 CENTRIFUGAL SEPARATOR FOR SEPARATING PARTICLES FROM A GAS STREAM

Abstract: A centrifugal separator and a method (1) for separation of particles from a gas stream is disclosed. The separator comprises a frame (2), a gas inlet (3) and a gas outlet (4). A centrifugal rotor (5) is arranged to be rotatable in the frame around a rotational axis (x) and comprising a plurality of separation plates (6) defining separation passages (7) between the plates. A central gas chamber (8) in the rotor communicates with a radially inner portion of the separation passages and the gas outlet. A space (9) surrounding the rotor communicates with a radially outer portion of the separation passages and the gas inlet. A device (10) is configured to bring the gas stream in rotation upstream of the rotor. The centrifugal rotor is configured such that the rotational flow of the gas mixture drives the rotation of the centrifugal rotor for separating particles from the same gas stream being conducted from the space surrounding the rotor, through the separation passages between the plates and towards the central gas chamber.

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CENTRIFUGAL SEPARATOR FOR SEPARATING PARTICLES FROM A GAS STREAM

Technical field
The present invention relates generally to a centrifugal separator and a method for separation of particles from a gas stream.

Background
WO 2010/090578 A1 discloses a centrifugal separator plant for separating oil in form of particles and/or mist from a fossil gas mixture for obtaining a separated gas. The plant comprises a centrifugal separator with a stationary casing defining a separation space. The centrifugal separator comprises an inlet for the gas mixture, a gas outlet for the separated gas and an oil outlet for discharging separated oil. A separating member for separating the gas mixture comprises a plurality of separating discs and is provided in the separation space. A drive motor is connected to the separating member via a spindle and rotates the separating member about an axis of rotation.

Summary
An object of the present invention is to simplify the construction and operation of a centrifugal separator for separation of particles from a gas stream, such as the type of centrifugal separator disclosed in the background art. Another object is to reduce the cost of this type of centrifugal separator. It is also an object to reduce the pressure drop over the centrifugal separator.

Thus the present invention relates to a centrifugal separator for separation of particles from a gas stream. Particles are defined as solid and/or liquid particles, such as oil droplets or oil mist. The centrifugal separator comprises a frame, a gas inlet and a gas outlet. A centrifugal rotor is arranged to be rotatable in the frame around a rotational axis and comprises a plurality of separation plates, such as frustoconical separation discs or axial plates, defining separation passages between the plates. A central gas chamber is formed in the rotor and communicates with a radially inner portion of the separation passages and the gas outlet. A space surrounding the rotor communicates with a radially outer portion of the separation passages and the gas inlet. The centrifugal separator further comprises a device configured to bring the gas stream in rotation upstream of the rotor, and the centrifugal rotor is further configured such that the rotational flow of the gas mixture drives the rotation of the centrifugal rotor for separating particles from the same gas stream.
gas stream being conducted from the space surrounding the rotor, through the separation passages between the plates and towards the central gas chamber.

Thus the centrifugal rotor is brought into rotation by the rotational flow of the gas stream, whereby the centrifugal separator may be independent on a separate drive motor to drive the rotor. Thereby the construction of the separator may be simplified, the cost may be reduced and the need for service and maintenance of the separator may be decreased. Since the rotor is driven in rotation by the rotational flow of the gas, the rotational speed of the rotor is similar to the rotational speed of the gas entering into the separation passages. This is particularly beneficial since it reduces the pressure drop over the separator. Further, since the rotating gas stream is led from the radially outer portions of the separation passages and towards the radially inner portions of the separation passages, the gas stream is spun up thanks to the conservation of angular momentum. Thus the transfer of the rotation from the gas to the rotor, such as by viscous forces, is particularly efficient. The centrifugal rotor may preferably be configured such that the rotational flow of the gas mixture alone drives the rotation of the centrifugal rotor for separating particles from the same gas stream, whereby the centrifugal rotor is not driven by a motor connected to the rotor.

