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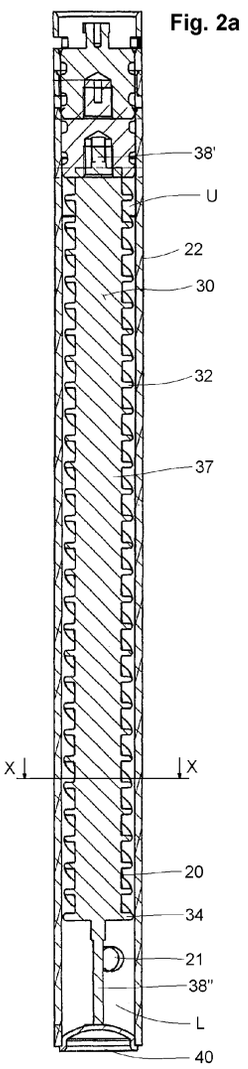
(54) Desiccant unit

(57) The present invention discloses a desiccant unit, especially for use in an air conditioning systems, comprising a housing (22) and a desiccant body (30) arranged inside said housing, said desiccant body including a desiccant agent and a supporting matrix (37). Said supporting matrix (37) comprises a thermoplastic polymer material and a channel agent. According to the invention, the desiccant body (30) has a tubular shaped form with a first spiral (32) arranged on an inner and/or outer surface of the tubular shaped form.

Fig. 2a



EP 1 566 600 A1

Description

Introduction

[0001] The present invention generally relates to a desiccant unit for use in air conditioning systems, and in particular in automotive air conditioning systems.

[0002] Desiccants are largely used in refrigeration systems, such as air conditioning systems, to keep refrigerant liquids dry, because water is detrimental both to a correct operation due to ice formation and to the properties of the refrigerant liquid itself due to chemical degradation, such as hydrolysis, eventually leading to corrosion.

[0003] Desiccants generally used to this purpose are small granules or beads comprising a major part of pure desiccant, such as molecular sieves, and a minor part of a mineral binding component. As these desiccant granules are more or less subject to attrition, especially in automotive air conditioning systems, a general requirement for these systems is the presence of a filter capable of retaining particulate matter, namely loose particles of desiccant and binding material. Hence, the desiccant is usually enclosed in permeable containers, such as bags, pouches or cartridges made of mesh or filter material through which the refrigerant liquid is passed to be separated from moisture and filtrated.

[0004] US-4,013,566 to Adsorbex Inc. describes a flexible solid desiccant body comprising finely divided particles of desiccant material encapsulated in a moisture transmissive polymer solid matrix of a cured thermoset aliphatic epoxy resin. This patent further states that certain epoxy copolymers, such as aromatic copolymers of epichlorhydrin-bisphenol A are not suited due to their extremely low vapour transmission rates.

Object of the invention

[0005] The object of the present invention is therefore to provide a desiccant unit with improved moisture adsorption capacity and which is not subject to physical attrition and to the release of loose particles.

General description of the invention

[0006] In order to overcome at least some of the abovementioned problems, the present invention provides for a desiccant unit as described in claim 1.

[0007] The present invention discloses a desiccant unit comprising a housing and a desiccant body arranged inside said housing, said desiccant body including a desiccant agent and a supporting matrix, wherein said supporting matrix comprises a thermoplastic polymer material and a channel agent. According to the invention, the desiccant body has a tubular shaped form with a first protruding spiral. This first spiral is arranged on an inner and/or outer surface of the tubular shaped form, preferably along substantially the whole length of the body.

[0008] A first role of this spiral is to guide the flow of refrigerant up or down the body while lengthening the path taken by the fluid. A second function of the spiral is to increase the contact or exchange surface of the desiccant body, thereby further enhancing its moisture adsorbing capacity. An auxiliary advantage of this spiral is to raise the dimensional stability of the desiccant body without undue increase in weight.

