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- (73) Patenthaver: **BWS Technologie GmbH, Nordstrasse 41, 41515 Grevenbroich, Tyskland**
- (72) Opfinder: **Thelen, Michael, Karolingerring 216, 41812 Erkelenz, Tyskland**  
**JANSSEN, Viktor, Geranienstraße 6, 47546 Kalkar, Tyskland**
- (74) Fuldmægtig i Danmark: **Budde Schou A/S, Hausergade 3, 1128 København K, Danmark**
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The invention relates to a discontinuous centrifuge with a control unit for controlling the operation of the centrifuge and the method for operating a centrifuge.

A discontinuous centrifuge is known for solid-liquid-separation of crystal suspensions in the production of food products. For example, in the processing of sugar cane and sugar beets, intermediate products are formed whose solid components and liquid components are separated batchwise of the discontinuous centrifuge in successive working steps. The discontinuous centrifuge comprises a centrifuge drum which is filled with the crystal suspension at the beginning of each working step, wherein the centrifuge rotates with a rotational speed of 100 to 250 rotationals per minute. After completing of the filling of the centrifuge drum, which now contains a predetermined amount of the filling material, the centrifuge drum is accelerated to a rotational speed in a range of 980 to 1500 rotationals per minute. This rotational speed is maintained until at desired separation and drying progress of the filling material is achieved. The centrifuge drum is then braked again and the filling material is cleared out of the centrifuge drum with a clearing out device. After the clearing of the centrifuge drum the working step is completed and a new batch of the crystal suspension is filled, spun and cleared out of the centrifuge drum in a subsequent working step.

The crystal suspension is a mixture of crystals and syrup. The syrup surrounds the crystals and is spinned off from the filling material by centrifugation, wherein the centrifuge syrup declines as green molasses. In a subsequent washing step the crystals of the filling material are washed by adding and centrifugation of a suitable wash fluid, for example syrup, water or steam. Conventionally the washing is carried out with the aid of a constant wash liquid stream, which is sprayed on the free surface of the filling material during a predetermined time span. The quantity of washing fluid thus supplied to the centrifuge drum is for each batch constant and dissolves the same amount of crystals per working step if the crystal structure is the same. The dissolved crystals decline as white molasses and are crystallized again in a downstream working step using energy.

In the operation of the discontinuous centrifuge for the solid-liquid-separation of the crystal suspension is their consistence of the crystal suspension according to experience subject of certain fluctuations, wherein a corresponding adjustment of the wash time point and the wash liquid amount is desirable batch by batch. The adjustment of the wash time point of the wash fluid amount for each batch is carried

out either conventionally manually by operating staff of the discontinuous centrifuge based on experience values or automatically if a wash control unit is present.

However, it is in any case desirable that the addition of the wash fluid into the centrifuge should be carried out cautiously by taking into account the filling material  
5 which is located in the centrifuge. A non-optional addition of the wash fluid into the centrifuge is accompanied by reductions in product quality and the product yields. In the worst case, even unstable operating conditions of the centrifuge may occur.

A centrifuge according to the preamble in the claim 1 is known in EP 2 275 207 A1.

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It is an object of the invention to create a discontinuous centrifuge with a control unit for controlling the operation of the centrifuge and the method for operating the centrifuge, wherein the centrifuge is safe and effectively operatable.

15 The object is solved with the features of the patent claim 1 and 6. Preferred embodiments thereto are given in the further patent claims.

The discontinuous centrifuge according to the invention for solid-liquid-separation of a crystal suspension, comprises a centrifuge drum, into which the crystal suspension is  
20 fillable as a filling material in a predetermined amount and which is rotary driveable with a drive unit, at least in a first acceleration phase and, chronological situated after the first acceleration phase, a second acceleration phase, a washing fluid addition unit with a control valve, via which a washing fluid is addable into the centrifuge drum for washing of the filling material, a detection unit, with which a first quotient is detectable  
25 in real time of the instantaneous torque and the instantaneous rotary acceleration of the centrifuge drum at the chronological early operating point lying in the first acceleration phase, and a second quotient is detectable in real time of the instantaneous torque and the instantaneous rotary acceleration of the centrifuge drum at the chronological late operating point lying in the second acceleration phase, and a  
30 control unit with which the control valve is controllable that the control valve is set to a throttled position as soon as the ratio of the first quotient to the second quotient is smaller than a predetermined threshold value at the late operating point so that the addition of the washing fluid into the centrifuge drum is reducible.

35 It is for example conceivable that it is accelerated product related only once, wherein the both acceleration phases lie next to each other and the both operating points lie

temporally one after another. The same applies if it is accelerated more than twice. The both accelerating phases can, but are not necessarily, be interrupted by an acceleration pause. Between the both accelerating phases can be accelerated or the both accelerating phases border temporally direct on each other.

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The method according to the invention for controlling the operation of the centrifuge according to the invention comprises the steps of: providing the centrifuge with the centrifuge drum filled with the filling material; operating the centrifuge drum in the spinning mode, which has the first acceleration phase and the second acceleration  
10 phase; detect in real time the first quotient of the instantaneous torque and the instantaneous rotary acceleration of the centrifuge drum at the chronologically early operating point lying in the first acceleration phase, and detect in real time the second quotient of the instantaneous torque and the instantaneous rotary acceleration of the centrifuge drum at the chronologically late operating point lying in the second  
15 acceleration phase; driving the control valve that the control valve is set into the throttled position as soon as the ratio of the first quotient to the second quotient is smaller as the predetermined threshold value at the late operating point so that the addition of the washing fluid is reducible into the centrifuge drum.

