

Separator

The invention relates to a separator according to the preamble of claim 1.

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Centrifugal separators for realizing a continuous operation have been known for a long time, separators of this type being known as nozzle separators in one embodiment from JP 62-117649 A. US 2,286,354 furthermore features a separator with solid drum lower
10 sections and drum upper sections which are bolted together. Known in addition to nozzle separators are separators of this type with solid-material discharge openings with which is associated a hydraulically operable piston slide valve by means of which the solid-material discharge openings can be closed and opened. As a
15 separator, US 2,017,734 features in one design a separator without solid-material discharge.

In the case of centrifuges of the known type of construction, the demand exists for new constructional methods especially with
20 regard to the processing of products under hygienic conditions.

Embodiments of the invention seek to solve this problem.

According to an aspect, there is provided a separator for the
25 centrifugal separation of a free-flowing product into different phases or for the centrifugal clarification of a product, the separator having at least the following features: a rotatable drum with a lower section and an upper section, a means arranged in the drum for the clarification of a product which is to be processed
30 in the centrifugal field, one or both of the following parts being of a conical design: the drum upper section and the drum lower section, one, a plurality, or all of the following elements consist of plastic or a plastic-

composite material: the drum lower section, the drum upper section and the means for clarification, wherein at least one discharge channel for a dense product phase is integrated into the drum upper section.

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The means for the clarification of a product which is to be processed - to be clarified - of solid material particles is preferably a separating plate packet consisting of conical separating plates consisting of plastic, but can also be for
10 example a one-piece clarification/separation cartridge consisting of plastic in the manner of DE 10 2008 052 630 A1 or another means for the clarification of a product of solid material particles such as a finned body with radial fins or the like.

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Accordingly, some, and preferably even all, of the product-contacting regions of the rotating system consist of plastic or a plastic-composite material, especially the drum lower section and the drum upper section and the plate packet.
20 Especially preferably, the feed system and the discharge system also consist of plastic or a plastic-composite material.

In such a way, it is possible to design a part of the drum
25 or preferably even the entire drum - preferably in addition to the feed and discharge systems or regions - for a one-time application, which is of interest and advantage especially with regard to the processing of pharmaceutical products such as fermentation broths or the like since,
30 after the operation for the processing of a corresponding batch, no cleaning of the drum is to be carried out during operation which is preferably continuous during the processing of the batch, but rather the drum is to be exchanged as a whole. Problems of hygiene which are
35 associated with cleaning are excluded in a simple manner as a result of this. The product-contacting parts can be entirely disposed of or recycled. The disposal is also of interest especially in the case of hazardous substances.

It is also conceivable, during a clarification process of a product, to concentrate very dense substances and to melt down the drum after the processing of a batch, or, for example, to dissolve the drum in an acid or the
5 like in order to produce the dense substance as a residue of this process.

By using plastic parts, the production costs can be kept relatively low, moreover.

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The drum can preferably be rotated by means of a spindle construction which preferably consists of plastic or a plastic-composite material and which is preferably coupled directly to the output shaft of a
15 motor, wherein the spindle construction has no rotational bearings on its outer circumference. This construction is simple and robust and very well suited to the lightweight drum construction. The electric motor or its rotor bearing arrangement undertakes the
20 function of the bearing of the drum in a simple manner.

It is advantageous and particularly hygienic in this case if the entire drum, especially also its feed system and its discharge system, is/are designed as a
25 sealed type of construction.

According to an advantageous embodiment, the drum is enclosed by a housing which preferably also consists of plastic or a plastic composite material. It is even
30 possible that the entire separator, apart from the motor, consists of plastic so that apart from the motor it can preferably be exchanged as a whole as a preassembled unit.

35 According to an especially advantageous embodiment of the invention, the drum lower section is provided directly in one piece with a distribution attachment

which has one or more distribution channels for transferring the product to be processed from a feed pipe into the drum interior. In such a way, two components or even sub-assemblies, which otherwise are
5 to be produced separately, are combined, which especially enables the production from plastic.

A recyclable plastic, especially PE (polyethylene), PP (polypropylene), or TK-PEEK (especially partially
10 crystalline polyetheretherketone), is preferably used as the plastic.