[0009] In the case of an outer spiral, the clearance between the tip of the spiral and the inner wall of the housing is generally chosen to substantially prevent the refrigerant fluid from flowing over this tip and thereby 'shortcutting' the preset flow path.

[0010] Thermoplastic materials are known and largely used because of their advantageous physical and chemical properties, such as high flexibility, resilience and resistance to physical and thermal shocks, as well as their good chemical inertness. Since the desiccant agent is integrated and strongly held inside such a thermoplastic supporting matrix, desiccant particles are efficiently prevented from being released into the refrigerant, even under heavy attrition conditions, such as in automotive air conditioning systems. Additional filtration devices, such as bags, pouches or cartridges of mesh material are therefore no longer required. Moreover, the risk of bag or filter leaking is advantageously discarded.

[0011] Contrarily to the teaching in US-4,013,566, a polymer matrix with low vapour transmission rates, such as thermoplastic polymers, may be used, especially in combination with a channel agent. Furthermore, the present invention uses thermoplastic polymers rather than thermoset epoxy polymers as described in the above patent. Thermoplastic polymers are made of largely available and less expensive starting materials, they require fewer ingredients and hence less complex preparation and mixing equipment and their use does not involve subsequent curing steps.

[0012] Thermoplastic polymers that may be used in the present invention encompass polymers, copolymers and block copolymers of one or more monomers, especially olefinic monomers. According to a preferred embodiment of the invention, thermoplastic polymers, which may advantageously be used in the supporting matrix, comprise one or more polymers or copolymers of ethylene and/or propylene.

[0013] The channel agent may be any substance forming channels or passages inside the polymer matrix, which, on one hand, increase the effectively exposed contact surface of the desiccant particles to the refrigerant and which, on the other hand, allow the permeation of the dried refrigerant fluid through the desiccant body. Examples of such channel agents are polyethylene glycol, polypropylene glycol, etc.

[0014] The desiccant incorporated inside the polymer matrix may be any of the conventional desiccant materials, such as molecular sieves, silica gel, etc.

[0015] In a more preferred design, the desiccant body

further comprises one or more additional spirals on at least part of its length arranged between two consecutive ribs of said first spiral. Such additional spirals, preferably one or two, advantageously further increase the contact surface between refrigerant and desiccant body without substantially raising the pressure drop.

[0016] In a further embodiment, the clearance between the tip of the ribs of the first spiral and the inner wall of said housing is smaller than the clearance between the tip of the ribs of said additional spirals and the inner wall. Hence, in such an embodiment the tip of the first spiral may extend toward and even touch the inner wall, whereas the height of the additional spirals is chosen to leave a sufficient clearance to allow for flow balancing and mixing inside two consecutive ribs of the first spiral.

[0017] Although the general shape of the desiccant body largely depends on the shape of the housing or vice versa, as mentioned above, the desiccant body preferably displays a generally tubular shape with one or more spirals on its outer and/or its inner surface. In a particularly preferred embodiment, said tubular shaped form is cylindrical, which is especially easy to manufacture.

[0018] In an alternative embodiment, this tubular shaped form preferably is biconical or hourglass shaped, thereby varying the cross sectional area of the flow path between to consecutive ribs of the first spiral. There are two major beneficial effects with this design. First, due to this varying cross section, the flow speed of the refrigerant is slowed down toward the centre of the desiccant body, thereby increasing the contact or exchange time between fluid and desiccant. Second, the varying flow speed is favourable to a better mixing of the refrigerant, thus further enhancing the moisture extraction from the fluid.

[0019] In a further embodiment, wherein said first and optional additional spirals are arranged on the outer side of said desiccant body, the latter advantageously further comprises an inner support structure. This support structure increases the dimensional stability thereof and thus allows reducing the wall thickness and the weight of the desiccant body.