The device configured to bring the gas stream in rotation may preferably be disengaged from the rotor, such that the rotor may rotate independently of the device configured to bring the gas stream in rotation.

The device configured to bring the gas stream in rotation may be stationary or at least non-rotating during operation of the apparatus. The device configured to bring the gas stream in rotation may comprise a gas deflecting member connected to the frame, configured to bring the gas stream in rotation by deflecting the gas stream towards a tangential direction of the centrifugal rotor. The gas deflecting member may comprise at least one, preferably a plurality of vanes inclined with respect to the axial direction of the centrifugal rotor and distributed around the rotational axis. The vanes may preferably be arranged at a large radius of the centrifugal separator with respect to the rotational axis, such extending radially outside the separation plates of the rotor or at a radial position close to or radially outside the radially outer portions of the separation passages. Thus a pre-separation of particles from the gas stream may be performed in the rotating gas in the space radially outside the separation plates. The inclination of the vanes with respect to the axial direction of the centrifugal rotor may increase gradually along the extent of the
vanes in the direction of the flow of the gas stream from the gas inlet to the gas outlet to provide smooth acceleration of the gas stream into rotation. Thus the rotational flow of the gas stream may be provided efficiently by a robust and uncomplicated construction which may be fitted close to the rotor and provided in line with the centrifugal rotor and which makes use of the momentum of the gas stream to provide the rotational flow.

The inclination of the vanes with respect to the axial direction of the centrifugal rotor may be adjusted during operation of the separator such that to control the rotational speed of the gas stream. Thus the rotation of the centrifugal rotor may be controlled by adjusting the inclination of the vanes. In particular, the rotational speed of the rotor may be limited by limiting the rotational speed of the gas stream in the vessel.

The gas inlet may be arranged at an angle to the rotational axis of the centrifugal rotor, wherein the angle is within the range of 70-1 10 degrees, preferably 80-1 00 degrees, more preferably 90 degrees, and wherein the device configured to bring the gas stream in rotation upstream of the rotor comprises an inlet gas deflecting member which is arranged to deflect the gas stream from the gas inlet towards a tangential direction of the centrifugal rotor. Thus the rotational flow of the gas stream may be provided while connecting the gas inlet at an angle close to 90 degrees to the vessel wherein the centrifugal separator is arranged. Thereby the connection may be configured to withstand high pressure in the vessel, while the gas deflecting member causes the rotational flow of the gas stream.

The gas inlet may alternatively be arranged in line with the rotational axis of the centrifugal rotor, and the device configured to bring the gas stream in rotation upstream of the rotor may comprise an inlet gas deflecting member which is arranged to deflect the gas stream from a direction along the rotational axis towards a tangential direction of the centrifugal rotor.

The inlet gas deflecting member may be arranged upstream of the gas deflecting member, to provide a pre-separation of particles from the gas stream such that in the form of a cyclonic separator.

The position or inclination of the inlet gas deflecting member may be adjusted during operation of the separator such that to control the rotational speed of the gas stream.

Thus the rotation of the centrifugal rotor may be controlled by adjusting the inclination of the inlet gas deflecting member.
The device configured to bring the gas stream in rotation may comprise a rotating fan arranged upstream of the rotor.

The rotor may have a first and a second axial end portion, and the rotor may be rotatably supported in the frame by means of a first bearing at the first axial end portion and a second bearing at the second axial end portion. Thus a more stable rotor construction may be achieved.

The frame may be configured to be mountable inside a vessel for guiding the gas stream, and may comprise a first partition for dividing the vessel into a first section upstream of the first partition and a second section downstream of the first partition, wherein the gas inlet is communicating with first section, the gas outlet is communicating with second section, and wherein the centrifugal separator is configured such that the first and second sections communicate via the separation passages of the rotor. A seal may be provided between the first partition and the centrifugal rotor. The seal may be a gap sealing the form of a narrow passage. Thus the gas stream is forced into the separation passages when flowing from the first section to the second section.

