

MOISTURE ABSORPTION APPARATUS**FIELD OF THE INVENTION**

5 The present invention relates to the field of dehumidification, in particular to a tubular moisture absorption apparatus provided with a desiccant in an upper chamber. On contact with moisture the desiccant forms an aqueous solution which is received by a liquid collection
10 chamber in communication with the desiccant chamber and disposed beneath it.

BACKGROUND OF THE INVENTION

15 The present invention departs from the tubular moisture-absorbing device disclosed in U.S. patent no. 5,676,739 (Gustafsson) designed for vertical disposition in, for instance, a closed steel container for transport of humidity-sensitive goods. The device is made of a
20 polymer coated board which provides required stiffness. Starting from its upper end, it comprises, in a longitudinal direction, a chamber with a moisture-absorbing material, such as calcium chloride, which forms an aqueous solution on contact with humid air. The salt
25 solution is continuously drained into a lower liquid collection chamber in form of a plastic container with which the upper chamber is in communication. The particulate desiccant material is retained in the upper chamber by sieve means comprising a non-return valve
30 means. Contact of the desiccant with ambient air is ensured by a netting element located in front of an opening in the wall of the upper chamber. The netting element is designed to prevent the aqueous solution from

leaving the upper chamber through it rather than through the sieve means.

While the moisture-absorbing device of Gustafsson has been shown to function well in industrial practice, there is room for improvement. Manufacture of the device of the '739 patent necessitates folding and longitudinal gluing of a sheet of plastic board to provide a tubular structure, to manufacture and attach several plastic parts, such as the sieve means and the netting element, to the tubular structure by gluing, to attach the plastic container forming the lower chamber to the sieve means, etc.

15 OBJECTS OF THE INVENTION

A main object of the present invention is to provide an apparatus of the aforementioned kind, which is easier and cheaper to manufacture while retaining the advantageous properties of the device of US 5,676,739.

Further objects of the invention will become evident from the following summary of the invention, the drawings, the description of preferred embodiments, and the claims.

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SUMMARY OF THE INVENTION

The moisture absorption apparatus of the invention comprises an elongate flexible plastic tube having sealed upper and lower ends, one or several wall openings disposed in a wall portion adjacent to the upper end portion, a tubular desiccant container holding a deliquescent desiccant (18) and having gas and liquid permeable walls disposed radially inwardly of said one or

several wall openings, and spacer means, preferably of tubular shape, interposed between the plastic tube wall and the desiccant container or/and integrated in the desiccant container to prevent liquid formed in the container from leaving the apparatus through the wall openings. It is preferred for the spacer means to be incorporated into the desiccant container. The desiccant container of the invention is of a gas and liquid permeable material, such as a woven or a non-woven plastic material. In the context of the present invention, "axial(ly)" refers to the tube axis while "radial(ly)" refers to a direction perpendicular thereto. Since the apparatus of the invention is designed for use in an upright position, "upper" and "lower" refer to this working position. The apparatus is kept in the working position by, for instance, a wire fastened at an eye provided at the upper end of the plastic tube and, with its other end, at a suitable point of fixation at the inner wall of a steel container or other compartment.

According to a preferred aspect of the invention, lumen restriction means disposed in-between the upper and lower ends divide the tube into an upper moisture absorption chamber and a lower liquid collecting chamber.

The present invention is based on the concept that the liquid formed in the container by the absorption of humidity by the desiccant should be kept away from the tube wall to prevent accidental spillage through the wall openings. This is accomplished through impeding flow in a radial direction by spacer means. The spacer means may be separate of the container or be integrated into its outer (in a radial direction) wall portion. If separate, a flexible hose of a netted plastic material such as, for instance, the tubular plastic devices used for protecting glass bottles from damaging each other, may be interposed

between the container and the wall. If integral, a tubular peripheral portion of the container may be shaped or treated to impede radial flow. For instance, the container may be made of a non-woven plastic material, such as
5 polyethylene terephthalate, in a way so as to make its inner wall portion more dense than its peripheral wall portion, that is, to keep the average distance between its filaments smaller in the inner wall portion than in the outer wall portion. Separately or additionally, the
10 filaments of the outer wall portion may be chemically treated to make them more hydrophobic or the filaments of the inner wall portion may be chemically treated to make the more hydrophilic, or both, thus using surface tension phenomena to keep the aqueous solution of the desiccant
15 away from the tube wall.