20 The addition of the washing fluid into the centrifuge drum during operating of the centrifuge has a relevant influence of the operation regarding the product yield, the product quality and the operational reliability. The invention is based on the recognition that the operation of the centrifuge is improved in terms of product quality, product yield and operational reliability only then, when the addition of the wash fluid is carried  
25 out when the permeability of the filling material for the wash fluid has reached a corresponding high grade. Only after the filling material is adequately permeable for the wash fluid, is for the operation of the centrifuge a beneficial mass flow of the wash fluid through the filling material achievable. This advantageously ensures that none impermissible high amounts of the wash fluid accumulates into the centrifuge and lead  
30 to possibly instabilities during operation of the centrifuge. Furthermore, the filling material is flown through with wash fluid sufficiently during centrifugation, whereby syrup remains on the crystal surface can be removed easily.

During operation of the centrifuge fluid is driven during centrifugation through the filling  
35 material, the fluid can be either the syrup of the crystal suspension or the wash fluid or both. The liquid outflow of the filling material is accompanied with a change of mass of

the filling material, whereby the centrifuge drum with the filling material experiences a corresponding change of its mass moment of inertia. According to the invention the change of the mass moment of inertia of the centrifuge drum with the filling material is used to deduce on the permeability of the filling material. Only if the permeability of the filling material is sufficiently high, namely when to the late operating point the ratio of the both quotients is bigger than the predetermined threshold value, can the washing fluid be added ideally into the centrifuge drum. Is the ratio of both quotients smaller than the predetermined threshold value the control valve is set into the throttled position by the control unit so that the addition of the washing fluid into the centrifuge drum is at least reduced or even suppressed. In this case, wash fluid may already have been added into the centrifuge drum before the late operating point or not.

By determining of the quotient of the mass moment of inertia at the beginning of the adding of the wash fluid and the mass moment of inertia at the end of the adding of the wash fluid a statement can be made how the wash fluid permeates the crystal layer.

Preferably the threshold value lies by 1.2. Further preferred is that with the control unit the drive unit is controllable that the rotational speed is reduced to a predetermined threshold rotational speed, which is lower than the rotational speed to the late operating point, once the ratio of the first quotient to the second quotient is smaller than the predetermined threshold value at the late operating point. Particularly preferred is the threshold rotational speed is zero that means that the centrifuge is stopped, if no separation or an insufficient operation is carried out. In the event that the permeability of the filling material is not sufficiently presented during the operation of the centrifuge at the late operating point, the rotational speed of the centrifuge drum is reduced or the centrifuge drum is stopped so that any instabilities are prevented by an excessively large amount of liquid in the centrifuge drum. This ensures the operation of the centrifuge according to the invention.

The wash fluid addition unit is preferred a wash water addition unit, with which wash fluid a wash water is supplyable into the centrifuge drum. It is preferred that the rotational speed is increased linearly over time during the accelerating phases. Furthermore, an intermediate spinning phase is preferably located between the first acceleration phase and the acceleration phase during which the rotational speed is kept constant over time. Preferably, the early operating point is located shortly before

the end of the first acceleration phase and the late operating point is located shortly after the beginning of the second acceleration phase.

5 Preferably, the early operating point coincides with the beginning of the intermediate spinning phase and the late operating point coincides with the end of the intermediate spinning phase. In addition it is preferred that the wash fluid will be added to the centrifuge drum at the or after the late operating point when the acceleration of the control valve is omitted that the control valve will be set in the throttled position.

10 Preferably, wash fluid is wash water. Preferably, wash fluid will be added into the centrifuge drum at the or before the early operating point. By determining the quotient of the mass moment of inertia at the beginning of the adding of the wash fluid and the mass moment of inertia at the end of the adding of the wash fluid a statement can be made how the wash fluid permeates the crystal layer.

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The torque will be determined preferably with the help of the effected moment of the frequency converter or DC-converter. According to the invention, the ratio of the two quotients is used for quantifying of the separating behaviour of the filling material during the accelerating phases of the centrifuge. All the required data for this purpose are preferably measured in the frequency converter or DC-converter, whereby no additional measuring devices are provided for determining the torque and the rotary acceleration in the centrifuge according to the invention. Based on the size of the ratio of the two quotients it can be deduced whether a separation in the filling material takes place or has already taking place at the late operating point. In addition, it is possible to meter according to the size of the ratio of the two quotients the amount of the addable wash fluid accordingly that a highest possible washing progress is achieved with the highest possible operational reliability of the centrifuge. Is the wash fluid added into the centrifuge drum if the separating behaviour of the filling material is not present or is very low, uncontrolled waves in the drum can occur. The waves lead to unbalance of the centrifuge drum, whereby the centrifuge drum could be damaged.

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Advantageously, it is possible with reference to the ratio of the quotients to stop the addition of the wash fluid or according to the delayed separation to delay or to completely stop the addition of the wash fluid.

In the following a preferred embodiment of the centrifuge according to the invention and three exemplarily methods for operating the centrifuge are explained on the basis of enclosed schematic drawings. It shows:

- 5 Figure 1 a schematic representation of a longitudinal section of the embodiment of the centrifuge according to the invention,

Figures 2 to 4 diagrams of three exemplarily methods for operating the centrifuge from figure 1.

