

DESCRIPTION

Title of Invention

VACUUM THERMAL INSULATOR, THERMAL INSULATION BOX, AND METHOD OF MANUFACTURING VACUUM THERMAL INSULATOR

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Technical Field

[0001]

The present invention relates to a vacuum thermal insulator, a thermal insulating box, and a method of manufacturing a vacuum thermal insulator.

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Background Art

[0002]

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Conventional vacuum thermal insulators are known that are used for thermal insulation for various devices including a refrigerator. One such thermal insulator is a vacuum thermal insulator in which a core formed of an assembly of glass fibers is enclosed in an enclosure having a gas barrier property, and the enclosure is hermetically sealed with inside being depressurized (see, for example, Patent Literature 1). A core of the vacuum thermal insulator is formed in advance to have a board-shape by heat pressing. The vacuum thermal insulator is manufactured by inserting the core into the enclosure formed in a bag shape, depressurizing the inside of the enclosure, and hermetically sealing an opening by thermal welding.

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[0003]

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Another conventional vacuum thermal insulator is known that includes a thermal insulator obtained by solidifying and forming with an organic binder using a fibrous material, and a laminate film formed of laminated layers of a metallic foil, an edge portion of the laminate film being sealed with inside being depressurized (see, for example, Patent Literature 2).

[0004]

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Another conventional vacuum thermal insulator is known that includes a core accommodating an inorganic fiber polymer in an inner bag having flexibility and another enclosure formed of a laminate film accommodating the core and welded for

sealing at peripheries thereof, with inside of the laminate film being depressurized (see, for example, Patent Literature 3).

Citation List

5 Patent Literature

[0005]

Patent Literature 1: Japanese Patent No. 3580315

Patent Literature 2: Japanese Unexamined Patent Application Publication No. 9-138058

10 Patent Literature 3: Japanese Unexamined Patent Application Publication No. 2007-9928

Summary of Invention

Technical Problem

[0006]

15 A vacuum thermal insulator includes a core composed of a fiber assembly, and an enclosure enclosing the core. The vacuum thermal insulator has a configuration in which an inside of the enclosure is depressurized and sealed. A change in volume of the fiber assembly used for the core before and after the inside of the enclosure is depressurized and sealed is large. Thus, when the core is inserted into
20 the enclosure, the enclosure needs to be much larger than the core. Therefore, after the inside of the enclosure is depressurized and sealed, an unnecessary margin portion where the core does not exist largely remains at a periphery of the vacuum thermal insulator. Since the unnecessary margin portion remains, a material cost of the enclosure is increased, and a margin folding step of folding the unnecessary
25 margin portion is also required when the vacuum thermal insulator is disposed in a thermal insulating box. Thus, there is a problem that the vacuum thermal insulator cannot be obtained at low cost.

[0007]

30 In order to decrease the change in volume of the core before and after the inside of the enclosure is depressurized and sealed, there are a method of molding

the core into a board shape in advance by hot pressing as described in Patent Literature 1, a method of binding the fiber assembly by using a binding agent such as an organic binder as described in Patent Literature 2, and a method of preliminarily depressurizing and sealing the core by using an internal packaging member (an inner bag) or the like as described in Patent Literature 3. However, when the methods are used, a power cost for heating the core, and material costs of the binding agent and the internal packaging member are increased. Thus, there is a problem that the vacuum thermal insulator cannot be obtained at low cost.

[0008]

The present invention has been made to solve the problems as described above, and an object thereof is to provide a vacuum thermal insulator, a thermal insulating box, and a method of manufacturing a vacuum thermal insulator capable of being obtained at low cost.

Solution to Problem

[0009]

A method of manufacturing a vacuum thermal insulator according to the present invention A method of manufacturing a vacuum thermal insulator, the method comprising: enclosing a core formed of a fiber assembly with an enclosure; compressing integrally the core and the enclosure by an external force into a compressed state to have a thickness of $1/10$ or less of the thickness before compressing, the compressing being performed before depressurizing an inside of the enclosure; forming a weld sealing portion along at least two sides facing each other of a periphery of the enclosure in the compressed state; and depressurizing and sealing the inside of the enclosure after the weld sealing portion is formed.

