

### Apparatus for Conditioning of Gases

The invention relates to an apparatus for the conditioning of gases, in particular of sealing gas, comprising a separator unit for separating liquids and/or particles from the gas flowing through the apparatus, and comprising a collecting container for the trapped substances.

Apparatuses of this kind are prior art. One area of application of such apparatuses is the conditioning of sealing gas. When handling corrosive process gases, for example, during pumping using turbo compressors, there is the known risk of sensitive parts of the pump, bearing points and/or sealing systems being attacked due to solid particles along with moisture present in the associated process gas. To counter this risk, sensitive parts, for example, the bearing points, must be protected by sealing gas in the form of a continuous flow of inert gas, the inert gas flowing over the parts of the system to be protected. An appropriate inert gas may be dry nitrogen. During operation, the pressure of the sealing gas should be higher (for example, approximately 3 bar) than the process gas pressure, so that no process gas is able to pass into the atmosphere. In view of the usually high pressure of the process gas, frequently greater than 100 bar, the gas conditioning apparatus must be designed up to a high pressure level.

Based on this prior art, the stated object of the invention is to provide an apparatus for the conditioning of gases, which is low-maintenance and, therefore, cost-effective to operate, and which is distinguished by an efficient separation effect.

The object is achieved according to the invention by an apparatus, which includes the features of patent Claim 1 in its entirety.

Accordingly, an essential particular feature of the invention is that the separator unit  
5 includes a cyclone separator. By using a cyclone separator, a largely maintenance-free operation of the apparatus with highly efficient separation is feasible, making the apparatus cost-effective and efficient to operate.

According to another aspect of the invention, the stated object is achieved by an  
10 apparatus which includes the features of patent Claim 2 in its entirety.

Accordingly, the invention is distinguished by the fact that the separator unit is mounted on the collecting container as a discrete, replaceable unit through which gas is able to flow. Adaptation to individual process conditions, such as type of gas, type of stresses  
15 caused by moisture and solid particles, by flow-through rates and the like, requires that only the separator unit be changed, while the collecting container together with the auxiliary equipment normally associated with it may remain in place. In view of the high pressure level of, for example, greater than 100 bar, and the corresponding complex, pressure-resistant construction, the potential for using the same collecting container  
20 with associated equipment, such as fittings and the like, under changing operating conditions is of great economic significance.

The separator unit may be advantageously mounted on the top of the collecting container and may be connected to the latter via an inlet opening of the collecting  
25 container.

With respect to the cyclone separator, it is possible to advantageously arrange it so that the former includes a cyclone housing, on which an inflow opening is disposed such that the gas flow within the housing forms a swirl flow about the vertical axis thereof, an  
30 outflow unit having an outflow channel extending upward coaxially relative to the vertical

axis being provided on the cyclone housing.

For an outflow connection situated on the side of the cyclone housing, it is possible to alternatively configure the outflow unit in such a way that the outflow channel includes a  
5 section, which is connected to its initial vertical section and which extends horizontally to the inflow connection located on the side.

Thus, apparatuses adapted to different process conditions, in each case with an identical collecting container, may be implemented in the form of a modular system, by  
10 appropriately replacing the cyclone housing on the collecting container and/or, if needed, by equipping the cyclone housing with an outflow unit, which is designed for an outflow connection situated on the top, or for an outflow connection located on the side.

In particularly advantageous exemplary embodiments, the apparatus includes a gas  
15 cooler in the flow path of the gas flowing toward the separator unit. This opens up the possibility during operation of the apparatus of cooling the particular gas to a temperature below the dew point, for example, to a temperature of 10° K below the dew point, in order to form condensate from the vaporous phase for separation with the aid of the cyclone.

20 Preferably, a controllable outlet device for trapped fluid is provided at the bottom of the collecting container. In this case, it is possible to arrange for the outlet device to be manually controllable, for example, by means of a needle valve or ball cock provided at the particular outlet connection.

25 In advantageous exemplary embodiments, a sensor device which detects the fill level of trapped fluid may be attached to the collecting container. Such exemplary embodiments offer the possibility of providing an outlet device controllable in response to a signal of the sensor device, so that the system may be designed for automatic operation over  
30 longer operating periods.

Instead of a manually controllable outlet device or an outlet device or an outlet device controllable by a signal of the sensor device, an outlet device may also be provided for an automatic operation, which is controllable by a float situated in the collecting  
5 container.