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As it can be seen from figure 1, a centrifuge 1 comprises a centrifuge drum 2. The centrifuge drum 2 comprises an axis of rotation 3 which coincides with the axis of symmetry of the centrifuge drum 2 and is in figure 1 arranged vertically. The centrifuge drum 2 comprises also a spindle 4 which serves for rotary driving of the centrifuge drum 2 and is fixedly connected with a hub 5. A distributor 6 in the form of a conical surface projecting radially outwards from the spindle 4 is arranged on the spindle 4. The centrifuge drum 2 is also formed by a cylindrical wall 7 and a cover 8 with which the cylindrical wall 7 is covered. A filling material 9 is added into the interior of the centrifuge drum 2, the filling material 9 is placed with the same thickness on the cylindrical wall 7 because of the centrifugal forces in the spinning mode of the centrifuge 1 with spinning rotational speed of the centrifuge drum 2. In this case a free surface 10 on the filling material 9 is formed seen from the radially inside, wherein the free surface 10 coincides with a about axis of rotation 3 imaginary symmetric cylinder.

25 For rotary driving of the centrifuge drum 2 a three-phase AC motor 11 is coupled to the spindle 4, wherein three-phase AC motor 11 can be connected to a power supply network via a frequency converter or DC-converter 12 and a main connection 13, wherein the three-phase AC motor or direct current motor 11, the frequency converter or DC-converter 12 and the main connection 13 form a drive unit. The frequency  
30 converter or DC converter 12 comprises a detection unit 14, with which instantaneous torques and instantaneous rotary accelerations can be determined at predetermined temporal operating points during the operation of the centrifuge 1. For this purpose, the effective moment of the frequency converter or the DC-converter is used by the detection unit 14. With the detection unit 14 the quotient of the respective torques and  
35 the values of the respective rotary accelerations can also be determined and stored in a storage element to the corresponding operating point. The centrifuge comprises a

first signal line 15 and a control unit 17, wherein the detection unit 14 and the control unit 17 are coupled via the first signal line 15.

5 A early operating point and late operating point are predetermined for the operation of the centrifuge 1. The detection unit 14 is configured in such a way that to the early operating point a quotient of the torque corresponding to the early operating point and the rotary acceleration corresponding to the early operating point is detected, determined and stored in the storing element. Furthermore, the detection unit 14 is configured in such a way in analogy to the early operating point the quotient out of the instantaneous torque and the instantaneous rotary acceleration is also to the late operating point detected, determined and stored. In addition, the detection unit 14 is able to recall the first quotient out of the storing element and to form the ratio of the first and the second quotient. If the ratio of the first quotient to the second quotient is smaller than a predetermined threshold value, in particular 1.2, the detection unit 14 is able to generate a corresponding signal which reaches the control unit 17 via the first signal line.

On its radially outer side, the centrifuge drum 2 comprises a sieve 18, which is perforated in such a way that during the operation of the centrifuge 1 fluid from the filling material 9 can be lead away from the centrifuge drum 2 through the sieve 18. Furthermore, the centrifuge 1 comprises a wash water addition unit 20 for adding wash water and/or a cover syrup addition unit 19 for adding cover syrup into the centrifuge drum 2 during the operation of the centrifuge 1. The cover syrup addition unit 19 comprises a cover syrup reservoir 21 which provides cover syrup. In analogy, the wash water addition unit 20 comprises a wash water reservoir 22 which provides wash water. The cover syrup addition unit 19 comprises a cover syrup nozzle 27 through which cover syrup can be added from the cover syrup reservoir 21 into the centrifuge drum 2 via a cover syrup control valve 23 which can be controlled by a cover syrup control unit 25. The wash water addition unit comprises a wash water nozzle 28 through which wash water can be added into the centrifuge drum 2 via a wash water control valve 24 which can be controlled by a wash water control unit 26. Both, the cover syrup valve control unit 25 and the wash water valve control unit 26 are coupled to the control unit 17 so that, depending on signals of the first signal line 15, the cover syrup valve control 25 and the wash water valve control unit 26 can be controlled.

The control unit 17 is configured in such a way that depending on signals of the first signal line 15 the control unit 17 gives signals to the second signal line 16 via which the control unit 17 is coupled to the frequency converter or DC converter 12. The frequency converter or DC converter 12 may process signals from the second signal  
5 line 16 such that the rotational speed of the centrifuge drum 2 can be reduced or set to zero.

The early operating point lies in the first acceleration phase and the second operating point lies in the late accelerating phase. Due to the fact that the centrifuge drum 2 is  
10 accelerated during the operating points, the rotary acceleration of the centrifuge drum 2 can be determined at a value greater than zero. The quotient of the torque and the rotary acceleration assumes a finite value in the operating points and is a measure of the mass moment of inertia of the centrifuge drum 2 and of the filling material 9 located in the centrifuge drum 2. The effective moment of the frequency converter or DC-  
15 converter 12 is used to determine the torque.

