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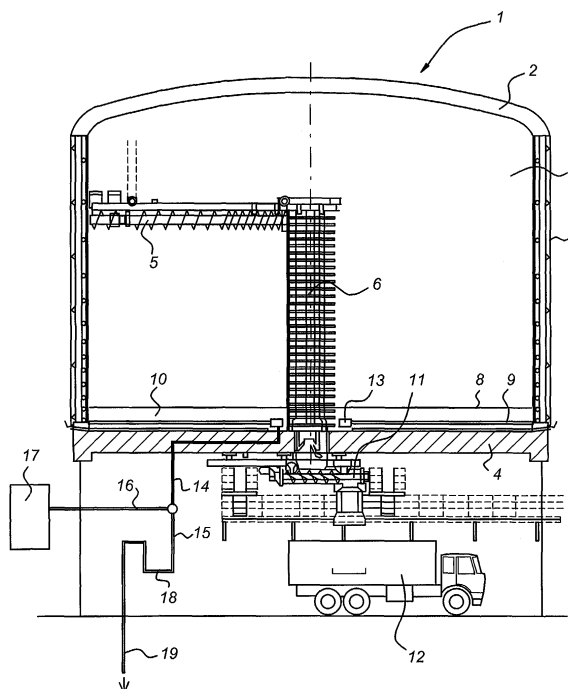
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(54) **Storage container for bulk material, and use of a storage container of this type**

(57) The invention relates to a storage container for bulk material (7), such as a silo (1). The storage container comprises a drainage device with a drainage system (9,13) provided at the bottom of the storage container. The drainage device also comprises suction means (17) which are connected to the drainage system for generating a pressure reduction in the drainage system (9,13). These suction means can be switched on and off at predetermined times using a time control. The suction means are designed to generate a pressure reduction of at least approximately 5 mbar, more particularly a pressure reduction in the range from 10 to 300 mbar. The bulk material (7) is in particular flue gas desulphurization gypsum. The invention also relates to the use of a storage container according to the invention for storing bulk material and/or for drying the bulk material in the storage container and/or drying a material in the storage container to form a bulk material.

Fig 1



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Description

[0001] The present invention relates to a storage container for bulk material, such as a silo, the storage container comprising a drainage device with a drainage system provided at the bottom of the storage container.

[0002] Storage containers of this type are known and are used, inter alia, to store flue gas desulphurization gypsum. Flue gas desulphurization gypsum is generally supplied in a slurry form and then has to be dried. The conventional storage containers are for this reason often provided with a drying installation placed on top of the storage container. The flue gas desulphurization gypsum is generally dried to a residual moisture content of 8 to 12%. One factor in this is that beyond approximately 15% residual moisture, problems arise in the drying process through the fact that the flue gas desulphurization gypsum then starts to settle in layers. Therefore, the flue gas desulphurization gypsum in the storage container is still stored in a state which contains relatively high levels of moisture. The residual moisture which is then still present in the flue gas desulphurization gypsum sinks downwards under the force of gravity and collects at the bottom of the storage container. As a result, a slurry is again formed in the bottom of the storage container, as a result of the increased moisture content. This in turn leads to problems with emptying the bulk material container, certainly if it is borne in mind that incomplete emptying of the bulk material container means that it will in fact be the bottom layers which remain in the bulk material container. If the bulk material container is emptied by means of a worm screw and a central column, it is generally the case that the emptying process is controlled entirely via the worm screw. This is because if the worm screw is stationary, the bulk material will not automatically flow into the central column. The worm screw ensures that bulk material is supplied to the central column. If the flue gas desulphurization gypsum returns to a very liquid form at the bottom of the bulk material container, as a result of the accumulation of moisture there, the effect occurs where this layer of liquid flue gas desulphurization gypsum will seek to flow outwards spontaneously, without the aid of the worm screw. It is known to solve this problem in the prior art by providing a drainage layer at the bottom of the bulk material container. This drainage generally comprises a layer of gravel with drainage lines therein. To prevent the layer of gravel or if appropriate another type of material for mixing with the bulk material, a cloth is also placed over this layer. The moisture which has sunk downwards in the flue gas desulphurization gypsum under the force of gravity can usually flow out via this drainage system under the force of gravity. It has been found, and it is known from the prior art, that this drainage does not always sufficiently prevent the abovementioned problem of the formation of liquid-like slurry in the bottom of the storage container.