The invention is described in detail below with reference to exemplary embodiments depicted in the drawing, in which:

10 — Figure 1 shows a perspective diagonal view of an exemplary embodiment of the apparatus according to the invention;

Figure 2 shows a longitudinal section of the collecting container with associated subcomponents of the exemplary embodiment of Figure 1 reduced by  
15 approximately a factor of eight in the drawing in relation to a practical embodiment;

Figure 3 shows a longitudinal section similar to Figure 2 of a modified exemplary embodiment, and  
20

Figure 4 shows a truncated longitudinal section of just the bottom area of a further modified exemplary embodiment of the apparatus according to the invention.

25 In Figure 1, a collecting container is identified by 1 and a removable cyclone separator mounted on the top thereof is identified by 3. Situated on the cyclone housing 5, shown in greater details in Figure 2, is an inflow connection 7 for the entry of the gas to be conditioned, and an outflow connection 9. The collecting container 1 is in the shape of a hollow cylinder having a vertical axis 11, which is closed at its top 13 located above in  
30 the drawing up to an inlet opening 15. The lower end is tightly sealed by a bottom piece

17. Collecting container 1 together with the bottom piece 17 exhibit a correspondingly high wall strength 1, for forming a pressure container for a high pressure level of greater than 100 bar.

5 As is most clearly seen in Figure 1, multiple connections, each provided with a connecting flange 19 and a needle valve 21, are situated on the collecting container 1, of which an outlet connection 23 and a sensor connection 25 are visible in Figure 2 in the area of the bottom piece 17. A second sensor connection 27 is situated vertically above the bottom sensor connection 25. Both sensor connections 25, 27 are connected  
10 to a sensor device 29, which, together with the interior space of the collecting container 1, form a type of communicating pipe. To detect the fill level in the collecting container 1, the sensor device 21 includes a device of a known type for contactlessly indicating the position of an element situated in the sensor tube, for example, a float having permanent magnetic or ferromagnetic components.

15 Apart from the connections visible in Figures 2 and 3, a ventilation connection 31 and a second outlet connection 33 situated at the bottom are provided on the collecting container 1, as shown in Figure 1, at the level of the upper sensor connection 27. Of the two outlet connections 23 and 33, the outlet connection 23 is provided for an  
20 automatically controlled outlet of substances trapped in the collecting container 1, whereas the second outlet connection 33 is provided for a manually controlled release by activating the associated needle valve 21.

As shown in Figures 2 and 3, the cyclone separator 3 with its cyclone housing 5 in the  
25 two exemplary embodiments shown in these figures, is removably mounted on the top 13 of the collecting container 1 by means of screws 35. Thus, depending on the conditions, separators of desired cyclone size and/or design may be mounted on the collecting container 1. As is conventional in the case of cyclone separators 3, the cyclone housing 5 includes an acceleration cone 39 at the lower end of the inlet cylinder  
30 37, which extends at the transition between housing 5 and the top 13 of the collecting

container 1 into the inlet opening 15 thereof and, therefore, into the interior space thereof. Due to the tapering of the cone 39, the rotational speed of the swirl flow generated by the flow of gas via the inflow opening 41 of the inlet connection 7 in the inlet cylinder 37 is accelerated in such a way that non-gaseous substances, such as fluids and/or particles, are flung against the wall of the cone 39, and decelerated to the point that they detach from the flow and migrate downward into the collecting container 1.

As shown in Figures 2 and 3, the acceleration cone 39 is formed in a plug 43. Thus, if needed, it is possible not only to replace the cyclone separator 3 with the cyclone housing 5, but, if needed, to also switch the plug 43, if another size and/or shape of the cone 39 is appropriate. Attached to the top of the cyclone housing 5, also replaceable, is an outflow unit 45. This unit has an outflow channel 47 as an immersion pipe extending coaxially relative to the vertical axis 11 in the inlet cylinder 37, which in the exemplary embodiment of Figure 2 runs in a straight line along axis 11 to the outflow connection 9 located above.

The exemplary embodiment of Figure 3 differs from the example in Figure 2 solely in the different design of the outflow unit 45. In contrast to Figure 2, the outflow channel 47 has a bend 49, at which the outflow channel 47 transitions into a horizontal section 52, which leads to the now laterally positioned outflow connection 9.