During the acceleration phases, the rotational speed of the centrifuge drum 2 increases linearly so that the rotary acceleration in the acceleration phases is constant. If the rotary acceleration is equal in both acceleration phases and if the  
20 acceleration phases lie directly adjacent to one another in time the rotational speed of the centrifuge drum 2 increases linearly over both acceleration phases. It is conceivable that the acceleration phases are interrupted by a phase with constant rotational speed, at which for example, intermediate spinning is to be accomplished. During operation of the centrifuge 1, the torque and the rotary acceleration are  
25 detected to the early operating point during the first acceleration phase, the quotient is formed therefrom and stored in the storing element. Subsequently, the torque and the rotary acceleration are determined for the late operating point during the second acceleration phase, and the quotient thereof is determined therefrom. It is, for example, conceivable that it is accelerated product related only once, wherein the two  
30 acceleration phases being adjacent to one another and the two operating points being successively arranged one after the other. The same applies if it is accelerated more than twice. The two acceleration phases can, but are not necessarily, be interrupted by an acceleration pause. Between the both acceleration phases it is possible to accelerate or the both acceleration phases border temporally directly on each other.

The first quotient from the storing element is then recalled and the ratio is formed from the first quotient and the second quotient. The resultant value is compared with a threshold value and, if the ratio is smaller than the threshold value, in particular 1.2, a signal is emitted from the detection unit 14 to the first signal line 15 and delivered to  
5 the control unit 17. In the control unit 17 the signal from the first signal line 15 is processed such that the valve control units 25, 26 are controlled by the control unit 17 such that at least one of the control valves 23, 24 is brought into a throttled position or is closed. Further, from the control unit 17 into the second signal line 16 a signal emitted which is input to the frequency converter or DC-converter 12 and is processed  
10 such that the rotational speed of the three-phase motor or the direct current motor 11 is reduced or is set to zero.

If in the late operating point one of the control valves 23, 24 or both control valves 23, 24, are already open so that the cover syrup and/or wash water can flow from the  
15 reservoirs 21, 22 into the centrifuge drum 2 via the nozzles 27, 28 is this supply of cover syrup and/or wash water into the centrifuge drum 2 by means of the control valves 23, 24 either reduced or stopped. If a supply of cover syrup or wash water into the centrifuge drum 2 is planned at a later time point than the late operating point this supply is correspondingly limited or prevented by controlling of the control valves 23,  
20 24 by the valve drive unit 25, 26.

The quotient of the torque and the rotary acceleration is a measure of the mass moment of inertia of the centrifuge drum 2 together with the filling material 9. The filling material 9 is a crystal suspension, which comprises a mixture of crystals and syrup.  
25 During centrifuging of the filling material 9 syrup declines out of the centrifuge drum 2 via the sieve 18, which is designated as green molasses. For further purification of the crystals, cover syrup and wash water are successively sprayed on the free surface 10 of the filling material 9 during centrifugation. During centrifugation, cover syrup and wash water are lead away from the centrifuge drum 2 via the sieve 18 as cover drain.  
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The speed with which the syrup, the cover syrup and the water can be lead away from the filling material 9 during centrifugation depends in particular on the permeability of the filling material 9.

35 The permeability of the filling material 9 results, for example, on the radial layer thickness of the filling material 9 and/or from the grain size of the crystals. If, for

example, the grain size of the crystals is comprehensively small, the crystals are so closed to one another during centrifugation that the syrup can hardly seep through the filling material 9 and can be lead away from the centrifuge drum 2. As a result thereof, the syrup remains during centrifugation mainly completely in the centrifuge drum 2, so  
5 that during centrifugation the mass moment of inertia of the centrifuge drum 2 together with the filling material 9 hardly changes. On an observed constancy of the mass moment of inertia during centrifugation it can therefore be concluded that the washing fluid is insufficiently removed during centrifugation and therefore are further addition of for example, cover syrup or wash water into the centrifuge drum 2 is to be omitted.

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If, in the case of such a poor separation of the syrup from the filling material 9, wash water would be added, for example, to the centrifuge drum 2, the wash water would also not be able to be centrifuged sufficiently. As a result, the wash water would accumulate on the free surface 10 of the filling material 9 and could be set in  
15 uncontrolled flow conditions. These uncontrolled flow conditions can lead to high mechanical stresses on the centrifuge 1, as a result of which the operational reliability of the centrifuge 1 is compromised.

In figures 2 to 4 are show with the aid of diagrams operating configurations of the centrifuge 1, wherein the abscissas of the diagrams are time axis 29 in each case. The  
20 rotational speed in the form of a curve 30, the filling thickness prevailing in the centrifuge drum 2 in the form of a curve 31 and the mass moment of inertia in the form of a curve 32 are plotted over the ordinates of the diagrams. The rotational speed curves 30 comprise sections with a constant rotational speed and sections with a  
25 constant rotational speed acceleration. The values for the curve 32 of the mass moment of inertia results from the quotients torque / rotary acceleration so that the curves from the mass moment of inertia 32 have gaps (product spinning) 33 in the regions with a constant rotational speed. Time intervals in which cover syrup is added into the centrifuge drum 2 are designated with the reference sign 34. Furthermore, the  
30 time intervals during which wash water is applied into the centrifuge drum 2 are designated with the reference sign 35.

Figure 2 shows a first operation of the centrifuge 1. The rotational speed increases linearly from a first operating point 41 to a second operating point 42 and remains  
35 constant up to a third operating point 43. From the third operating point 43 the rotational speed 30 increases linearly up to a fourth operating point 44 and then

remains constant up to a fifth operating point 45. The rotational speed between the second operating point 42 and the third operating point 43 is an intermediate spinning rotational speed. In the first region of the curve 32, the mass moment of inertia between the first operating point 41 and the second operating point 42 is

5 comparatively constant over time from which it can be deduced that virtually no separation of the filling material 9 in the centrifuge drum 2 occurs during centrifugation. Rather, after the application of cover syrup 34 the curve 32 of the mass moment of inertia raises likely up to the second operating point 32. This increase is an indication that the cover syrup added during period 34 has accumulated in the centrifuge drum 2

10 and cannot be centrifuged sufficiently quickly.