The vessel may be configured to permit a pressure of at least 10 bars in the gas stream guided by the vessel. The centrifugal separator may comprise a portion of the vessel. In such a vessel the centrifugal separator is particularly beneficial since the separator may be operated inside the vessel without any major modifications to the vessel, such as electrical or mechanical components or connectors led through the vessel wall.

The frame may be a self-supporting frame for mounting inside an existing vessel for guiding the gas stream, and wherein the frame comprising a holding means to hold the frame at a position inside the vessel. Thus the centrifugal separator may be fitted in existing vessel systems, such as pipelines for transporting gas or air ducts and the like.

This is beneficial since the vessel system does not need to be reconstructed for mounting the centrifugal separator, and the vessel system may be maintained and optimized to withstand high pressures and/or the installation may be simplified. The frame may be configured to be releasably mountable in an existing vessel for guiding the gas stream.

The frame may comprise a passage upstream of the rotor, wherein the device configured to bring the gas stream in rotation is arranged in the passage. A flow directing element may be provided upstream of the passage to direct the gas stream into the passage. Thus
the flow of the gas stream may be efficiently forced into the device configured to bring the

gas stream in rotation.

The plurality of separation plates may comprise a stack of frustoconical separation discs
provided at mutual distances from one another, defining the separation passages between
the discs and wherein each separation disc is provided with distance members extending
from a radially inner portion of the separation disc to a radially outer portion of the
separation disc to define the separation passages between the discs of the stack of
frustoconical separation discs. Thus the rotation of the gas stream may efficiently be
transferred to a rotation of the rotor upon spinning up of the rotating gas in the separation
passages. The distance members may increase the efficiency by providing a function as
vanes transferring rotational momentum from the gas to the rotor. The distance members
may alternatively or additionally comprise distance members in the form of dot-shaped
caulks or microcaulks, distributed over the surface of the separation discs.

The separation plates may be formed in polymeric material or in metal, such as stainless
steel.

The centrifugal separator may be configured to provide the rotor with a rotational speed in
the range of 100-1 000 rpm, preferably 1000-3000 rpm, during operation of the device
and driven by the rotational flow of the gas stream. The separation is efficient even at
relatively low rotational speeds.

The invention further relates to a method of separating particles from a gas stream, the
method comprising providing a centrifugal rotor arranged to be rotatable around a
rotational axis and comprising a plurality of separation plates defining separation
passages between the plates, a central gas chamber in the rotor communicating with a
radially inner portion of the separation passages and the gas outlet, a space surrounding
the rotor and communicating with a radially outer portion of the separation passages and
the gas inlet, bringing a gas stream in rotation upstream of the rotor, and rotating the rotor
by the rotational flow of the gas stream for separating particles from the gas stream.

The gas stream may be a stream of fossil gas, natural gas, biogas, exhaust gas,
ventilation gas, crankcase gas, carbon dioxide (C\textsubscript{2}O\textsubscript{2}), hydrogen sulfide (H\textsubscript{2}S), etc.

The invention further relates to the use of a centrifugal separator as disclosed for
separation of particles, such as solid or liquid particles from a stream of gas, such as a
stream of fossil gas, natural gas, biogas, exhaust gas, ventilation gas, crankcase gas, carbon dioxide (CO$_2$), hydrogen sulfide (H$_2$S), etc, and/or applied to positions in gas compression, amine processes, Shell Claus off-gas treating (SCOT) processes, in exhaust gas scrubbing and the like.

5 The invention further relates to the use of a centrifugal separator as disclosed for separation of particles, such as solid or liquid particles from a stream of gas in a pressure vessel, which vessel may be configured to permit a pressure of at least 10 bars in the gas stream guided by the vessel.