In the two exemplary embodiments of Figures 2 and 3, the additional outlet connection 23 visible in Figures 2 through 4 is automatically controllable, in addition to the manually controllable outlet connection 33, which is visible only in Figure 1. As an example of such a control, Figures 2 through 4 show a highly schematic simplified representation of a valve plug 51 situated the outlet connection 23, which contains a float valve. This float valve may be activated by a float ball 53, which floats to the surface of the fluid trapped in the collecting container 1. To generate a reliable buoyancy, the float ball 53 is preferably formed as a hollow ball, as shown in Figure 4. In order to prevent the hollow

float ball 53 from compressing under the at times substantially high pressure, which can build up in the collecting container 1, a pressure equalization device is provided for the interior space 55 of the ball 53, as shown in Figure 4, which in the example in Figure 4 is formed by an equalizing tube 57, which is kinked at its upper end in such a way that substances trickling from above do not enter the pipe opening 59.

With the invention, a kind of modular system may be implemented by using different cyclone sizes and cyclone designs in conjunction with a collecting container 1 that has the same design with associated components, whereby further adaptations may be made by variously designing the outflow unit 45 for the outflow connection 9 located above or the lateral outflow connection 9, and/or different plugs 43 may be used for desired shapes of the acceleration cone 39.

As shown in Figure 1, a gas cooler 61 is connected to the connecting flange 19 of the inflow connection 7, in which the gas to be conditioned flowing into the cyclone separator 3 may be cooled. By cooling at a temperature below the dew point, for example, 10° K below the dew point, it is possible to transition vaporous phases into liquid phases in order thereby to obtain an optimum separation in the cyclone separator 3.

### Claims

1. An apparatus for the conditioning of gases, in particular, sealing gas, comprising  
5 a separator unit (3), in particular for separating liquids and/or particles from the gas flowing through the apparatus, and comprising a collecting container (1) for trapped substances, characterized in that the separator unit (3) includes a cyclone separator (3).
2. An apparatus for the conditioning of gases, in particular, sealing gas, comprising  
10 a separator unit (3), in particular for separating liquids and/or particles from the gas flowing through the apparatus, and comprising a collecting container (1) for trapped substances, characterized in that the separator unit (3) is mounted on the collecting container (1) as a discrete, replaceable unit through which gas is able to flow.
- 15 3. The apparatus according to Claim 1 or 2, characterized in that the separator unit (3) is mounted on the top (13) of the collecting container (1) and is connected to the former via an inlet opening (15).
4. The apparatus according to one of the preceding claims, characterized in that the  
20 cyclone separator (3) includes a cyclone housing (5), on which an inflow opening (41) is disposed in such a way that the gas flow within the housing (4) forms a swirl flow about the vertical axis (11) thereof, and in that a replaceable outflow unit (45) having an outflow channel (47) extending vertically upward coaxially relative to the vertical axis (11) is mounted on the cyclone housing (5).
- 25 5. The apparatus according to one of the preceding claims, characterized in that the outflow channel (47) extends in a straight line, preferably in a predefinable axial direction, relative to an outflow connection (9).
- 30 6. The apparatus according to one of the preceding claims, characterized in that the

outflow channel (47) includes a section (52) connected to its vertical section and extending horizontally relative to an outflow connection (9).

7. The apparatus according to one of the preceding claims, characterized in that it  
5 includes a gas cooler (61) in the flow path of the gas flowing toward the separator unit (3)

8. The apparatus according to one of the preceding claims, characterized in that a  
10 controllable outlet device (21; 51) for trapped fluid is provided at the bottom of the collecting container (1).

9. The apparatus according to one of the preceding claims, characterized in that a  
manually controllable outlet device, for example, in the form of a needle valve (21), is  
15 provided.

10. The apparatus according to one of the preceding claims, characterized in that a  
sensor device (29), which detects the fill level of the trapped fluid, is attached to the  
collecting container (1).

20 11. The apparatus according to one of the preceding claims, characterized in that an outlet device (23) is provided, which is controllable in response to a signal of the sensor device (29) detecting the fill level.

25 12. The apparatus according to one of the preceding claims, characterized in that the outlet device (23) includes an outlet valve (51) controllable by a float (53) situated in the collecting container (1).