[0003] It is now an object of the present invention to

more adequately overcome the abovementioned problem, and in particular to improve the drainage in the storage container of the type described in the introduction.

[0004] According to the invention, this object is achieved through the fact that the drainage system comprises suction means, which are connected to the drainage system, for generating a pressure reduction in the drainage system.

[0005] Surprisingly, the applicant has found that there is an interplay of forces which seeks to retain moisture in bulk material such as flue gas desulphurization gypsum. The discovery of the applicant is that this must highly probably be a capillary action. In any event, the applicant has found that a relatively low pressure reduction is sufficient to prevent the accumulation of moisture in the bottom of the bulk material container when flue gas desulphurization gypsum is stored in it. This can be achieved by connecting suction means which generate a pressure reduction and thereby suck moisture out of the bottom layer of the bulk material, in particular flue gas desulphurization gypsum, to the drainage system.

[0006] In this context, according to the invention it is particularly advantageous if the suction means are provided with a time control for switching the suction means on and off at predetermined times. Energy can be saved by not operating the suction means continuously. In fact, it has been found that the actively sucking drainage becomes less effective after a certain time and that the drainage efficiency is initially higher if the suction means have been switched off for a certain time and then switched on again than is the case when the drainage means were first switched off. It is assumed that this restorative effect has to do with settling phenomena, in the sense that while the drainage means are switched off the moisture which is present in the higher layers, which are less accessible to the suction, sinks downwards and can then be sucked out with a yield which is temporarily increased in relative terms after the suction means have been switched on again.

[0007] In the storage container according to the invention, the suction means are advantageously designed to generate a pressure reduction of at least approximately 0.5 mbar, more particularly a pressure reduction in the range from approximately 5 mbar, such as 10, 50, 150, 300, 500 or 700 mbar, in the drainage system. For practical reasons, the pressure reduction which is to be generated will be at most approximately 1000 mbar, in particular if it is used only for draining purposes. If the suction is to completely or partially replace the preliminary drying, higher pressure reductions may also be effective. This is because the applicant has found that even relatively slight suction forces of approximately 0.5 mbar make it possible to achieve results, and that very good results can be achieved at above approximately 5 mbar. Higher suction forces may be required for accelerated drainage or may even enable the bulk material to be partially or completely dried in the bulk material container, so that drying prior to the introduction of the

bulk material into the bulk material container can be completely dispensed with, or so that this preliminary drying is not required to such a great extent.

[0008] With regard to the practical design, according to the invention it is advantageous if the suction means comprise a suction line which, at a suction port, is connected to a vertically orientated discharge pipe of the drainage system, which discharge pipe comprises a water seal on that side of the suction port which is remote from the drainage system. The water seal makes it possible to ensure that the suction force exerted by the suction means is transmitted to the drainage system and not to the discharge side thereof, in which case, by way of example, air would be sucked out of the sewer or the environment.

[0009] The invention very particularly also relates to a storage container containing bulk material, and in particular a bulk material with a liquid capillary action. In the present context, a liquid capillary action is understood as meaning a capillary action which effects liquid, such as water. According to a further advantageous embodiment of the invention, the grain size of the bulk material is in this case in the range from 25 µm to approximately 500 µm, and is, for example, approximately 50 µm, as is the case with flue gas desulphurization gypsum. According to the invention, the bulk material is in particular flue gas desulphurization gypsum.

[0010] According to a further aspect, the invention relates to the use of a storage container according to the invention for storing bulk material, in particular a bulk material as described in Claims 6, 7 or 8, in which case the bulk material can advantageously be dried in the storage container.