[0020] Preferably, such an inner support structure comprises protrusions radially extending from the inner wall of the desiccant body. The height of these protrusions may only represent part of the inner radius, thereby forming longitudinal ribs inside the body. These protrusions may also connect in the centre of the body dividing the inside of the body into separate channels or ducts around a central longitudinal solid or hollow axis. An additional beneficial effect of such an inner support structure is that the overall exchange surface and hence the overall efficiency is further increased.

[0021] In order to install and maintain the desiccant body in a correct position inside the housing, it preferably further comprises fixing means on at least one end of said desiccant body to secure it inside said housing. These fixing means may be attached to or preferably be part of the desiccant body, for example an extension of the tubular shaped body or an extension of the inner support structure.

[0022] In a further aspect, the invention also encompasses the use of a desiccant unit as described above in an air conditioning system, especially in automotive air conditioning systems.

[0023] In a particularly preferred aspect, said desiccant unit is part of an integrated receiver-dryer unit, i.e. its housing is produced as one part of or attached to the condenser housing, e.g. by welding, brazing, etc.

[0024] In a still further aspect of the invention, the desiccant unit may be used optionally or additionally as part of pipes, compressor inlet, condenser inlet, evaporator inlet or outlet. It is of particular advantage to gain an additional dehydration function out of other parts usually made of plastic material, such as trumpet tubes, T-shape tubes, etc., without added weight. Furthermore such additional dehydration will take place all along the flow path of the refrigerant fluid.

Detailed description with respect to the figures

[0025] The present invention will be more apparent from the following description of two non limiting embodiments with reference to the attached drawings, wherein

Fig. 1 is a schematic view of a condenser with integral receiver dryer.

Fig. 2a and 2b are cross sections (section W-W in Fig. 1 and X-X in Fig. 2a, respectively) of an embodiment of a desiccant unit of the invention.

Fig. 3a shows a view and Fig. 3b and 3c are cross sections (section Y-Y and Z-Z, respectively) of another embodiment of the invention.

[0026] Referring first to Fig. 1, a typical condenser 10 of the cross flow, headered type has an inlet/outlet header tank 12 on one side, and a return header tank 14 on the other, each of which is divided into upper U and lower L sections by separators 16 and 18, respectively. Heated, compressed refrigerant vapour enters the upper section U of header tank 12, above separator 16, and flows across and through the flow tubes in the main pass section (not illustrated in detail). In the main pass, refrigerant is condensed to liquid form and flows into the upper section U of return tank 14, above the separator 18. From there, all liquid refrigerant is forced, by the separator 18, to flow through an upper inlet 20 and into an attached reservoir canister housing 22 comprising a prior art desiccant bag or a desiccant body 30 according to the invention (not illustrated within canister housing 22 in Figure 1, see Figures 2, 3a, 3b and 3c for preferred embodiments). After its passage through the desiccant body 30, liquid refrigerant can flow down and through a lower outlet 21, into lower section L of return tank 14 and ultimately into a sub cooler section of condenser 10,

comprised of those flow tubes located below the two separators 16 and 18. In the subcooler section, liquid refrigerant is further cooled, below the temperature necessary to simply condense it, and flows finally back into the lower section L of header tank 12.

[0027] Fig. 2a and 2b show an embodiment of a desiccant unit comprising a housing 22 with a cylindrical desiccant body 30 arranged inside. A single (first) spiral 32 on the outer side of the desiccant body 30 with a sealing separator 34 between upper U and lower L sections forces the refrigerant entering the housing through inlet 20 (partially hidden) up along the flow path defined by said first spiral 32. While in contact with the desiccant body 30, the moisture contained in the refrigerant is withdrawn and the liquid permeates through the channels formed by the channel agent to the inner ducts 36 (as shown in Fig. 2b) formed by joining inner radial protrusions 42 of the inner support structure 37. The dehydrated liquid drops fall down through the inner ducts 36 to the lower section L where the liquid passes through outlet 21 into the subcooler section of the condenser 10 (see Fig. 1). The desiccant body 30 further comprises upper and lower fixing means 38' and 38", such as a plastic foot, to secure the structure inside said housing 22. The bottom of the latter is closed by a cover 40, which may be removable for serviceable devices or welded or brazed for non-serviceable applications.