The parts which consist of plastic can be produced in an injection molding process and, if applicable, are
15 aftermachined, e.g. are provided with holes or the like, where it is necessary.

Screws and the like can also consist of plastic but they can also be produced from another material,
20 especially if they do not come into contact with the product.

An operation of the rotating system at sub-critical rotational speeds (below the first resonance frequency
25 of the rotating system) appears to be especially advantageous since such a drive simplifies the drive system considerably and owing to the material selection this separator, in contrast to other currently common separators, is operated in other rotational speed
30 ranges.

The power demand can usually be reduced compared with existing constructions. As a result of the low rotational speed, the noise emission is corresponding
35 low, moreover.

According to another aspect, there is provided a use of a separator according to the above as a disposable separator for the one-time processing of a

product batch. In an embodiment, the separator, without the drive, is preferably disposed off after the processing of this product batch, for example by professionally conducted incineration, for example, in
5 order dispose of hazardous materials, for example.

According to another aspect, there is provided a method for operating a separator according to the above. With this method, very dense substances, which collect in
10 the drum interior in the region of the largest inside circumference, are concentrated during a clarification process of a product. The drum is then disintegrated after the processing of a batch - for example incinerated or melted down or, for example, dissolved
15 in an acid or the like - in order to produce the dense substance as a residue of this process.

If solid materials are densely compacted so that they cannot be discharged, or discharged only with great
20 difficulty, or clog or block the solid-material discharge holes, it is possible to release or to re-dilute the solid materials from time to time, or when necessary, via the discharge system (diverter and possibly holes in the drum cover) by short-term
25 flushing with a medium (water, clarified product, buffer solution) so that these solid materials can still be discharged via the emptying holes.

Further advantageous embodiments are to be gathered
30 from the remaining dependent claims.

The invention is described in more detail below based on exemplary embodiments with reference to the figures. In the drawing:

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Fig. 1 shows a view of a separator according to the invention with a direct drive and with a housing and drum shown in section.

5 Fig. 1 shows a section through the region of the housing 1 and the drum 2 of a separator according to the invention, by means of which a liquid product can be separated in the centrifugal field into two phases. The housing 1 has an (almost a hemispherical segment-
10 like) upper section 1a and a corresponding lower section 1b which in this case by way of example are connected by screws 1c to a flange section. The housing can consist of plastic or a plastic-composite material.

15 The drum 2 has a vertical rotational axis D and in this case is mounted on a driving - in a simple type of construction here -sleeve-like spindle construction 3 which is coupled directly, or via interposed
20 transmission elements, to a drive motor 4.

A particularly compact design is achieved if the drive motor is an electric motor 4 which is arranged directly in the axial extension of the spindle construction 3,
25 preferably on the side of the spindle construction 3 facing away from the drum.

In this case, the spindle 3 is connected axially to an output shaft 5 directly by a bolt 16. It is also
30 connected in a rotation-resistant manner in the circumferential direction to the output shaft 5 of the electric motor 4 by means of a torque transmission means, in this case a feather key 17. The torque transmission means can also be designed in another
35 form, for example as a torque transmitting contour (not shown here).

The rotatable drum 2 can be connected to the drive spindle construction 3 by a press fit (e.g. in a conical section) or by means of another torque transmission means (not shown here).

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In this case a separate bearing arrangement of the spindle construction 3 is preferably dispensed with, which makes the construction able to be realized in simple and relatively cost-effective manner. Instead, 10 the bearing arrangement of the output shaft 5 in the motor housing 6 of the electric motor 4 also serves, preferably directly, as the bearing arrangement of the entire rotor systems consisting of output shaft 5, spindle construction 3 and drum 2.

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The motor 3, on its side facing the spindle 3, is furthermore fastened on a flange section 18 of the housing 1 in this case, for example being screwed on by threaded bolts 40. The housing or the flange section 20 can in turn be fastened in a way not shown here - for example by a screw fastening - on a base or machine frame or the like, which is not shown here.

The drum 2 has a conical lower section 7 and a conical 25 upper section 8 so that altogether a double-cone body is formed. The drum lower section 7 and the drum upper section 8 are bolted together, preferably in the region of their largest circumference, by means of circumferentially distributed threaded bolts 9. The 30 connection could also be achieved in another way, however, for example by a type of bayonet joint between the two parts or by a screwed fastening in the form of a separate locking ring, similar to separators consisting of metal. Also conceivable would be a tri- 35 clamp connection (ring clamped by conical surfaces). Also conceivable would be a type of spring ring for securing the one drum section in the other.