Brief description of drawings

10 The invention is now described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 shows a cross-section along the rotational axis of a centrifugal separator according to the invention, arranged in a cylindrical vessel for conveying a gas stream.

Fig. 2 shows a partially cut-out perspective view of a rotor of such a centrifugal separator.

Fig. 3 shows an axial cross-section of a holding means with frustoconical slotted disc.

Fig. 4 shows a perspective view of a device configured to bring the gas stream in rotation.

Fig. 5 shows a cross-section perpendicular to the rotational axis of a device configured to bring the gas stream in rotation according to another embodiment.

Description of embodiments

20 In Fig. 1 a centrifugal separator for separation of particles from a gas stream is shown arranged in a cylindrical vessel 19 in the form of a cylindrical pipe for guiding the gas stream. The separator comprises a self-supporting frame 2 for mounting inside the vessel 19. Self-supporting is understood as an ability of the frame to support itself without relying on support from the vessel such as during mounting and dismounting. The frame is provided with a first partition 15 for dividing the vessel into a first section 16 upstream of the partition and a second section 17 downstream of the partition. The separator further comprises a gas inlet 3 communicating with the first section and a gas outlet 4 communicating with the second section.
The centrifugal separator further comprises a centrifugal rotor 5 arranged to be rotatable in the frame around a rotational axis x. The rotational axis extends in the direction of the extension of the vessel. The rotor comprises a shaft 26 having a first and a second end portion. The first end portion is supported in a first frame portion 15a by means of a first bearing 13. The first frame portion 15a comprises the first partition 15. The second end portion is supported in the frame by means of a second bearing 14 held in a second frame portion 21. With reference to Fig. 2, the rotor is described in more detail. The rotor comprises a disc support structure 27 connected to the rotor axis and extending between the first and second end portions of the rotor axis. The disc support structure has three plate like wings extending along the rotor axis and radially outwards from the rotor axis. In an alternative embodiment the disc support structure comprises two or more wings, such as six wings. Towards the second end portion of the rotor axis, a bottom disc 28 is attached to the wings of the disc support structure. On the bottom disc, and guided by the radially outer portions of the plate like wings, a plurality of frustoconical separation discs 6 are stacked. The separation discs may be made of a lightweight material such as plastic, or of metal such as stainless steel. The separation discs are each provided with distance members in order to provide separation passages 7 between the discs in the stack. The distance members are in the form of elongated protrusions extending from a radially inner portion to a radially outer portion of each separation disc, having an extension along a line or a curve. The elongated distance members, or caulks, may be straight or curved and may be integrated in the discs or attached to the discs. The distance members may alternatively or additionally comprise distance members in the form of dot-shaped caulks or microcaulks, distributed over the surface of the separation discs. On top of the stack of separation discs a top disc 29 is provided. The top disc is attached to the wings of the disc support structure. The stack of separation discs are compressed by the top disc and the bottom disc. Radially inside the separation discs a central gas space 8 is formed, divided into three parts by the wings of the disc support structure 27. The top disc is provided with a central opening 30 such that the central gas space of the rotor is open for passage of gas through the top disc. The top disc is provided with a flange 31 circumventing the central opening providing a cylindrical outer sealing surface, 18a.

Again turning to Fig. 1, a narrow gap is formed between a sealing surface 18a formed on the flange 31 of the top disc and a corresponding cylindrical sealing surface 18b on the first partition. The gap forms a gap sealing 18 between the first 16 and second 17 sections in the vessel. The central gas chamber 8 in the rotor communicates with a radially inner portion of the separation passages 7 and the gas outlet 4 via the central opening of the
top disc and openings 32 formed in the first partition, surrounding the first bearing 13. Further, a space 9 is formed radially outside and surrounding the rotor. The space 9 surrounding the rotor communicates with the radially outer portion of the separation passages 7 and the gas inlet 3. The centrifugal separator is configured such that the first and second sections of the vessel communicate via the separation passages 7 of the rotor.