[0028] In Fig. 3a, 3b and 3c an alternative embodiment (without housing 22) is shown, wherein an hourglass shaped desiccant body 30 comprises two additional spirals 33 on its outer side between two consecutive ribs of a first spiral 32. The additional spirals 33 do not extend to the bottom sealing separator 34 to facilitate the passage of the refrigerant entering through upper inlet 20 (not shown). The heights of the tip of the first spiral 32 and of the additional spirals 33 are chosen to get a greater clearance with respect to the inner wall of housing 22 (not shown). Upper and lower fixing means 38' and 38" are provided to lock the desiccant body 30 inside the housing. The six radial protrusions 42 forming an inner supporting structure 37 shown in Fig. 3c do not join in the centre and leave an essentially hollow core representing a single inner duct 36 wherethrough dried liquid flows to a lower outlet 21 (not shown) in the lower section L.

Example

[0029] A classic desiccant composite is made of 80% pure desiccant and 20 % of natural mineral component. 60 grams of molecular desiccant beads of 2 mm in average with a density of 0.85 kg/litre are enclosed in a bag of mesh material. This amount represents around 3000 beads with an exchange surface of about 60,000 mm^2.

[0030] For a desiccant body according to the invention, the proportion of native product is 70% desiccant to 30% thermoplastic polymer matrix. Hence, 40 grams of pure desiccant are mixed with 20 grams of plastic polypropylene and channel agent to reach a total of 60 grams. The volume of this polypropylene-desiccant mixture is about 53 cm^3 with a density of 0.88 kg/litre. This mixture is then moulded to form a tube with an outer diameter of 20 mm, an inner diameter of 14 mm, a length of 240 mm reinforced with an internal cross of 2 mm thick and 3 spirals on the whole length with a 2 mm gage, 5 mm wide with a pitch of 120 mm. The exchange surface thus obtained is about 70,000 mm^2.

[0031] The moisture adsorption results achieved are at least as good as those obtained with classic desiccant beads, without the need of tedious assembly steps and the risk of leaking. Furthermore, the weight can easily be adjusted by decreasing or increasing the wall thickness of the desiccant body.

Claims

1. A desiccant unit comprising

   - a housing (22) and
   - a desiccant body (30) arranged inside said housing (22), said desiccant body including a desiccant agent and a supporting matrix and said supporting matrix comprising a thermoplastic polymer material and a channel agent,

   characterized in that said desiccant body (30) has a tubular shaped form with a first spiral (32) arranged on an inner and/or outer surface of the tubular shaped form.

2. The desiccant unit according to claim 1, wherein said thermoplastic polymer material comprises one or more polymers or copolymers of ethylene and/or propylene.

3. The desiccant unit according to claim 1 or 2, further comprising one or more additional spirals (33) on at least part of the length of said desiccant body between two consecutive ribs of said first spiral (32).

4. The desiccant unit according to claim 3, wherein the clearance between the tip of the ribs of said first spiral (32) and the inner wall of said housing (22) is smaller than the clearance between the tip of the ribs of said additional spirals (33) and the inner wall of said housing (22).

5. The desiccant unit according to any of claims 1 to 4, wherein said tubular shaped form is cylindrical.

6. The desiccant unit according to any of claims 1 to 4, wherein said tubular shaped form is biconical (hourglass shaped).

7. The desiccant unit according to any of claims 1 to 6, wherein said first and optional additional spirals (33) are arranged on the outer side of said desiccant body, further comprising an inner support structure (37).

8. The desiccant unit according to claim 7, wherein said inner support structure (37) comprises radially extending protrusions (42).