During the intermediate spinning between the second operating point 42 and the third operating point 43 the filling material 9 is separated because the value of the mass moment of inertia to the second operating point 42 is about one third higher than to the

15 third operating point 43. The second operating point 42 is the front operating point and the third operating point 43 is the rear operating point. From the curve 32 for the mass moment of inertia, the ratio of the values of the mass moments of inertia from the front operating point 42 to the rear operating point 43 is approximately 1.78. As a result, of the fact that the threshold value is set at 1.2 a signal of this kind is outputted by the

20 detection unit 14, whereby the wash water control valve 24 is enabled via the wash water control valve unit 26. As a result, at a later point in time than the rear operating point 43 the adding of wash water 35 can follow which leads to an increase in the curve 32 of the mass moment of inertia shortly behind the rear operating point 43 to the fourth operating point 44. From this comprehensively strong increase in the curve

25 32 of the mass moment of inertia can be deduced that the wash water penetrates to slowly the filling material 9 and runs to slowly out of the centrifuge drum 2. It is centrifuged between the fourth operating point 44 and the fifth operating point 45 at the constant rotational speed, wherein the curve 31 indicates the filling thickness in the centrifuge drum 2 over the entire period. The course after the addition of wash water

30 between the points 43 and 44 is an indication for a poor penetrability of the filling material caused mostly by a) too late water adding, b) too small crystal sizes or variation coefficients, or c) presence of fine grain, and can be evaluated in the control unit 17.

35 Figure 3 shows a second operation of the centrifuge drum 2. From a first operating point 51 to a second operating point 52 the centrifuge 1 is operated at a constant

comprehensively low rotational speed. During this period the centrifuge drum 2 will be filled with the filling material 9. From the second operating point 42 the centrifuge drum 2 is driven with a constant rotary acceleration up to a third operating point 53, wherein the curve 32 of the mass moment of inertia has a substantially constant course in this region from which it can be deduced that virtually no separation takes place between the second operating point 52 and the third operating point 53. Between the third operating point 53 and the fourth operating point 54 the centrifuge 1 is driven in an intermediate spinning mode at constant rotational speed, wherein the third operating point 53 is the early operating point and the fourth operating point 54 is the late operating point. The ratio of the mass inertia moment from the early operating point 53 to the late operating point 54 is approximately 1.18 and is thus lower than the threshold value of 1.2. As a result, a possible addition of cover syrup and/or wash water is reduced or omitted under the action of the detection 14 and the control unit 17. This means that the adding of washing water 35 initiated between the earlier operating point 53 and the late operating point 54 is reduced or omitted to the late operating point 54. At a fifth operating point 55 after the fourth operating point 54 the centrifuge 1 is operated at a constant rotational speed for spinning.

Figure 4 shows a third operation of the centrifuge 1. Between a first operating point 61 and a second operating point 62 the centrifuge drum 2 will be filled with the filling material 9. The centrifuge drum 2 is constantly accelerated between the second operating point 62 and the fifth operating point 65, wherein a third operating point 63 as the early operating point and a fourth operating point 64 as the late operating point are located between the second operating point 62 and the fifth operating point 65. A adding of cover syrup 34 takes place before the early operating point 63 which is indicated by a corresponding increase in the curve 32 of the mass moment of inertia. The cover syrup can quickly leave a centrifuge drum 2, whereby the curve 32 of the mass moment of inertia drops comparatively sharply between the early operating point 63 and the late operating point 64. A adding of wash water 35 is provided around the late operating point 64. The ratio of the value of the curve 32 of the mass moment of inertia to the early operating point 63 and to the late operating point 64 is 1.31 and is thus above the threshold value of 1.2. Thus, the wash water control valve 24 is unlocked by the detection unit 14 and the control unit 17 so that the adding of wash water 35 can take place. At the adding of wash water 35, a comparatively constant course of the curve 32 of the mass moment of inertia results, whereby the curve 32 of

the mass moment of inertia caused by centrifuging of the wash water drops towards the fifth operating point 65.

## List of Reference Signs

- 1 centrifuge
- 2 centrifuge drum
- 5 3 axis of rotation
- 4 spindle
- 5 hub
- 6 distributor
- 7 cylindrical wall
- 10 8 cover
- 9 filling material
- 10 free surface of the filling material
- 11 three-phase motor or direct current motor
- 12 frequency converter or DC-converter
- 15 13 power supply
- 14 detection unit
- 15 first signal line
- 16 second signal line
- 17 control unit
- 20 18 sieve
- 19 cover syrup addition unit
- 20 wash water addition unit
- 21 cover syrup reservoir
- 22 wash water reservoir
- 25 23 cover syrup control valve
- 24 wash water control valve
- 25 cover syrup valve control unit
- 26 wash water valve control unit
- 27 cover syrup nozzle
- 30 28 wash water nozzle
- 29 time axis
- 30 revolution speed
- 31 filling thickness
- 32 mass moment of inertia
- 35 33 gap (product spinning)
- 34 adding of cover syrup