[0010]

Also, a vacuum thermal insulator according to the present invention includes a core composed of a fiber assembly, and an enclosure enclosing the core, an inside of the enclosure being depressurized and sealed, and the entire vacuum thermal insulator having a heat-insulator thickness of 10 mm or more, wherein the enclosure has a weld sealing portion at a periphery, a distance between the weld sealing portion

and the core is 5 mm or less on at least two sides facing each other of the periphery of the enclosure, the weld sealing portion is fixed along a shape of the core, and a thickness of the core under an atmospheric pressure when the core is removed from the inside of the enclosure is 10 times or more of the heat-insulator thickness.

Advantageous Effects of Invention

[0011]

In accordance with the present invention, it is possible to reduce a width of a margin portion at the periphery of the vacuum thermal insulator while suppressing an increase in a power cost and a material cost. Therefore, since a material cost of the enclosure can be reduced, the vacuum thermal insulator can be obtained at low cost.

Brief Description of Drawings

[0012]

[Fig. 1] Fig. 1 is a sectional view illustrating a schematic configuration of a vacuum thermal insulator 1 according to Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is a view illustrating a step of manufacturing the vacuum thermal insulator 1 according to the Embodiment 1 of the present invention.

[Fig. 3] Fig. 3 is a view illustrating a step of manufacturing the vacuum thermal insulator 1 according to the Embodiment 1 of the present invention.

[Fig. 4] Fig. 4 is a view illustrating a step of manufacturing the vacuum thermal insulator 1 according to the Embodiment 1 of the present invention.

[Fig. 5] Fig. 5 is a sectional view illustrating a schematic configuration of a vacuum thermal insulator 2 according to Embodiment 2 of the present invention.

[Fig. 6] Fig. 6 is a sectional view illustrating a schematic configuration of a thermal insulating box 3 according to Embodiment 3 of the present invention.

Description of Embodiments

[0013]

Embodiment 1

A vacuum thermal insulator 1 according to Embodiment 1 of the present invention and a method of manufacturing therefor are described. Fig. 1 is a sectional view illustrating a schematic configuration of the vacuum thermal insulator 1

according to Embodiment 1. Note that, in the drawings including Fig. 1, the dimensional relationship, shape, and the like of each constituent member are different from actual ones in some cases. The specific dimension and the like of each constituent member should be determined in view of the following description.

[0014]

As illustrated in Fig. 1, the vacuum thermal insulator 1 includes a core 10 formed of a fiber assembly, enclosure films 20, 21 (may be collectively referred to as "an enclosure 20, 21" herein) having a gas barrier property, which cover both surfaces of the core 10, and a moisture adsorbent 30, which is inserted in an inner space of the enclosure 20, 21 and adsorbs moisture to suppress the degradation with time of the core 10 or other enclosed elements. The inner space of the enclosure 20, 21 is depressurized and hermetically sealed by sealing an opening in a state depressurized to a vacuum degree of about from 1 Pa to 3 Pa. The opening is sealed by welding peripheries of the enclosure films 20, 21 by heat sealing or the like to form weld sealing portions 40 (may be collectively referred to as a "weld sealing portion 40"). The vacuum thermal insulator 1 has a substantially rectangular plate shape as a whole.

[0015]

The enclosure films 20, 21 are an enclosure used for known vacuum thermal insulators and are formed of a laminate film having a multi-layer structure. The multi-layer structure has a configuration, for example, in which a polyethylene layer, an aluminum deposited layer, a polyethylene terephthalate layer, a stretched nylon layer as an outermost layer are laminated in the named order from an inner side (core 10 side). The thickness of each layer can be set to about from 10 μm to 30 μm , but is not limited thereto. The configuration of the enclosure films 20, 21 is not limited to the above-mentioned configuration, and may include an alumina deposited layer, an ethylene-vinyl alcohol layer, and a polypropylene layer. Further, there is no particular limitation on the configuration of the enclosure films 20, 21 as long as the enclosure films 20, 21 have a gas barrier property.

[0016]

The moisture adsorbent 30 is formed of, for example, calcium oxide (CaO) or the like inserted into a bag having good air permeability. The moisture adsorbent 30 is not limited to only CaO, and a material having a moisture adsorptive property such as silica gel or zeolite may be used.