The frame comprises a bottom sealing ring 33 forming the gas inlet 3 in the frame. The bottom sealing ring is sealingly connected, 38, to the inner vessel wall 25. A cylindrical frame tube 24 extends along the inner wall of the vessel as a part of the frame, from the bottom sealing ring to the first partition 15 and connects with the other parts of the frame to provide a self-supporting frame structure. The second frame portion 21 supporting the second bearing 14 is connected to and supported by the inner wall of the cylindrical frame tube.

The frame 2 further comprises a holding means 20 to hold the frame at a position inside the vessel. The holding means comprises in a ring shaped part 34 sealingly connected, by means of a sealing member 37, to the inner vessel wall 25. The holding means is configured to engage with the cylindrical inner surface of the vessel by providing an expandable outer diameter. With reference to Fig. 3, the holding means is described in more detail. The ring shaped part 34 is connected to the first partition 18 by a plurality of bolts 35 distributed around the circumference of the ring shaped part 34. The holding means comprises one or more radially slotted frustoconical discs 36 mounted such that compression of the disc by tightening the bolts of the ring shaped part causes slotted radially outer portions 36a of the disc to expand and engage with the cylindrical inner surface of the vessel. Thus the expandable outer diameter is realized by a by tightening the compressive bolts 35.

Again with reference to Fig. 1, the centrifugal separator comprises a stationary device 10 configured to bring the gas stream in rotation. The device 10 configured to bring the gas stream in rotation is positioned upstream of the rotor and formed in the second frame portion 21. The device 10 comprises a ring shaped gas deflecting member 11 comprising a plurality of vanes 12 which are inclined with respect to the axial direction x of the centrifugal rotor and distributed around the rotational axis. The vanes are arranged in a passage 11a formed in the second frame portion upstream of the rotor. The passage 11a extends radially outside the separation plates of the centrifugal rotor. With reference to
Fig. 4, the device 10 configured to bring the gas stream in rotation is shown in further
detail. The device 10 comprises a ring shaped gas deflecting member 11 comprising a
plurality of vanes 12 extending outwardly from the ring shaped member and distributed
around the rotational axis of the rotor. The vanes are inclined with respect to the axial
direction of the rotor, which inclination is gradually increased along the length of the vanes
in the direction of the flowing gas.

According to one embodiment, the vanes may be movable/or and the inclination of the
vanes may be adjusted during operation in order to control the speed of rotation of the gas
stream.

In addition to, or as an alternative to what is shown in Fig. 4, the gas inlet 3 upstream of
the centrifugal rotor may be arranged at a right angle to the rotational axis of the
centrifugal rotor, as shown in Fig. 5. This figure shows a cross-section of the vessel,
perpendicular to the rotational axis of the rotor, at the inlet side of the centrifugal
separator. It is preferred to connect external pipe connections at right angles in order to
withstand high pressure in the vessel. In this embodiment, the device 10 configured to
bring the gas stream in rotation upstream of the rotor comprises an inlet gas deflecting
member 11' which is arranged to deflect the gas stream from the gas inlet towards a
tangential direction of the centrifugal rotor. The inlet gas deflecting member 11' may be
stationary or pivotally connected to the vessel 19 and may be slanted or bent such that
gas flowing through the inlet 3 is deflected towards a tangential direction of the centrifugal
rotor, thus achieving a rotational flow of the gas stream in the vessel. The position or
inclusion of the deflecting member may be adjusted during operation of the separator
such that to control the rotational speed of the gas stream. As shown, this may be
achieved by the inlet gas deflecting member 11' being pivotally connected to the vessel at
a point 39, and biased towards an initial position by means of a spring 40. The spring may
be integrated with the inlet gas deflecting member at the pivot point or connecting the inlet
gas deflecting member to another point of the vessel. At an increasing flow of gas the inlet
gas deflecting member is deflected by the gas flow, which may result in a limitation of the
speed of rotation of the gas in the vessel.