A preferred desiccant is calcium chloride or desiccant mixtures containing calcium chloride but, in principle, all desiccants becoming deliquescent on contact with humid air can be used. The aqueous solution of the
20 desiccant flows through the lumen restriction means into the liquid collection chamber. A non-return valve may be arranged at the restriction means but this is of no importance for the performance of the apparatus of the invention; its only function is to prevent liquid from
25 flowing back into the upper chamber and out from there in the event the apparatus falls on the container floor by the suspending wire breaking or coming loose.

The lumen restriction means of the invention preferably support the desiccant container when the
30 apparatus of the invention is in an upright position. In absence of lumen restriction means or if so desired, the desiccant container can be fastened, for instance, at the sealed upper end of the plastic tube.

The sealing of the tube ends and/or the provision of the lumen restricting means can be obtained by any appropriate technique, such as heat or microwave welding or gluing.

5 To prevent moist air from prematurely entering into the apparatus of the invention the wall openings are suitably covered by a removable seal, such as a plastic sheet applied to outside of the wall portion comprising the openings, using a non-permanent adhesive of
10 appropriate strength.

 The upper and lower end seal portions of the plastic tube are preferably oriented in the same radial direction, that is, as if the tube were sealed in a position flattened against a flat surface. If the seal
15 portions are arranged in this manner it is preferred for a least some of the wall openings to be disposed in a wall portion intermediate between one or both pairs of axially corresponding seal radial ends, the reason being that the apparatus of the invention, when suspended in a working
20 position and resting with its one side against a steel container or similar wall, will align its seals in parallel with the external wall. Plastic tube wall openings disposed in a wall portion axially intermediate between corresponding radial ends of the upper and lower
25 plastic tube seal portions therefore will have little chance to abut against an external wall. Such abutment would prevent or at least hinder the apparatus of the invention to from exerting its beneficial humidity absorption effect.

30 The invention will now be explained in more detail by reference to a drawing illustrating preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

- Fig. 1 is a cross sectional view of a first embodiment of the moisture absorption apparatus of the invention in a flattened position, the desiccant container not being shown, in the direction of the upper and lower seal portions and the lumen restricting means;
- Fig. 2 is a corresponding view of the apparatus of Fig. 1, but in a non-flattened and upright position working position, with a desiccant container with integral spacer means inserted;
- Fig. 3 is a cross sectional view A-A of the apparatus of Figs. 1 and 2;
- Fig. 4 is a corresponding cross sectional view of a second embodiment of the invention with separate spacer means.

The first embodiment of the moisture absorption apparatus of the invention illustrated in Figs. 1-3 comprises an elongated semi-transparent polyethylene plastic tube 1 with heat seal portions 4,7 at its upper and lower ends, respectively. In the upper seal portion 4 a central eye 9 is provided for fastening the apparatus in an upright position by means of a wire or similar (not shown). By means of a welded restriction 6 having a central opening 5 the main portion of the tube extending between the seal portions 4,7 is divided into an upper chamber 2 for moisture absorption and a lower chamber 3 for collection of liquid; a passage 5 provides for communication between the chambers 2 and 3. In the wall of the upper chamber 2 a number of circular openings 8;8',8'',8''' provide for access of ambient air. In the ready for use apparatus the

plastic tube wall openings 8 are covered by a removable plastic sealing sheet 11 with a gripping tongue 12.

In Fig. 1 the sealed but, for the sake of clarity, empty tube 1 is shown in a flattened position. In
5 Fig. 2 the same tube is shown with the desiccant container inserted. The air in the upper chamber 2 is in communication with ambient air through tube wall openings 8; 8', 8'', 8'''. The container is of a non-woven material, as evident from Fig. 3, and consists of a (radially) inner
10 portion 15 of higher density and an outer portion 16 of lower density, that is, a portion having larger interstices at average between the filaments. Materials of this kind are marketed in sheet form by Scandfilter AB, Svenljunga, Sweden (PET filter media, weight about 160
15 g/m³, thickness about 14 mm). Enclosed in the desiccant container is a particulate desiccant 18, such as anhydrous calcium chloride. The border 17 between the inner 15 and outer 16 portions indicates the limit of radial travel of the desiccant solution the flow of which thereby is
20 diverted in a downward direction. The solution 10 leaves the upper chamber 2 through the restriction 5 and accumulates on the bottom of the lower chamber 3. For reasons of clarity the thickness of tube wall 13 in Fig. 3 has been highly exaggerated. Its normal thickness would be
25 in the range of 0.5 mm and less.