5 [0017]

The core 10 has a configuration in which aggregates of fibers such as glass wool are laminated. The core 10 has a thickness of 10 mm or more (for example, 50 mm or less) under an atmospheric pressure in the completed vacuum thermal insulator 1. That is, the entire vacuum thermal insulator 1 has a thickness of 10 mm or more under the atmospheric pressure. If the core 10 is removed from an inside between the enclosure films 20 and 21, the thickness of the core 10 under the atmospheric pressure is 10 times or more (for example, 20 times or less) of the thickness of the vacuum thermal insulator 1. The fiber assembly is typically produced by a centrifugation method in a case of glass wool, and by a spunbond method in a case of resin fibers; however, a method of manufacturing the fiber assembly is not particularly limited. In the present embodiment, the fiber assembly constituting the core 10 is directly covered with the enclosure 20 without interposing an internal packaging member such as an inner bag. That is, in the vacuum thermal insulator 1, the fiber assembly constituting the core 10 is in direct contact with an inner side surface of the enclosure 20. Also, the core 10 does not contain a binding agent for binding the fiber assembly.

15 [0018]

The weld sealing portions 40 are formed along at least three sides (for example, four sides) of the periphery (a margin portion) of the enclosure films 20 and 21. The weld sealing portion 40 is formed continuously along an entire periphery of the peripheries of the enclosure films 20, 21. At least on two opposed sides of the peripheries of the enclosure films 20, 21, a distance A between the weld sealing portion 40 and the core 10 is set to 5 mm or less, (for example, 1mm or more). The weld sealing portion 40 is fixed along the shape of the core 10. The width of the

weld sealing portion 40 can be set to about from 5 mm to 50 mm, but is not limited thereto.

[0019]

Next, a method of manufacturing the vacuum thermal insulator 1 according to Embodiment 1 is described. Fig. 2 to Fig. 4 are views illustrating a manufacturing process of the vacuum thermal insulator 1. Further, a configuration of a processing device 50 to be used in the manufacturing process is also illustrated in Fig. 2 to Fig. 4. As illustrated in Fig. 2 to Fig. 4, the processing device 50 includes a compression mechanism 51 and welding mechanisms 52a and 52b. The compression mechanism 51 integrally pressurizes and compresses the core 10 and the enclosure films 20, 21 enclosing the core 10. The welding mechanisms 52a and 52b form the weld sealing portions 40 on two opposed sides of the peripheries of the enclosure films 20, 21 in a state in which the core 10 and the enclosure films 20, 21 are pressurized and compressed by the compression mechanism 51. The welding mechanisms 52a and 52b are arranged on both sides with the compression mechanism 51 interposed therebetween. Further, the welding mechanisms 52a and 52b are provided close to the compression mechanism 51 so as to form the weld sealing portions 40 closely to the core 10 in a state in which the core 10 and the enclosure films 20, 21 are compressed by the compression mechanism 51. For example, the welding mechanisms 52a and 52b are adapted to form the weld sealing portions 40 in which the distance A between the weld sealing portions 40 and end portions of the core 10 is 5 mm or more and 100 mm or less.

[0020]

In the manufacturing process of the vacuum thermal insulator 1, first, as illustrated in Fig. 2, the core 10 is processed into a width and a length required as the vacuum thermal insulator 1 and placed in the processing device 50 (compression mechanism 51) in a state in which both surfaces (upper surface and lower surface) of the core 10 are enclosed in the enclosure 20, 21. This step is performed under atmospheric pressure. A thickness T1 of the core 10 at this time is 10 times or more as large as the thickness of the vacuum thermal insulator 1 (or the thickness of the

core 10) after completion.

[0021]

Next, as illustrated in Fig. 3, the core 10 and the enclosure films 20, 21 are integrally pressurized and compressed mechanically from both outside surfaces of the enclosure films 20, 21 by the compression mechanism 51 (pressurizing and compressing step). The pressurizing and compressing step is performed under atmospheric pressure. A pressure for the compression is preferably 0.10 MPa or more corresponding to the atmospheric pressure, more preferably 0.17 MPa or more. A thickness T2 of the core 10 in a compressed state is 1/10 or less of the thickness T1 of the core 10 before being compressed under atmospheric pressure. Further, the total thickness of the core 10 and the enclosure films 20, 21 in the compressed state is substantially the same as that of the completed vacuum thermal insulator 1.