[0011] According to yet a further aspect, the invention relates to the use of a storage container according to the invention for drying a material to form a bulk material and storing the said bulk material, the material being introduced into the storage container and this material being dried in the storage container to form bulk material.

[0012] The present invention will be explained in more detail below with reference to the appended drawing, in which:

Figure 1 diagrammatically depicts, partially in longitudinal section, a storage container according to the invention;

Figure 2 shows a diagrammatic plan view of the floor of the storage container shown in Figure 1; and

Figure 3 shows a graph illustrating the measurements carried out on a test arrangement.

[0013] Figures 1 and 2 present highly diagrammatic illustrations of a storage container according to the invention.

[0014] The storage container comprises a silo 1 with a roof 2, a wall 3 and floor 4. In the centre of the silo

there is what is known as a disc column 6 with a worm screw 5 which can rotate around it and, moreover, can be vertically adjusted along the disc column 6. A bulk material 7 is situated inside the silo 1. As a result of the worm screw 5 then being activated, the bulk material is moved towards the central disc column 6 in order to enter this column 6 via slots and to drop downwards via the column 6. The bulk material can then be loaded into a lorry 12, for example, by means of a loading system 11. The bulk material 7 is in this case in particular flue gas desulphurization gypsum, but could quite easily also be a different type of bulk material.

[0015] On the floor 4 of the silo there is a drainage layer. This drainage layer consists of gravel 10 with drainage lines 9 and 13 therein. On the top side, the gravel is covered by means of a cloth 8. The drainage layer is used to enable liquid, in particular water, to be discharged. In the bulk material, this liquid tends to sink downwards under the force of gravity and to accumulate at the bottom of the silo 1. Because a drainage system is now provided, the liquid which accumulates at the bottom of the silo can be discharged, specifically via line 14.

[0016] What has been described thus far with reference to Figures 1 and 2 does not differ from the known prior art. Furthermore, it is also possible for numerous variants to be made to the above within the scope of the invention as defined by the claims of the present application.

[0017] According to the invention, in particular there are suction means 17 which, via a suction line 16, are connected at a suction port 15 to discharge line 14 in order to generate a pressure reduction in the drainage system 9, 13. To ensure that this pressure reduction is not cancelled out by false air being sucked in via the discharge side 19 of the discharge line 14, according to the invention a water seal 18 is provided in the discharge line 14. This water seal 18 comprises a U-shaped pipe in which water or at least liquid is left to stand.

[0018] Since the suction force generated by the suction means is relatively low, and it is possible to make do with a suction force of the order of magnitude of 5 mbar to 50 mbar, liquid which stands in the water seal 18 will not be sucked out.

[0019] The effect of the invention can be explained in more detail with reference to Figure 3 on the basis of a test arrangement.

[0020] This test arrangement used a column with a height of 180 cm and a diameter of approximately 30 cm. This column is filled with flue gas desulphurization gypsum with a residual moisture content of approximately 10%. The bottom end of the column is open and positioned in a tray. This tray is filled with water. It was found that this water is absorbed by the flue gas desulphurization gypsum in the column and is drawn upwards into the column. The filling of the tray is continued until no further water was observed to be drawn up into the flue gas desulphurization gypsum.

[0021] The underside of the column was then con-

nected to a suction source which generates a pressure reduction of approximately 150 mbar. The quantity of water sucked out in grams per hour of suction under the influence of this pressure reduction was then measured. The procedure was as follows:

[0022] On the first day, suction was carried out for X1 hours, (Section A in Figure 3), followed by a break of many hours. Then, on the second day, suction was carried out uninterrupted for X2 hours (Section B in Figure 3), again followed by a break of many hours. On the third day, suction was again carried out uninterrupted for X3 hours (Section C in Figure 3). The suction periods are shown in succession on the horizontal axis, with the breaks between them omitted.