Axially adjoining one part - in this case the lower part 10 - of the drum lower section 7 in one piece is a distribution attachment 11 which coaxially encompasses the rotational axis and forms a complete distributor for introducing the material to be centrifuged into the drum interior 15 and for accelerating the material to be centrifuged in the circumferential direction during rotations of the drum 2.

10 Formed in the distribution attachment 11, in the upper region, is a blind hole-like bore 12 into which opens a feed pipe 13. The feed pipe is sealed by its outside circumference against the inside circumference of the bore 12 by a first circumferential seal (e.g. an O-ring) 14.

The feed pipe 13 and the distribution attachment 11 form in such way a feed system which is preferably advantageously designed so that is sealed against the environment.

At its lower end, the bore 12 also opens into one or more distribution channels 19 which are formed at an angle to the rotational axis and in this case also open at an angle into the actual drum interior 15.

Arranged in the drum interior 15 are means for clarification such as especially a one-piece or preferably multi-piece plate packet 20 which is formed as a stack of axially spaced apart separating plates 20' which have a conical basic shape and which are preferably mounted in a rotation-resistant manner on the distribution attachment 11. The means for clarification could also be designed in another form, such as a finned body with radial or arc-shaped fins or as a clarification cartridge with clarifying chambers.

The separating plates 20' in this case preferably have different radii in each case, which is brought about by the conical basic shape of the drum lower section 7 because the separating plates 20' preferably extend
5 outward until just before the inner edge of the drum lower section 7 so that its diameter correspondingly reduces from the top downward.

A product introduced into the drum interior 15 is
10 separated in the drum 2 into different, preferably two, product phases of different density.

Serving for the discharging of the different product phases from the drum 2 is a discharge system with two
15 or more discharge regions.

In this way, a lighter liquid phase flows radially inward and in a channel 21 on the distribution attachment 11 is directed there axially upward into an
20 annular channel 22 which is formed between the outside circumference of the feed pipe 13 and a pipe section 23 of larger diameter which also projects into the drum 2 from the top.

25 A denser liquid phase (or a solid phase which is still not free flowing), on the other hand, is directed from the region of the largest inside circumference of the drum interior through a channel 25 in the drum upper section 8, in fact preferably into a second annular
30 channel 26 between the outer pipe section 23 and a drum cover 27 which preferably also consists of plastic.

The denser and the lighter liquid phases flow out of the annular channels 22, 26 towards the top in each
35 case into annuluses 28, 29, arranged axially one above the other, in annular bodies 30, 31 which are provided with radial discharge pipes 32, 33 through which the lighter and denser phases discharged from the drum can

be further discharged. Towards the top, an annular cover 34, with a through-hole 35 for introducing liquid into the feed pipe 13, is arranged on the annular body 33. The elements 30, 31, 34 also preferably consist of plastic.

A first ring seal 36 is arranged between the inner feed pipe and the annular body 31 or the cover 34. A further ring seal 37 is also arranged between the outer pipe section 23 and the annular body 31. Moreover, a further ring seal 38 is arranged between the cover 27 and the lower annular body.

The housing 1, the annular bodies 30, 31 and the cover 34 are compactly and reliably axially clamped together in this case in a simple manner by one or more bolts, especially threaded bolts 39.

The feed system and also the discharge system with the at least two discharges, and therefore the entire drum 2, are preferably of a hermetically sealed design, especially in the featured way or in another way, so that the product does not come into contact with the environment of the drum and is pressurized by the rotating system.

In this case, some, or preferably even all, of the product-contacting regions of the rotating system consist of plastic or a plastic-composite material, especially the drum lower section 7 and the drum upper section 8. The separating plates 20 especially preferably also consist of plastic as well as all of the product-contacting regions of the feed system and the discharge system, even if these do not rotate during operation.

It is also possible and advantageous, however, to produce the housing 1 from plastic or from a plastic-composite material.

- 5 In such way, the construction is very light and can be disposed of after the processing of a sufficiently large product batch.