[0022]

Next, as illustrated in Fig. 4, the weld sealing portion 40 is formed on one side of the peripheries of the enclosure films 20, 21 by the welding mechanism 52a in the compressed state in which the core 10 and the enclosure films 20, 21 are integrally pressurized and compressed by the compression mechanism 51 (weld sealing portion forming step). Further, in the compressed state, the weld sealing portion 40 is formed on the other side opposed to the one side of the peripheries of the enclosure films 20, 21 by the welding mechanism 52b. The weld sealing portions 40 may be formed concurrently. Further, each of the weld sealing portions 40 is formed, for example, so that the distance A between the weld sealing portion 40 and the end portion of the core 10 becomes 5 mm or less (for example, 1mm or more). The weld sealing portion forming step is performed under atmospheric pressure. When the weld sealing portions 40 are formed on the two opposed sides, the core 10 and the enclosure films 20, 21 are integrated, and the compressed state of the core 10 is maintained even when the pressurization by the compression mechanism 51 is cancelled. In the weld sealing portion forming step, the weld sealing portions 40 may be formed on three or more sides of the enclosure films 20, 21 so that an opening is ensured in a part of the peripheries of the enclosure films 20, 21.

[0023]

Next, the pressurization by the compression mechanism 51 is cancelled, and the core 10 and the enclosure films 20, 21, which are integrated, are taken out of the processing device 50. Then, a drying step of removing moisture from the core 10 and the enclosure films 20, 21 is performed. The drying step is performed under the condition (for example, heating at 100 degrees centigrade for 2 hours) that allows moisture of the core 10 and the enclosure films 20, 21 to be removed. Note that, the condition of the drying step is not limited thereto, and it is sufficient that the condition allow moisture of the core 10 and the enclosure films 20, 21 to be removed.

[0024]

Next, the moisture adsorbent 30 is inserted into the inner space of the enclosure films 20, 21 (moisture adsorbent inserting step). Note that, the moisture adsorbent inserting step may not be performed after the drying step, and may be performed before the drying step or before the pressurizing and compressing step.

[0025]

Next, the inside of the enclosure 20, 21 is depressurized to a vacuum degree of about from 1 Pa to 3 Pa. In the depressurized state, the weld sealing portion 40 is formed in an opening (for example, on a side other than the two sides on which the weld sealing portions 40 have already been formed) by heat sealing or the like, and thus the inside of the enclosure 20, 21 is depressurized and hermetically sealed (depressurizing and hermetically sealing step). The weld sealing portion 40 formed in the depressurizing and hermetically sealing step may also be formed so that the distance from the core 10 becomes 5 mm more and 10 mm or less. Through the above-mentioned steps, the vacuum thermal insulator 1 is obtained.

[0026]

Next, effects of the present embodiment will be described. In the method of manufacturing of the present embodiment, before the inside between the enclosure films 20 and 21 is depressurized, the core 10 and the enclosure films 20 and 21 are integrally compressed by an external force into the compressed state in which the thickness of the core 10 is 1/10 or less of that before compression. In the

compressed state, the weld sealing portions 40 are formed along at least the two sides facing each other of the periphery of the enclosure films 20 and 21. Accordingly, the distance A between the weld sealing portion 40 and the core 10 can be shortened on at least the two sides facing each other of the periphery of the enclosure films 20 and 21. For example, the distance A can be set to 5 mm or less. Accordingly, a width of the margin portion where the core 10 does not exist at the periphery of the vacuum thermal insulator 1 can be reduced, so that a material cost of the enclosure films 20 and 21 can be reduced. Also, since the width of the margin portion can be reduced, a margin folding step can be omitted in some cases. Therefore, in accordance with the present embodiment, the vacuum thermal insulator 1 can be obtained at low cost.

[0027]

Comparison between the vacuum thermal insulator 1 of the present embodiment and a general vacuum thermal insulator in which a distance between the weld sealing portion 40 and the core 10 is about 20 mm is considered. In accordance with the vacuum thermal insulator 1 of the present embodiment, the distance A between the weld sealing portion 40 and the core 10 can be set to, for example, 5 mm or less on at least the two sides facing each other of the periphery of the enclosure films 20 and 21. Accordingly, the width of the margin portion where the core 10 does not exist can be made smaller than that of the general vacuum thermal insulator. Consequently, a usage amount of the enclosure films 20 and 21 can be reduced, and the material cost of the enclosure films 20 and 21 can be reduced. Therefore, in accordance with the present embodiment, the vacuum thermal insulator 1 can be obtained at low cost.