- 35 adding of wash water
- 41 first operating point in the first operation phase
- 42 second operating point in the first operation phase
- 43 third operating point in the first operation phase
- 5 44 fourth operating point in the first operation phase
- 45 fifth operating point in the first operation phase
- 51 first operating point in the second operation phase
- 52 second operating point in the second operation phase
- 53 third operating point in the second operation phase
- 10 54 fourth operating point in the second operation phase
- 55 fifth operating point in the second operation phase
- 61 first operating point in the third operation phase
- 62 second operating point in the third operation phase
- 63 third operating point in the third operation phase
- 15 64 fourth operating point in the third operation phase
- 65 fifth operating point in the third operation phase

**PATENTKRAV**

1. Diskontinuerlig centrifuge til faststof-væskeadskillelse af en krystalsuspension, med en centrifugetromle (2), i hvilken krystalsuspensionen kan indfyldes som et påfyldningsmateriale (9) i en forudbestemt mængde og som kan rotationsmæssigt drives med en drivenhed (11, 12), i det mindste i en første accelerationsfase (41, 42; 52, 53; 62, 63) og, tidsmæssigt placeret efter den første accelerationsfase (41, 42; 52, 53; 62, 63), i en anden accelerationsfase (43, 44; 54, 55; 64, 65), en vaskevæsketilførselseenhed (19, 20) med en styreventil (23, 24), via hvilken en vaskevæske kan tilføres i centrifugetromlen (2) for vaskning af påfyldningsmaterialet (9), en detektionsenhed (14), hvormed en første kvotient kan detekteres i sand tid for det øjeblikkelige moment og den øjeblikkelige rotationsacceleration for centrifugetromlen (2) ved det tidsmæssigt tidlige driftpunkt (42, 53, 63), som ligger i den første accelerationsfase (41, 42; 52, 53; 62, 63), og en anden kvotient kan detekteres i sand tid for det øjeblikkelige moment og den øjeblikkelige rotationsacceleration for centrifugetromlen (2) ved det tidsmæssigt sene driftpunkt (43, 54, 64), som ligger i den anden accelerationsfase (43, 44; 54, 55; 64, 65), og en styreenhed (17), hvormed styreventilen (23, 24) kan styres, at styreventilen (23, 24) er indstillet til en droslet position, så snart forholdet mellem den første kvotient og den anden kvotient er mindre end en forudbestemt tærskelværdi ved det sene driftpunkt (43, 54, 64), således at tilførslen af vaskevæsken i centrifugetromlen (2) kan reduceres.

2. Centrifuge ifølge krav 1, hvor den droslede position er den lukkede position for styreventilen (23, 24), således at tilførslen af vaskevæske i centrifugetromlen (2) kan afbrydes.

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3. Centrifuge ifølge krav 1 eller 2, hvor tærskelværdien ligger ved 1,2.

4. Centrifuge ifølge ethvert af kravene 1 til 3, hvor drivenheden (11, 12) kan styres med styreenheden (17), at rotationshastigheden reduceres til en forudbestemt tærskelrotationshastighed, som er lavere end rotationshastigheden ved det sene driftpunkt (43, 54, 64), især til nul, såsnart forholdet mellem den første kvotient og den anden kvotient er mindre end den forudbestemte tærskelværdi ved det sene driftpunkt (43, 54, 64).

5. Centrifuge ifølge ethvert af kravene 1 til 4, hvor vaskevæsketilførselseenheden er en vaskevandstilførselseenhed (20), hvormed vaskevæsken som vaskevand kan tilføres i centrifugetromlen (2).

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**6.** Fremgangsmåde til styring af driften af en diskontinuerlig centrifuge (1) ifølge ethvert af kravene 1 til 5, med følgende trin:

- 5 a) tilvejebringelse af centrifugen (1) med centrifugetromlen (2) fyldt med påfyldningsmaterialet (9),
- b) drift af centrifugetromlen (2) i spindemodus, som har den første accelerationsfase (41, 42; 52, 53; 62, 63) og den anden accelerationsfase (43, 44; 54, 55; 64, 65);
- 10 c) detektion i sand tid af den første kvotient for det øjeblikkelige moment og den øjeblikkelige rotationsacceleration for centrifugetromlen (2) ved det tidsmæssigt tidlige driftpunkt (42, 53, 63), som ligger i den første accelerationsfase (41, 42; 52, 53; 62, 63), og detektion i sand tid af den anden kvotient for det øjeblikkelige moment og den øjeblikkelige rotationsacceleration for centrifugetromlen (2) ved det tidsmæssigt sene driftpunkt (43, 54, 64), som ligger i den anden accelerationsfase
- 15 (43, 44; 54, 55; 64, 65);
- d) drift af styreventilen (23, 24) således, at styreventilen (23, 24) er sat til den droslede position, såsnart forholdet imellem den første kvotient og den anden kvotient er mindre end den forudbestemte tærskelværdi ved det sene driftpunkt (43, 54, 64), således at tilførslen af vaskevæske ind i centrifugetromlen (2) kan redu-
- 20 ceres.

**7.** Fremgangsmåde ifølge krav 6, hvor den droslede position er den lukkede position for styreventilen (23, 24), således at tilførslen af vaskevæsken i centrifugetromlen (2) afbrydes.

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**8.** Fremgangsmåde ifølge krav 6 eller 7, hvor tærskelværdien ligger ved 1,2.