[0023] At the changes from the first day to the second day and from the second day to the third day, it is clearly apparent that there is initially a considerable increase in the amount of water sucked out per unit time and this increase then flattens out. This observation was again found at the change from the second day to the third day. If the graph shown in Figure 3 is considered as a whole, it is possible to recognize an exponential curve. The changes from the first day to the second day and from the second day to the third day seem to represent merely a slight disturbance in this curve, apparently indicating a restorative effect. The conclusion which can be drawn from this is that uninterrupted suction throughout the entire day is not required, but rather periodic suction is sufficient. At the end of the third suction period C, it was found that approximately 95° of the water which was initially added had been sucked out.

Claims

1. Storage container for bulk material, such as a silo, the storage container comprising a drainage device with a drainage system provided at the bottom of the storage container, **characterized in that** the draining device comprises suction means connected to the drainage system for generating a pressure reduction in the drainage system.
2. Storage container according to Claim 1, **characterized in that** the suction means are provided with a time control for switching the suction means on and off at predetermined times.
3. Storage container according to one of the preceding claims, **characterized in that** the suction means are designed to generate a pressure reduction of at least approximately 0.5 mbar, more particularly a pressure reduction which lies in the range of 5 mbar and above, such as 10, 50, 150, 300, 500 or 700 mbar, in the drainage system.
4. Storage container according to one of the preceding claims, **characterized in that** the suction means

comprise a suction line which, at a suction port, is connected to a vertically oriented discharge pipe, which on that side of the suction port which is remote from the drainage system comprises a water seal.

5. Storage container according to one of the preceding claims, **characterized in that** the storage container comprises bulk material, in particular bulk material with a liquid capillary action.
6. Storage container according to Claim 5, **characterized in that** the grain size of the bulk material is in the range from 25 µm to 500 µm, for example is approximately 50 µm.
7. Storage container according to Claim 5 or 6, **characterized in that** the bulk material is flue gas desulphurization gypsum.
8. Use of a storage container according to one of Claims 1-4 for storing bulk material, in particular a bulk material as described in one of Claims 5, 6 or 7.
9. Use according to Claim 8, in which the bulk material is dried in the storage container.
10. Use of a storage container according to one of Claims 1-4 for drying a material to form a bulk material and storing the said bulk material, the material being introduced into the storage container and then being dried in the storage container to form a bulk material.