9. The desiccant unit according to any of claims 1 to 8, further comprising fixing means (38' and/or 38") on at least one end of said desiccant body to secure it inside said housing (22).

10. Use of a desiccant unit according to any of the preceding claims in an air conditioning system.

11. The use according to claim 10, wherein said desiccant unit is part of an integrated receiver-dryer unit.

12. The use according to claim 10, wherein said desiccant unit is part of pipes, compressor inlet, condenser inlet, evaporator inlet and/or evaporator outlet.

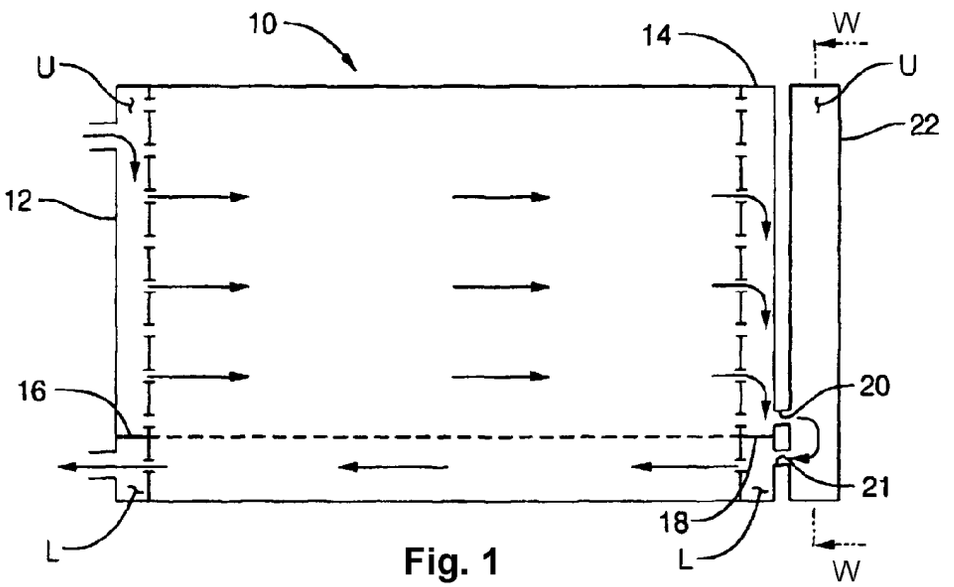
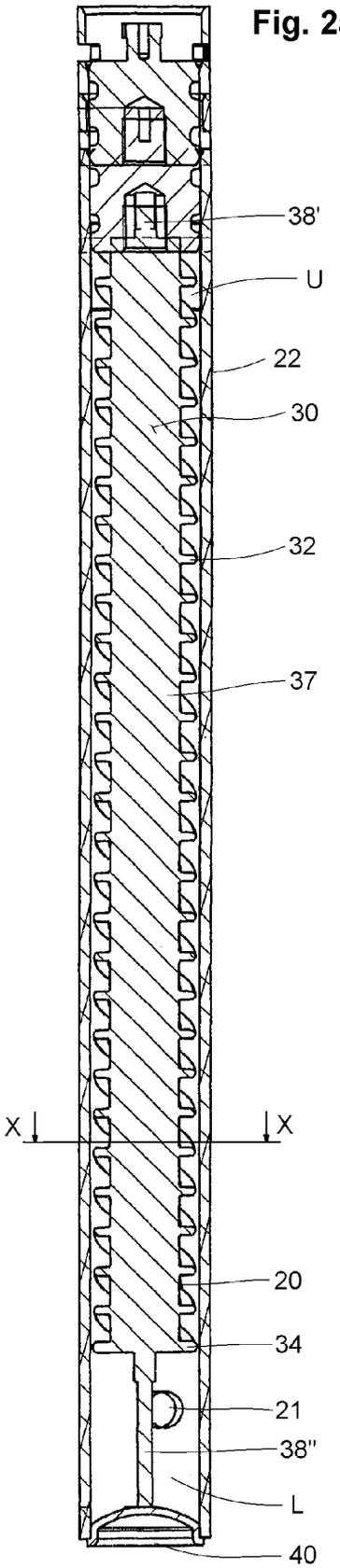


