

METHOD FOR MONITORING A CENTRIFUGAL SEPARATOR FOR DRUM LEAKAGE

5 The present invention relates to a method for monitoring a drum of a centrifugal separator for leakage.

When operating a disk centrifuge, it is advantageous to detect leaks, particularly in the area of the so-called main drum seal.

10 It is desirable to at least regularly check the drum interior for leaks. This ensures that the separator functions properly and improves overall operational safety.

Based on the aforementioned problem, it is the object of the present invention to provide a method for monitoring a drum leakage, in particular during operation and,
15 optionally, quantifying the extent of the leakage.

The present invention solves the aforementioned object by a method with the features of claim 1.

20 A method according to the invention for monitoring a drum of a centrifugal separator for leakage has the following steps:

A Providing the centrifugal separator comprising an emptied drum and
providing a value for a reference volume of the drum;

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Provision can either take place during commissioning or during ongoing operation of the separator by emptying the drum beforehand, as well as subsequent refilling and metrological recording of the feed volume and the pressure in a product discharge of the drum. In the case of commissioning, the provision of the reference volume can be
30 a predetermined design value, which is specified by the manufacturer for the type of separator. Step A is then followed by step B.

B Measuring, by means of a measuring device, an inflowing volume at least
until the reference volume of the drum is reached;

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In step B, the drum is filled. The inflowing volume, in particular the flushing medium, is recorded until the reference volume is reached. However, measurement is also carried out after the reference volume has been reached, wherein an increase in pressure is now also detected and evaluated by sensors.

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A flushing medium in the sense of the present invention can be any liquid without solids, e.g. displacement water or a product phase.

If the pressure rise does not occur exactly when the reference volume is reached, the determined feed volume can be recorded at the time the measured value of the pressure rise is recorded. A new reference volume for filling the drum can be determined and stored from this feed volume.

If, for example, the pressure then continues to rise until a constant overpressure is set at the outlet while the feed volume remains the same, this is a sign that the drum is tight. If no pressure rise is detected at the product outlet of an outgoing phase when the reference volume is reached or if a pressure rise is determined after the time of detection of reaching the reference volume, the volume runs out of the drum at another point. In other words, if the pressure rise is only observed later despite the reference volume being reached, the drum is leaking.

C Measuring a pressure by means of a pressure sensor in the outlet of a phase;

D Evaluating the temporal sequence of the measured values of the pressure after the reference volume has been reached, and thus determining a pressure rise;

and

E Outputting a signal if the determined pressure rise occurs outside of a time interval after the reference volume has been reached.

As can be seen from the above description, individual steps can be carried out at the same time as the respective subsequent steps or can merge directly into the subsequent steps.

Advantageous designs of the method are the subject matter of the subclaims.

The following steps can be used to provide the value for a reference volume of the drum, preferably when the separator is commissioned:

- I. Providing a centrifugal separator with a predefined reference volume depending on its geometric dimensions;

- II. Filling the drum and determining the volume of liquid required to fill the drum, which corresponds to the currently available free drum volume of the drum, until a limit level is reached.

5 The limit level can be determined, for example, by a pressure sensor or a limit level switch. Corresponding switches are known from process and measurement technology. They can be vibronic switches or capacitive switches, for example. However, the pressure sensor is preferred as it can also be used to determine the free drum volume, e.g. as an adapted reference volume, or to quantify the extent of
10 the leakage.

The pressure sensor and/or the level switch can be arranged in particular at the outlet of the heavier liquid phase or the clarified phase of the separator.

15 The liquid introduced to fill the drum is preferably a flushing medium, wherein a flushing medium inlet of the separator for filling the drum and a product inlet of the separator flow into a common inlet pipe.

The volume required to fill the drum can advantageously be determined using a flow
20 meter. For conductive media such as water, a magnetic-inductive flow meter is particularly suitable.

The flow meter can be arranged in or at the product inlet of the separator and/or particularly preferably in or at the flushing medium inlet.

25 If a signal is generated according to step E, the signal generates an output at an output unit, preferably a warning. Alternatively or additionally, an immediate action can be taken on the operation of the separator, in particular emptying and/or shutting down of the separator can be initiated to prevent further product loss due to leakage
30 and to protect the drum from wear.

Steps A-E can be repeated at least twice, in particular at regular intervals, wherein filling can take place in step B after the drum has been emptied.

35 At least steps B-E and preferably the entire process should be carried out with the drum rotating.

Another advantage of the method is that the measurement can be carried out online during the process without dismantling.

Further advantages, features and details of the invention are shown in the following description, in which an exemplary embodiment of the invention is explained in more detail with reference to the accompanying drawings. The person skilled in the art will
 5 also usefully consider the features disclosed in combination in the drawing, the description and the claims individually and combine them to form useful further combinations. In particular, there are a large number of possibilities for modifying and further developing these within the framework of the present invention, wherein:

- 10 Fig. 1 shows a perspective view of a separator according to the invention;
- Fig. 2 shows a sectional view of the separator according to the invention for carrying out the method according to the invention; and
- 15 Fig. 3 shows a schematic representation of the method sequence according to the invention.

