

5. A centrifuge according to Claim 1, wherein the discharge for the third phase for discharging the fine-grained solids consists of one or more overflow pipes that are positioned approximately radially and distributed over the basket periphery.

6. A centrifuge according to Claim 1, wherein several nozzle-shaped discharge openings for discharging the coarse-grained solids are distributed around the basket periphery, and the fine-grained solids are discharged at the far right discharge openings.

7. A. centrifuge according to Claims 1, characterized by the fact that the discharge for the third phase comprises of a skimming pipe or a skimming disk system with a partial axial discharge of the suspension containing the fine-grained solids.

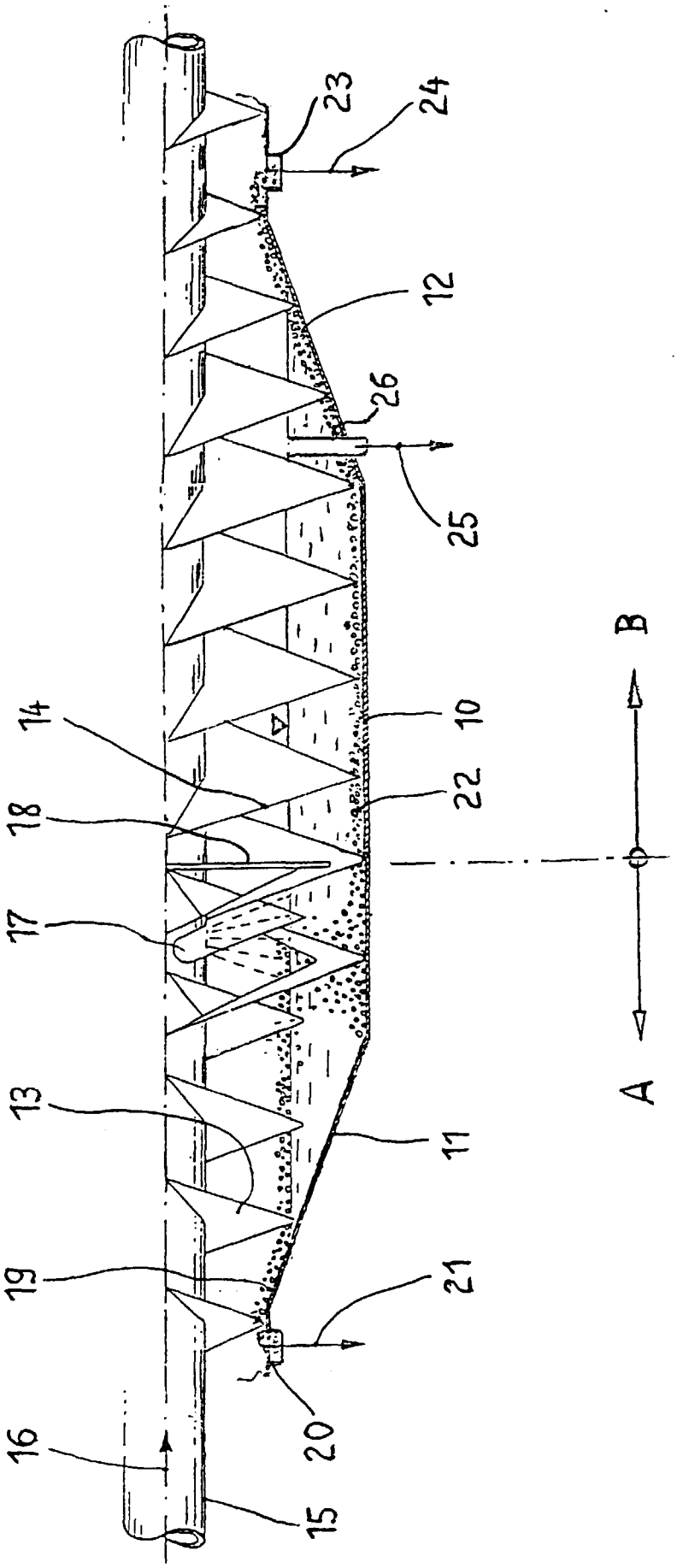
8. A centrifuge according to Claim 1, wherein the conveyor screw which is positioned coaxially in the basket shell of the biconical solid basket centrifuge includes oppositely spiraled screws, namely a sinks screw and a floats screw, that transport the sinks and the floats to the ends of the centrifuge in oppo-

site directions.

9. A. centrifuge according to Claim 8, wherein the helical screw for sinks in the conical basket shell part has a pitch that differs from the pitch of the helical screw in the cylindrical basket shell part.

10. A centrifuge according to Claim 1, wherein the cylindrical basket shell part has a length that is smaller than approximately 5 times the basket shell diameter.

11. A centrifuge according to Claim 1, wherein the axial length of the conical basket shell part with the sinks discharge differs from the axial length of the conical basket shell part with the floats discharge.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EUROPEAN SEARCH REPORT

Application Number
EP 00 10 0957

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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B04B
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 April 2000	Leitner, J

CATEGORY OF CITED DOCUMENTS

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