With reference to Fig. 1, the separator is mounted in the vessel 19 by placing the
separator with its self-supporting frame 2 inside the vessel, at a desired position inside the
vessel, and expanding the diameter of the holding means 20 so that the holding means
engage with the inner surface 25 of the vessel, to hold the separator at the desired position inside the vessel.

During operation of the centrifugal separator a stream of gas enters into the inlet 3 of the centrifugal separator 1. The stream of gas is forced into the passage 11a where the inclined vanes 12 deflect the gas towards a tangential direction of the rotor of the separator. Thus the gas stream is brought into rotation by the vanes 12, and enters into the space 9 surrounding the rotor 5. In this space a pre-separation occurs whereas larger particles in the form of solid particles and/or liquid droplets having a density larger than the gas in the gas stream are separated from the gas stream by means of centrifugal forces in the rotating gas stream and deposited on the inner surface of the cylinder 24.

From the space 9 surrounding the rotor, the rotating gas stream enters into the separation passages 7 formed between the separation discs 6 in the rotor. The rotor 5 is brought into rotation by the rotating gas stream by means of viscous forces acting on the separation discs in the separation passages. The rotation of the rotor is also facilitated by the elongated distance members of the disc stack working as vanes or turbine blades to improve the transfer of momentum from the gas stream to the rotor. Since the rotating gas stream is led from the radially outer portions of the separation passages and towards the radially inner portions of the separation passages, the gas stream is spun up thanks to the conservation of angular momentum. Thus the transfer of the rotation from the gas to the rotor is particularly efficient in this configuration.

In the separation passages, particles in the form of solid particles and/or liquid droplets having a density larger than the gas in the gas stream are separated from the gas stream by centrifugal forces. Due to the smaller separation distances in the separation passages of the stack of frustoconical discs this even allows for separation of smaller and/or less dense particles from the gas stream. Particles separated from the gas stream are deposited on the inner surface of the frustoconical separation discs and transported radially outwardly by means of centrifugal forces. From the radially outer edge of the separation discs, particles separated from the gas stream in the separation passages are thrown towards and deposited at the inner surface of the cylinder 24.

Thus the rotational flow of the gas mixture alone drives the rotation of the centrifugal rotor, without a drive motor driving the rotor. The resulting rotation causes separation of particles from the same gas stream. Cleaned gas conducted towards the central gas
chamber 8 of the rotor is provided to the outlet 4 through the passages 30 and 32 formed in the rotor and the first partition, and transported from the separator through the vessel.
CLAIMS

1. A centrifugal separator (1) for separation of particles from a gas stream, comprising
a frame (2), a gas inlet (3) and a gas outlet (4),
a centrifugal rotor (5) arranged to be rotatable in the frame around a rotational axis (x) and comprising a plurality of separation plates (6) defining separation passages (7) between the plates,
a central gas chamber (8) in the rotor communicating with a radially inner portion of the separation passages and the gas outlet,
a space (9) surrounding the rotor and communicating with a radially outer portion of the separation passages and the gas inlet,
a device (10) configured to bring the gas stream in rotation upstream of the rotor, and wherein the centrifugal rotor is configured such that the rotational flow of the gas mixture drives the rotation of the centrifugal rotor for separating particles from the same gas stream being conducted from the space surrounding the rotor, through the separation passages between the plates and towards the central gas chamber.

2. The centrifugal separator according to claim 1 wherein the device configured to bring the gas stream in rotation is stationary or at least non-rotating during operation of the apparatus.

3. The centrifugal separator according to any one of the preceding claims wherein the device configured to bring the gas stream in rotation comprises a gas deflecting member (11) connected to the frame, configured to bring the gas stream in rotation by deflecting the gas stream towards a tangential direction of the centrifugal rotor.