The exemplary embodiment shown in Figs. 1 and 2 shows a separator 1 with a rotatably mounted drum 2, which has a technical drum volume as a predetermined
 20 reference volume.

This drum volume is determined from the dimension of the inner volume 12 of the drum 2, as well as superstructures arranged in the inner volume 12, such as the dimension and number of disks of a disk stack 3 and the distance between them.
 25 Furthermore, the size of the technical drum volume includes, among other things, the design of one or more feed areas 4, distribution areas 5, separating plates 6, paring chambers 7, paring disks 8, discharge areas 9 and the like. The above list is by no means exhaustive. Depending on the design, individual structures listed above can be omitted or replaced by other structures without changing the overall principle
 30 described below.

The separator 1 also has a product inlet 10 and a flushing medium inlet 11, which flow into a common inlet pipe 13, which in turn at least partially forms part of an inlet area 4 in the inner volume 12 of the drum 2.

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Furthermore, the separator 1 has a first outlet 14 for a light liquid phase, a second outlet 15 for a heavy liquid phase and a solids outlet 16 as part of a solids discharge system. The separator 1 is recognizably designed as a three-phase separator.

However, the following principle can also be applied to a two-phase separator, e.g. a clarifier.

- 5 The separator 1 shown in Figs. 1 and 2 has a respective pressure sensor 23 and 24 at the first and second outlet 14 and 15 of the liquid phases. These pressure sensors 23 and 24 typically enable process monitoring during the separation of a light and a heavy phase, such as the purification of water in oil.
- 10 Within the scope of the present invention, however, it is also possible to determine a reference volume and a leakage by means of the aforementioned sensors.

In addition, the separator 1 also has a control water inlet 22, which is provided for controlling the solids discharge or the solids emptying, e.g. by hydraulically actuated
 15 linear displacement of a piston slide as part of a solids emptying system. A water inlet 28 of the separator 1 branches into the two aforementioned water inlets 11 and 22. However, as already mentioned, the inlets 11 and 22 can also be led separately to the separator. There is therefore no restriction to the aforementioned configuration.

- 20 The supply of the quantity of flushing medium into the first flushing medium inlet 11 is controlled by a valve arrangement 29, in Fig. 2 specifically by valve 18. These can preferably be solenoid valves. Of course, the two valves 17 and 18 can also be combined in a multi-port valve, so that the valve arrangement 29 can also comprise just one valve.

25 The quantity and/or volume of flushing medium supplied through the flushing medium inlet 11 is determined by a corresponding measuring device 19, preferably a flow meter. In particular, this can be arranged in the flushing medium inlet 11.

- 30 The second outlet 15 for the heavy phase preferably also has a valve 20, preferably a solenoid valve.

The measured values determined by the measuring device 19, as well as the measured values of the pressure sensors 23 or 24, can be transmitted to a control
 35 and/or evaluation unit 21, which then controls the valves 17 and 18 for the control and flushing medium and the valve 20 for the heavy phase.

The aim of measuring the flow rate of flushing medium and the associated valve control is to determine an adjusted reference volume.

The determined reference volume can be compared with the initial reference volume specified by the manufacturer or the actual free volume (e.g. calculated from the geometry or determined in tests). The free drum volume (technical drum volume) depends on the machine type (size of the drum, number and spacing of the disks, etc.) and is stored in the machine control system. The degree of soiling of the drum can then also be determined from the comparison.

The determination of a leakage requires several steps, as shown in Fig. 3.

A first step 101 is to provide a separator with an empty drum and closed inlet and outlet. Depending on the design, an initial value for a reference volume or a reference pressure is available for the separator when the drum is filled for the first time.

During commissioning, the volume of the drum can be measured for the first time. For this purpose, after reaching the nominal speed, the drum is filled in step 102 until a defined pressure rise is detected at the pressure transmitter in one of the respective phases. The volume is stored in the drum as an adjusted reference volume. Flushing medium in particular can be used for filling. The drum is filled by opening the valve 18 until the gripper 8 dips into the water and the pressure at the pressure sensor 24 increases. In this way, the filling volume of liquid for filling the drum volume is determined by the measuring device 19, preferably a flow meter, in particular an EMF.

The determined drum volume can be saved as an adjusted reference value. If this newly determined reference value exceeds a limit level, for example 20% of a previously stored reference value, i.e. if the drum is 20% overfilled, an increase in pressure should typically be observed at the outlet of one of the phases at pressure sensor 24. If this is not the case, a drum leakage message is issued.