Fig. 1

Fig. 2a



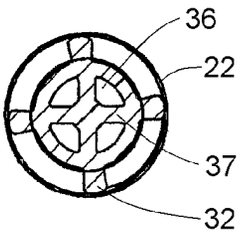


Fig. 2b

Fig. 3a

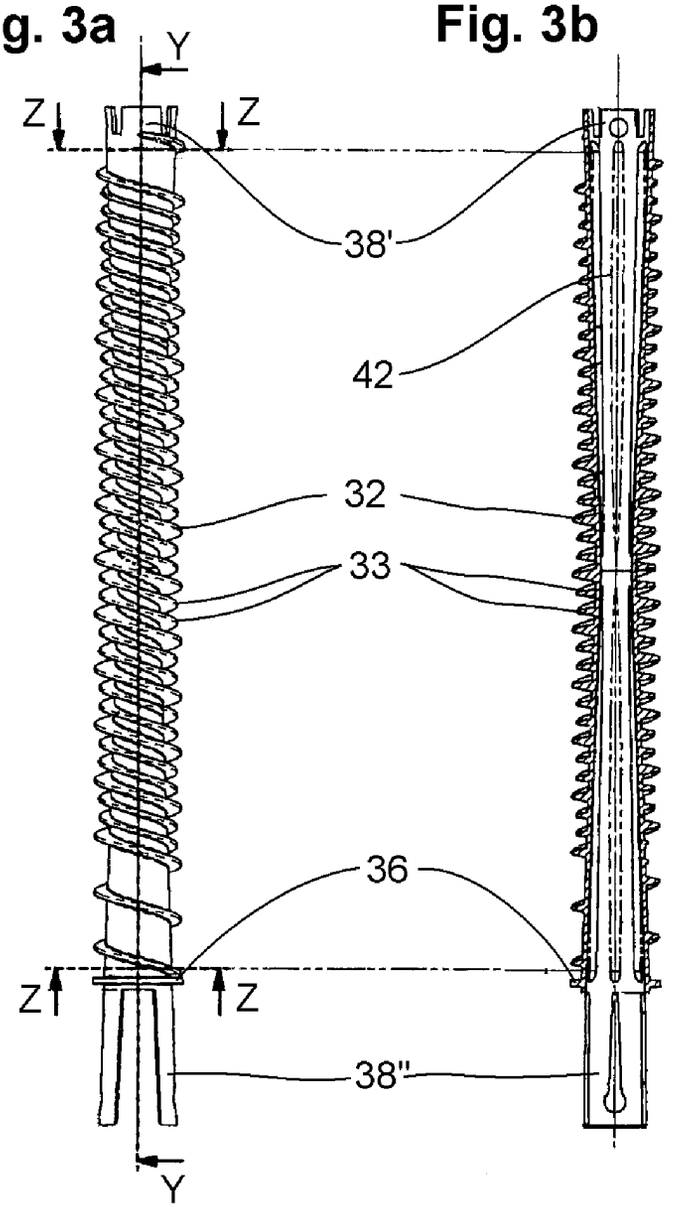
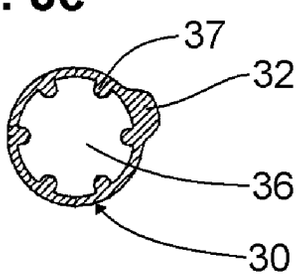


Fig. 3b

Fig. 3c



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EUROPEAN SEARCH REPORT

Application Number
EP 04 10 0691

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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F25B
B01D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 July 2004	Léandre, A

CATEGORY OF CITED DOCUMENTS

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EUROPEAN SEARCH REPORT

Application Number
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