4. The centrifugal separator according to claim 3 wherein the gas deflecting member comprises at least one, preferably a plurality of vanes (12) inclined with respect to the axial direction of the centrifugal rotor and distributed around the rotational axis.

5. The centrifugal separator according to claim 4 wherein the at least one vane extends radially outside the separation plates of the rotor.

6. The centrifugal separator according to claim 4 or 5 wherein the inclination of the vanes with respect to the axial direction of the centrifugal rotor increases gradually along
the extent of the vanes in the direction of the flow of the gas stream from the gas inlet to
the gas outlet.

7. The centrifugal separator according to any one of the claims 4-6 wherein the
inclination of the vanes may be adjusted during operation of the separator such that to
control the rotational speed of the gas stream.

8. The centrifugal separator according to any one of the preceding claims wherein
the gas inlet is arranged at an angle to the rotational axis of the centrifugal rotor, wherein
the angle is within the range of 70-1 10 degrees, preferably 80-1 00 degrees, more
preferably 90 degrees, and wherein the device (10) configured to bring the gas stream in
rotation upstream of the rotor comprises an inlet gas deflecting member which is arranged
to deflect the gas stream from the gas inlet towards a tangential direction of the centrifugal
rotor.

9. The centrifugal separator according to claim 8 wherein the position or inclination
of the deflecting member may be adjusted during operation of the separator such that to
control the rotational speed of the gas stream and thus the rotor.

10. The centrifugal separator according to any one of the preceding claims wherein
the rotor has a first and a second axial end portion, and wherein the rotor is rotatably
supported in the frame by means of a first bearing (13) at the first axial end portion and a
second bearing (14) at the second axial end portion.

11. The centrifugal separator according to any one of the preceding claims wherein
the frame is configured to be mountable inside a vessel (19) for guiding the gas stream,
and comprises a first partition (15) for dividing the vessel into a first section (16) upstream
of the first partition and a second section (17) downstream of the first partition, wherein
the gas inlet is communicating with first section, the gas outlet is communicating with
second section, and wherein the centrifugal separator is configured such that the first and
second sections communicate via the separation passages of the rotor.

12. The centrifugal separator according to claim 11 wherein a seal (18) is provided
between the first partition and the centrifugal rotor.

13. The centrifugal separator according to claim 11 or 12 wherein the frame is a
self-supporting frame for mounting inside an existing vessel (19) for guiding the gas
stream, and wherein the frame comprising a holding means (20) to hold the frame at a
position inside the vessel.

14. The centrifugal separator according to any one of claims 11 to 13 wherein the
frame comprises a passage (11a) upstream of the rotor, and wherein the device
configured to bring the gas stream in rotation is arranged in the passage.

15. The centrifugal separator according to any one of the preceding claims wherein
the plurality of separation plates comprises a stack of frustoconical separation discs
provided at mutual distances from one another, defining the separation passages between
the discs and wherein each separation disc is provided with distance members extending
from a radially inner portion of the separation disc to a radially outer portion of the
separation disc to define the separation passages between the discs of the stack of
frustoconical separation discs

16. A method of separating particles from a gas stream, the method comprising
- providing a centrifugal rotor arranged to be rotatable around a rotational axis
(x) and comprising a plurality of separation plates defining separation passages between
the plates, a central gas chamber in the rotor communicating with a radially inner portion
of the separation passages and the gas outlet, a space surrounding the rotor and
communicating with a radially outer portion of the separation passages and the gas inlet;
- bringing a gas stream in rotation upstream of the rotor, and
- rotating the rotor by the rotational flow of the gas stream for separating
particles from the gas stream.
A. CLASSIFICATION OF SUBJECT MATTER

INV. B01D45/14 B04B5/12 B04B7/02 B04B9/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B01D B04B B04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search: 17 February 2014

Date of mailing of the international search report: 26/02/2014

Authorized officer: Desi ttere, Michiel
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