**9.** Fremgangsmåde ifølge ethvert af kravene 6 til 8, hvor drivenheden (11, 12) drives således, at rotationshastigheden reduceres til den forudbestemte grænsehastighed, især til nul, når forholdet imellem den første kvotient og den anden kvotient er mindre end den forudbestemte tærskelværdi ved det sene driftpunkt (43, 54, 64).

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**10.** Fremgangsmåde ifølge ethvert af kravene 6 til 9, hvor omdrejningshastigheden forøges lineært over tiden over de respektive accelerationsfaser (41, 42; 52, 53; 62, 63; 43, 44; 54, 55; 64, 65).

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**11.** Fremgangsmåde ifølge ethvert af kravene 6 til 10, hvor en mellemliggende spindemodus foreligger imellem den første accelerationsfase (41, 42; 52, 53; 62, 63) og den anden accelerationsfase (43, 44; 54, 55; 64, 65), under hvilken rotationshastigheden vil blive holdt konstant over tiden.

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**12.** Fremgangsmåde ifølge ethvert af kravene 6 til 11, hvor vaskevæsken tilføres centrifugetromlen (2) ved eller efter det sene driftpunkt (43, 54,64), når aktiveringen af styreventilen (23, 24), hvormed styreventilen (23, 24) sættes til den droslede position, udelades.

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**13.** Fremgangsmåde ifølge krav 12, hvor skyllevæsken er skyllevand.

**14.** Fremgangsmåde ifølge ethvert af kravene 6 til 13, hvor dæksirup tilføres centrifugetromlen (2) ved eller før det tidlige driftpunkt (42, 53, 63).

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**15.** Fremgangsmåde ifølge ethvert af kravene 6 til 14, hvor momentet bestemmes ved hjælp af det effektive moment for frekvenskonverteren eller DC-konverteren (12).

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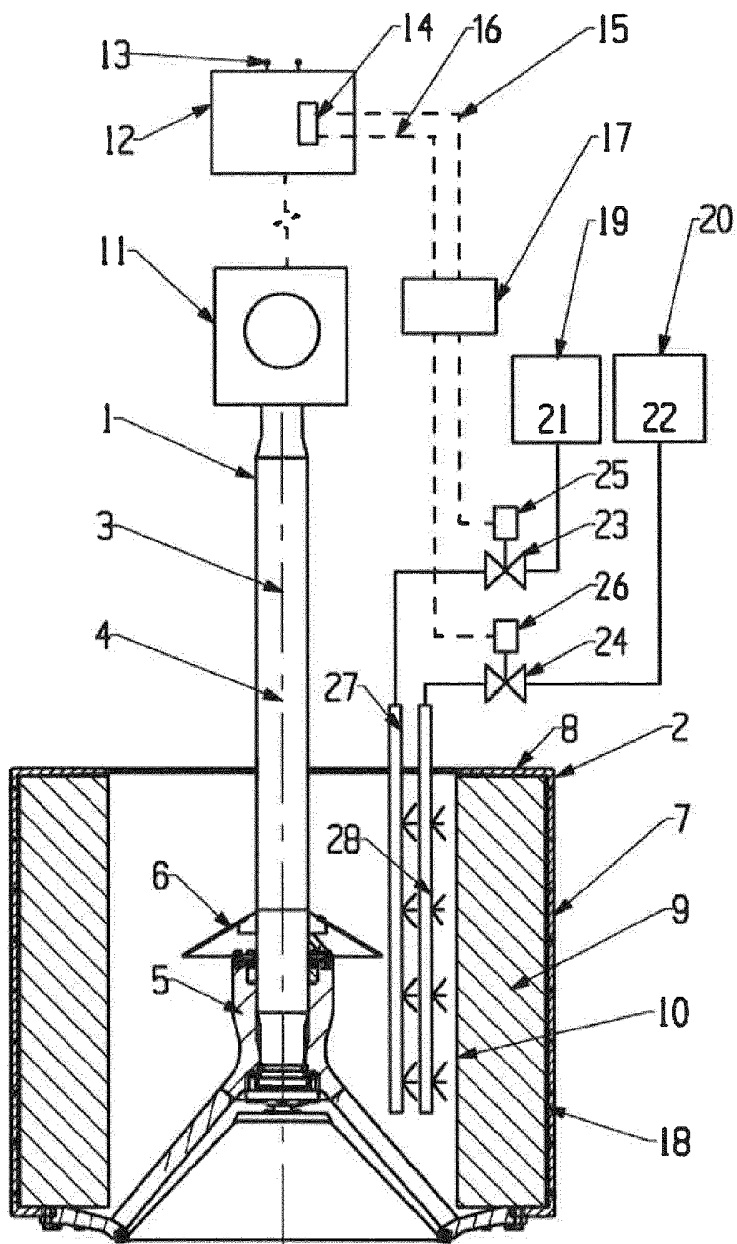