Fig 1

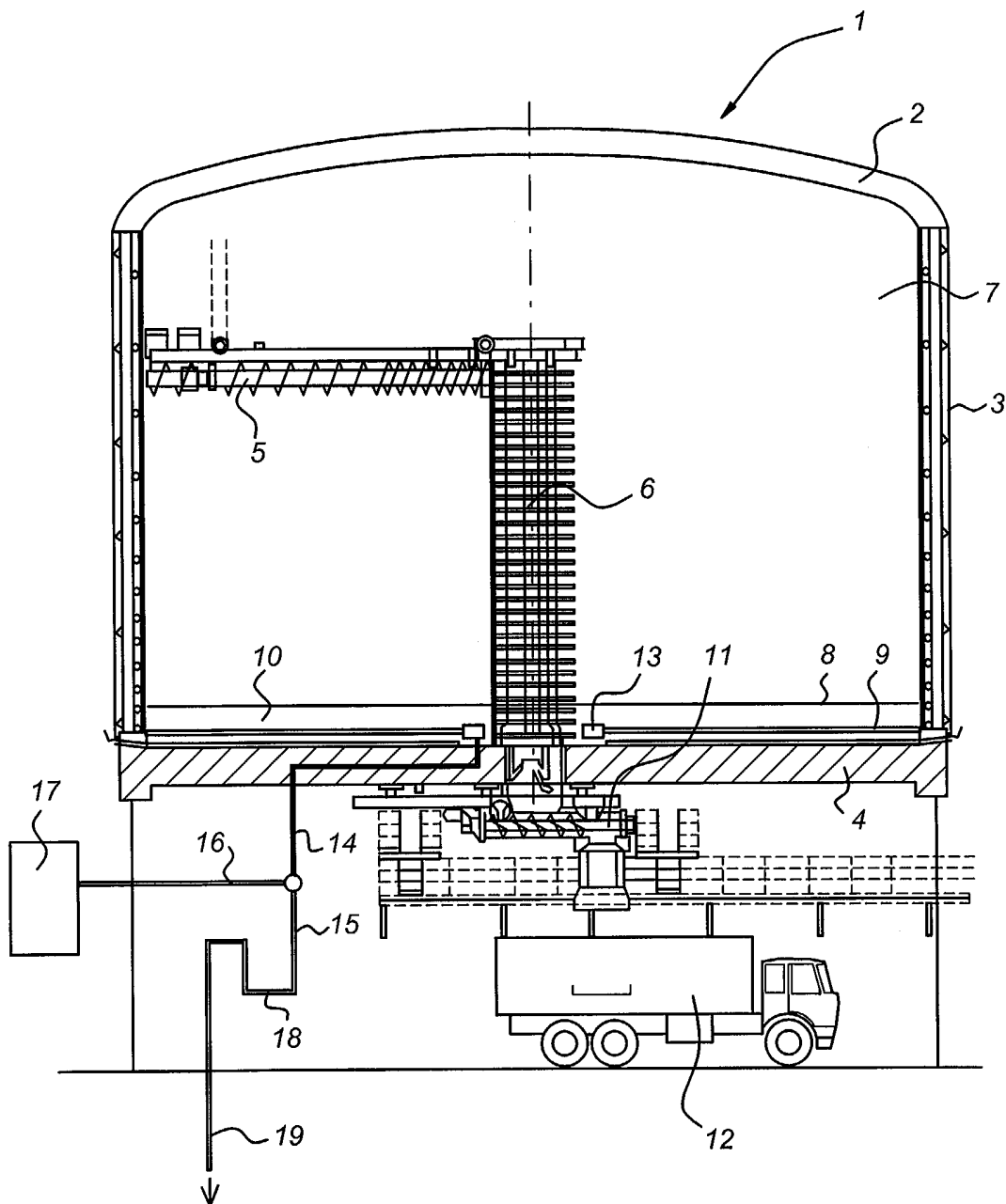


Fig 2

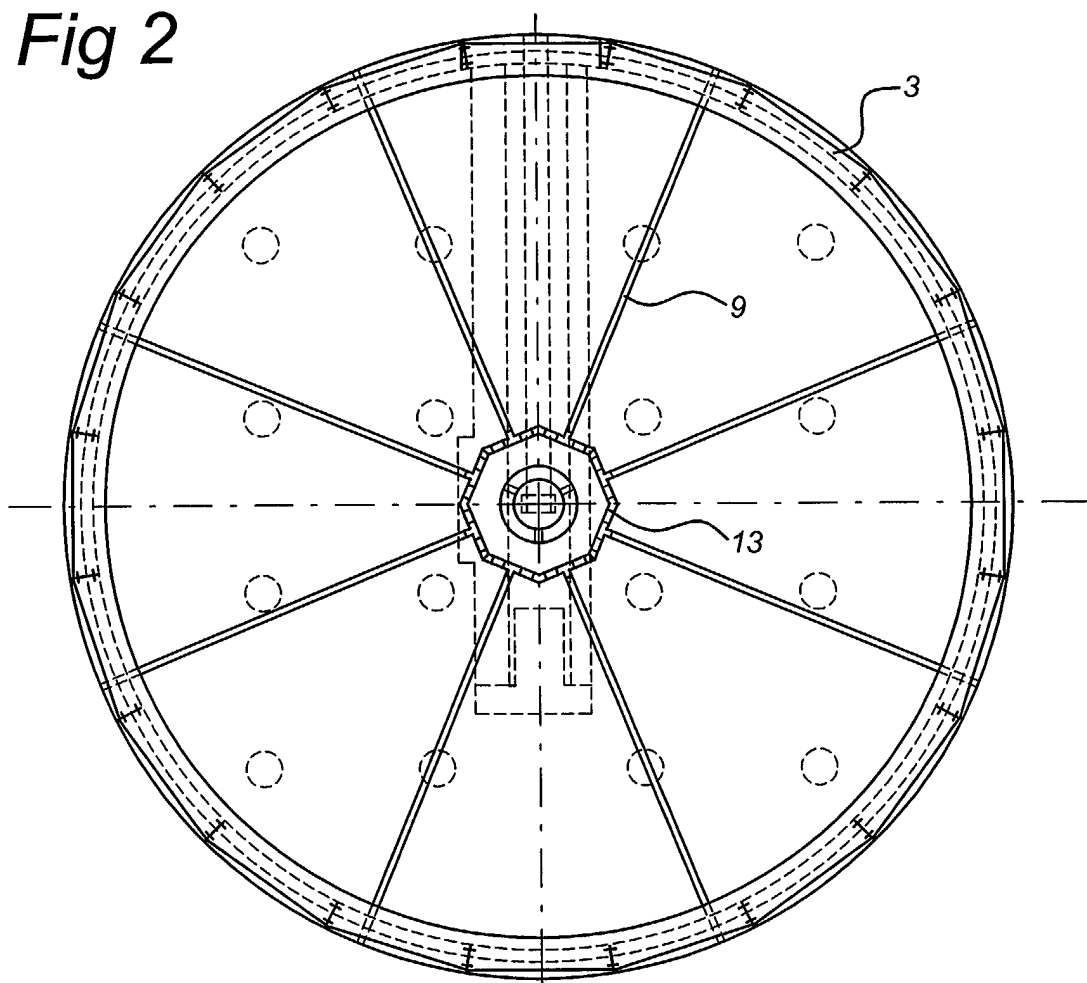
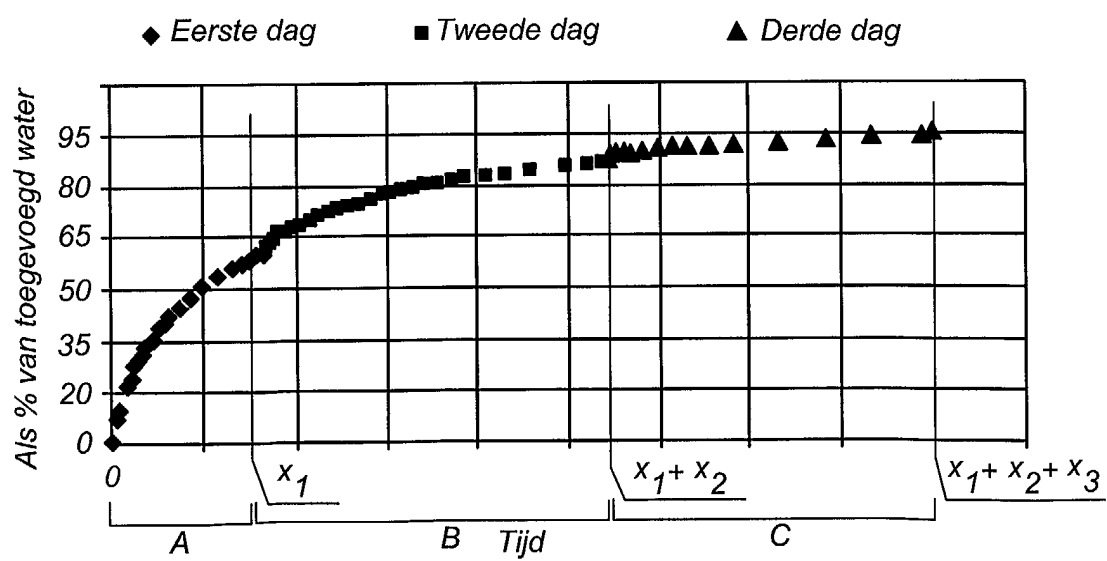


Fig 3





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EUROPEAN SEARCH REPORT

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