Instead of having two tubular portions 15 and 16 the interstices of the container wall could be made to increase continuously in a radial direction. This would make the border 17 to broaden into a border zone, but the
30 technical effect would remain the same.

It is possible to make an outer desiccant container portion corresponding to portion 16 water-repellent by chemical treatment, for instance with a non-

curing or curing silicone. Thereby the radial spread of the aqueous desiccant solution would also be impeded.

The desiccant container can be manufactured from a corresponding radially layered tube. The radially
5 layered tube is cut to pieces of appropriate length which are closed at their one end, filled with desiccant, and closed at their other end by gluing or cautious welding, for instance.

In Fig. 2, the plastic tube wall openings
10 8', 8'', 8''' are disposed in a wall portion intermediate between one pair of axially corresponding radial ends 14; 19 of seal portions 4; 7, which arrangement prevents the plastic tube wall openings 8', 8'', 8''' to be accidentally
15 closed by the apparatus of the invention abutting against an external steel container or similar wall when suspended in a working position. The plastic sheet 11 covering the plastic tube wall openings 8', 8'', 8''' to protect the desiccant prior to use has been removed and thus is not shown in Fig. 2 (nor in Figs. 3 and 4).

20 The second embodiment of the invention illustrated in Fig. 4 comprises a desiccant container having a uniform wall 23 of a three-dimensional net of plastic fibers enclosing the particulate desiccant 22. The desiccant solution can spread freely in all directions in
25 the desiccant container wall 23 but its contact with the plastic tube wall 20 is prevented by a net 24 of coarse polyethylene fibers in form of a hose circumferentially interposed between the desiccant container wall 23 and the plastic tube wall 20. Thereby the solution is prevented
30 from leaving the apparatus through tube wall openings 21. The second embodiment of the invention has the additional advantage that the wall thickness of its desiccant container can be made as thin as the strength of the material used would allow, thus saving space for

additional desiccant; in this case a desiccant container having walls of a woven material is particularly appropriate.

C L A I M S

1. A moisture absorption apparatus comprising an elongate flexible plastic tube (1) having sealed upper and lower
5 end portions (4,7), one or several wall openings (8;8',8'',8''') disposed in a wall portion adjacent to the upper end portion (4), a substantially tubular desiccant container holding a deliquescent desiccant (18) and having gas and liquid permeable walls (15,16;23) disposed
10 radially inwardly of said one or several wall openings (8;8',8'',8'''), and spacer means (16;24) interposed between the plastic tube wall (20) and the desiccant container or/and integrated (16) in the desiccant container to prevent liquid formed in the desiccant
15 container from leaving the apparatus through the wall openings (8;8',8'',8''').

2. The apparatus of claim 1, wherein the spacer means (16;24) are tubular.

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3. The apparatus of claim 1 or 2, wherein the spacer means (24) are separate of the desiccant container.

4. The apparatus of claim 3, wherein the spacer means
25 have the form of a flexible netted hose (24).

5. The apparatus of claim 1 or 2, wherein the spacer means (16) are comprised by the desiccant container, the outer diameter of which essentially corresponds to the
30 inner diameter of the elongate flexible plastic tube (1) so as to make the outer face of the desiccant container abut the inner face of the wall (13) of said tube (1).

6. The apparatus of claim 5, wherein the container comprises tubular inner (15) and outer (16) portions, the spacer means (16) being comprised by said outer portion.

5 7. The apparatus of claim 6, wherein said inner (15) and outer (16) portions are of a non-woven plastic material, the density of the outer portion (16) being smaller than the density of the inner portion (15).

10 8. The apparatus of claim 6, wherein said outer portion (16) has been treated with a water-repellant.

9. The apparatus of claim 8, wherein the water-repellant comprises silicone.

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10. The apparatus of claim 1, further comprising an eye (9) disposed at the sealed upper end portion (4) and a removable plastic sheet (11) covering said wall openings (8).

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11. The apparatus of any of claims 1-10, wherein the sealed upper and lower end portions (4;7) are oriented in the same radial direction.

25 12. The apparatus of claim 11, wherein one or several of the wall openings (8',8'',8''') are disposed in a wall portion axially intermediate between corresponding radial ends (14;19) of the sealed upper and lower end portions (4;7).

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13. The apparatus of any of claims 1-12, comprising lumen restriction means (6) disposed between the desiccant container and the sealed lower end portion (7).

14. The apparatus of claim 13, wherein the lumen restriction means (6) are arranged for supporting the container.