10 Fig. 1 shows an embodiment as a two-phase separating machine (separation of a product into "liquid/liquid" phases), wherein the second liquid phase is discharged through the drum cover 8.

15 Three-phase machines (for separation into three phases) can also be realized (not shown here).

20 The entire drum 2, in addition to the feed system and discharge system and possibly a part of the housing 1 - the housing upper section 1a - is advantageously and simply designed as an exchangeable preassembled module consisting of plastic or a plastic-composite material.

List of designations

	Housing	1
5	Housing upper section	1a
	Housing lower section	1b
	Screws	1c
	Drum	2
10	Spindle	3
	Drive motor	4
	Output shaft	5
	Motor housing	6
	Drum lower section	7
15	Drum upper section	8
	Threaded bolt	9
	Section	10
	Attachment	11
	Bore	12
20	Sealing material	14
	Feed pipe	13
	Circumferential seal	14
	Drum interior	15
	Bolt	16
25	Feather key	17
	Flange section	18
	Distribution channels	19
	Plate packet	20
	Separating plates	20'
30	Channel	21
	Annular channel	22
	Pipe section	23
	Channel	25
	Annular channel	26
35	Drum cover	27
	Annuluses	28, 29
	Annular bodies	30, 31
	Discharge pipes	32, 33
	Cover	34

	Through-hole	35
	Ring seal	36
	Ring seal	37
	Ring seal	38
5	Threaded bolt	39
	Threaded bolt	40

Claims

1. A separator for the centrifugal separation of a free-flowing product into different phases or for the centrifugal clarification of a product, having at least the following features:
 - a. a rotatable drum with a lower section and an upper section,
 - b. a means arranged in the drum for the clarification of a product which is to be processed in the centrifugal field,
 - c. one or both of the following parts being of a conical design: the drum upper section and the drum lower section,
 - d. a plurality or all of the following elements consist of plastic or a plastic-composite material:
 - the drum lower section,
 - the drum upper section,
 - the means for clarification,wherein
 - e. the drum comprises a feed system and a discharge system, and the entire drum is designed in a sealed type of construction, and
 - f. at least one discharge channel for a dense product phase is integrated into the drum upper section.
2. The separator as claimed in claim 1, wherein the means for clarification is a plate packet consisting of a stack of separating plates.
3. The separator as claimed in claim 1 or 2, wherein the drum can be rotated by means of a spindle construction which consists of plastic or a plastic-composite material.

4. The separator as claimed in claim 3, wherein the spindle construction is coupled directly to the output shaft of a motor, and wherein the spindle construction has no rotational bearings on its outside circumference.
5. The separator as claimed in one of the preceding claims, wherein all the product-contact regions of the drum consist of plastic.
6. The separator as claimed in claim 1, wherein the drum is enclosed by a housing which consists of plastic.
7. The separator as claimed in claim 4, wherein the entire separator, apart from the motor, consists of plastic.
8. The separator as claimed in one of the preceding claims, wherein the drum lower section is provided directly in one piece with a distribution attachment which has distribution channels for transferring the product to be processed from a feed pipe into the drum interior.
9. The separator as claimed in claim 6, wherein the entire drum, in addition to the feed system and discharge system and possibly a part of the housing, is designed as an exchangeable preassembled module consisting of plastic or a plastic-composite material.
10. The separator as claimed in claim 4, wherein the entire separator, apart from the motor, is designed as an exchangeable preassembled module consisting of plastic or a plastic-composite material.
11. The separator as claimed in claim 4, wherein the motor is flanged directly onto the housing.

12. The separator as claimed in one of the preceding claims,
wherein the product-contacting sections of the
discharge system consist of plastic.
- 5 13. The separator as claimed in one of the preceding claims,
wherein the discharge regions of the discharge system
are designed as annular channels which open axially
into annuluses in annular bodies.
- 10 14. The separator as claimed in claim 13, wherein the
annular bodies consist of plastic or a plastic-
composite material.
- 15 15. The separator as claimed in one of the preceding claims,
wherein a drum cover consisting of plastic is mounted
on the drum upper section.
- 20 16. A use of a separator as claimed in claims 1 to 15 as a
disposable separator for the one-time processing of a
product batch.