The centrifugal separator can then be operated continuously, e.g. to process a product. In continuous operation, the drum can be completely or partially emptied again in a third step 103 after a predefined time interval and the measurement can be carried out again by introducing flushing medium, analogous to step 102. The

inflowing volume is determined by the flow meter 19 and the reference volume can be adjusted again. The pressure sensor detects an increase in pressure.

5 Finally, in a fourth step 104, the feed volume is compared as a reference value against the current measurement with the flow sensor 19. If there is no pressure rise after the adjusted reference value of the drum volume is reached, a message 105 is issued regarding a leak.

10 If, for example, no pressure is displayed when filling to 20% above the reference volume, an error should be displayed immediately.

If the pressure rises, valve 18 can be opened again after 5 minutes, for example, and it is checked whether a pressure rise is immediately detected at pressure sensor 24. If this is not the case, a warning "Check drum seal" can be issued

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The measurement can therefore also be carried out at regular intervals while the separator is in operation. For this purpose, either a total emptying or several partial emptying operations are carried out. A pressure measurement can then be started as described above.

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List of reference signs

	1	Separator
	2	Drum
5	3	Disk stack
	4	Inlet area
	5	Distribution area
	6	Separation plate
	7	Gripper chamber light phase
10	8	Gripper chamber heavy phase
	9	Discharge area
	10	Product inlet
	11	First flushing medium inlet
	12	Inner volume
15	13	Inlet pipe
	14	First outlet (light phase)
	15	Second outlet (heavy phase)
	16	Solids outlet
	17	Valve
20	18	Valve
	19	Measuring device
	20	Valve
	21	Control and/or evaluation unit
	22	Control water inlet
25	23	Pressure sensor
	24	Pressure sensor
	25	Bypass tube
	26	Solids collection area
	27	Separator hood
30	28	Water inlet
	29	Valve arrangement
	101	First step (commissioning)
	102	Second step (first determination of a reference volume)
	103	Third step (repetition during operation)
35	104	Fourth step (comparison & output)
	105	Message

CLAIMS:

1. Method for monitoring a drum of a centrifugal separator (1) for leakage,
characterized by the following steps of:
 - 5 A providing the centrifugal separator (1) comprising an emptied drum and providing a value for a reference volume of the drum (2);
 - B measuring, by means of a measuring device (19), an inflowing volume at least until the reference volume of the drum (2) is reached;
 - 10 C measuring a pressure by means of a pressure sensor (24) in the outlet of a phase.
 - D evaluating the temporal sequence of the measured values of the pressure after the reference volume has been reached, and thus determining a pressure rise, and
 - 15 E outputting a signal if the determined pressure rise occurs outside of a time interval after the reference volume has been reached.

2. Method according to claim 1, **characterized in that** the provision of the value for a reference volume of the drum (2), preferably during commissioning of the separator, takes place in the following steps of:
 - 20 I. providing a centrifugal separator (1) with a predefined reference volume depending on its geometric dimensions;
 - II. filling the drum (2) and determining the volume of liquid required to fill the drum (2), which corresponds to the currently available free drum volume of the drum (2), until a limit level is reached.

- 25 3. Method according to claim 2, **characterized in that** the limit level for indicating the maximum filling of the drum (2) is detected by measurement by means of one or more pressure sensors (23, 24) and/or by a limit level switch in the outlet of a phase.

- 30 4. Method according to one of the preceding claims, **characterized in that** the pressure sensor (23, 24) and/or the limit level switch is arranged at the outlet (15) of the heavier liquid phase of the separator (1).

- 35 5. Method according to one of the preceding claims, **characterized in that** the liquid introduced for filling the drum is flushing medium, wherein a flushing medium inlet (11) of the separator (1) for filling the drum (2) and a product inlet (10) of the separator (1) open into a common inlet pipe (13).

6. Method according to one of the preceding claims, **characterized in that** the volume required to fill the drum (2) is determined by a flow meter (19).
- 5 7. Method according to one of the preceding claims, **characterized in that** the flow meter (19) is arranged in or at the product inlet (10) of the separator and/or particularly preferably in or at the flushing medium inlet (11).
- 10 8. Method according to one of the preceding claims, **characterized in that** the signal initiates an output at an output unit, preferably a warning, and/or performs an immediate action on the operation of the separator, in particular initiates emptying and/or a shutdown of the separator.
- 15 9. Method according to one of the preceding claims, **characterized in that** steps A-E are repeated at least twice, wherein in step B a partial or complete filling can take place after a partial or complete emptying of the drum.
- 20 10. Method according to one of the preceding claims, **characterized in that** at least steps B-E, preferably the entire method, are carried out while the separator is rotating.
11. Method according to one of the preceding claims, **characterized in that** the extent of the leakage is determined and output by evaluating the pressure rise and the volume supplied within a time interval.
- 25 12. Method according to one of the preceding claims, **characterized in that** the entire method is carried out without dismantling the separator, in particular the drum.