Fig. 1

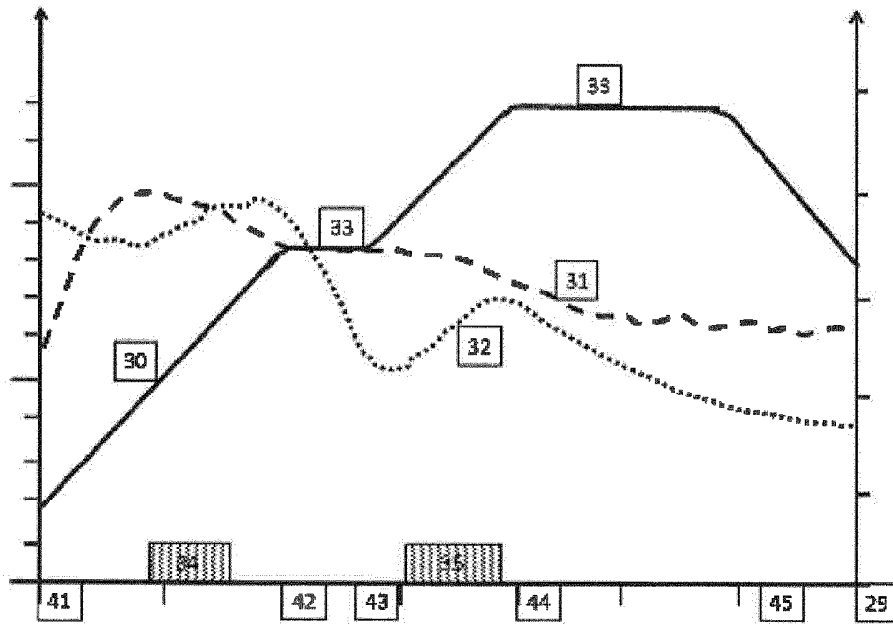


Fig. 2

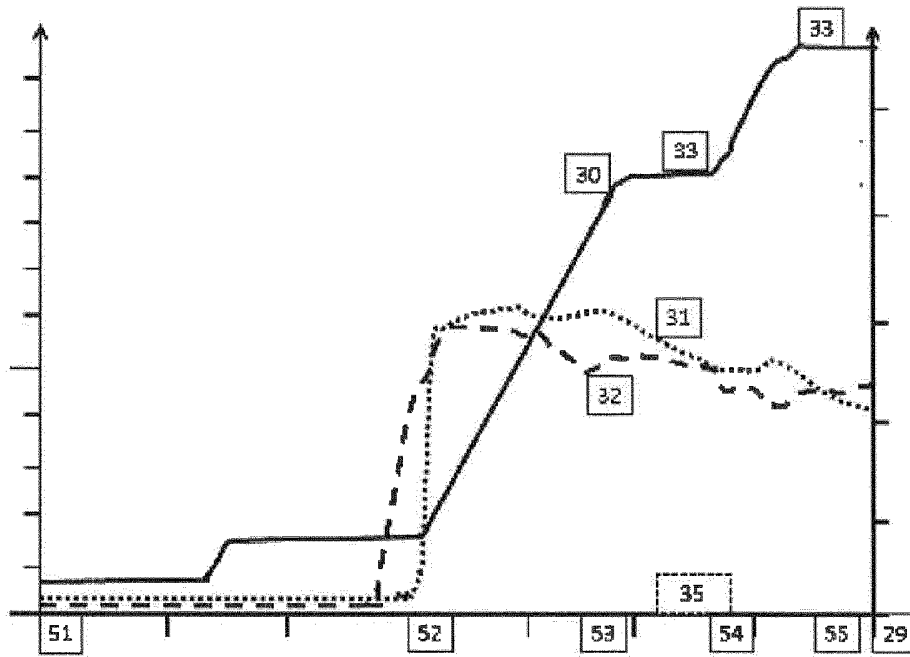


Fig. 3

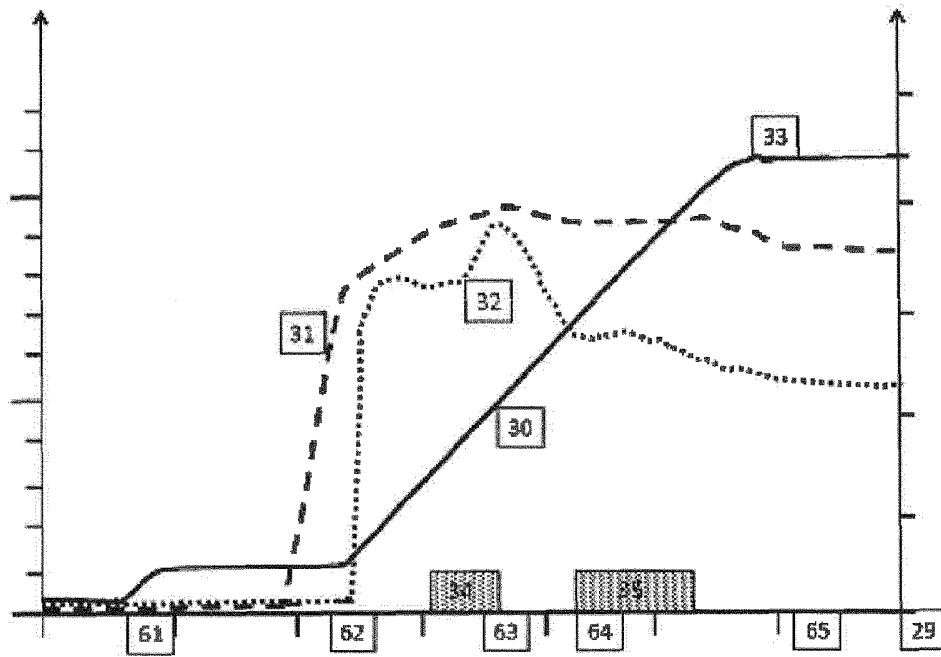


Fig. 4