[0028]

Also, in accordance with the present embodiment, since the distance A between the weld sealing portion 40 and the core 10 can be shortened (for example, the distance A can be set to 5 mm or less) on at least the two sides facing each other, an expanding action of the core 10 by a restoring force can be suppressed by the enclosure films 20 and 21 and the weld sealing portions 40. Therefore, at a stage of

manufacturing, the thickness of all of the core 10 and the enclosure films 20 and 21 removed from the processing device 50 (before the depressurizing and sealing) and the thickness of the completed vacuum thermal insulator 1 (after the depressurizing and sealing) can be made almost equal to each other. Accordingly, a change in volume of the core 10 before and after the inside between the enclosure films 20 and 21 is depressurized and sealed can be decreased even without using a method of molding the core into a board shape in advance by hot pressing, a method of binding the fiber assembly by using a binding agent, and a method of preliminarily depressurizing and sealing the core by using an internal packaging member or the like. Therefore, an increase in a power cost for heating the core, and material costs of the binding agent and the internal packaging member can be suppressed. Consequently, in accordance with the present embodiment, the vacuum thermal insulator 1 can be obtained at low cost.

[0029]

Embodiment 2.

A vacuum thermal insulator and a method of manufacturing the vacuum thermal insulator according to Embodiment 2 of the present invention will be described. Fig. 5 is a sectional view illustrating a schematic configuration of a vacuum thermal insulator 2 according to the present embodiment. Note that constituent elements having the same functions and operations as those of the Embodiment 1 are assigned the same reference numerals, and description thereof is omitted.

[0030]

The vacuum thermal insulator 2 of the present embodiment is featured in that a width B on one side of the weld sealing portions 40 (for example, all the weld sealing portions 40 formed along the four sides of the periphery of the enclosure films 20 and 21) is 50 mm or more (for example, 100 mm or less). That is, in the present embodiment, the width B of the weld sealing portions 40 is set to 50 mm or more in the weld sealing portion forming step or the depressurizing and sealing step in the steps of manufacturing the vacuum thermal insulator 2. Other portions of the

vacuum thermal insulator 2 have a configuration similar to that of the vacuum thermal insulator 1 of the Embodiment 1 described above.

[0031]

A fiber length of the general fiber assembly used as the core 10 is about 20 mm. In the vacuum thermal insulator 2 of the present embodiment, by setting the width B of the weld sealing portions 40 to 50 mm or more, the width B of the weld sealing portions 40 can be made sufficiently larger than the fiber length of the core 10. Therefore, even if the fibers of the core 10 bite into the weld sealing portion 40 when the weld sealing portions 40 are formed by using the welding mechanism 52b or the like, it is possible to prevent occurrence of a vacuum leak from a point where the fibers bite. Thus, in accordance with the present embodiment, effects similar to those of the Embodiment 1 can be obtained, and the vacuum thermal insulator 2 having higher reliability can be also obtained.

[0032]

Embodiment 3.

A thermal insulating box according to Embodiment 3 of the present invention will be described. Although the vacuum thermal insulator and the method of manufacturing the vacuum thermal insulator have been described in the above Embodiments 1 and 2, a thermal insulating box having high heat insulation performance can be obtained at low cost by using the vacuum thermal insulator 1 or 2 according to the above Embodiment 1 or 2 for the thermal insulating box. Fig. 6 is a sectional view illustrating a schematic configuration of a thermal insulating box 3 according to the present embodiment. In the present embodiment, a thermal insulating box of a refrigerator is described as an example.

[0033]

As illustrated in Fig. 6, the thermal insulating box 3 includes an inner box 60 and an outer box 61. The vacuum thermal insulator 1 or the vacuum thermal insulator 2) is arranged in a space between the inner box 60 and the outer box 61. The vacuum thermal insulator 1 (is arranged, for example, in close contact with an outer wall surface of the inner box 60. A urethane foam thermal insulator 62 is filled

into an area other than the vacuum thermal insulator 1 in the space between the inner box 60 and the outer box 61. The other area of the thermal insulating box 2 is the same as an ordinary thermal insulating box of a refrigerator, and hence the illustration and description are omitted.

5 [0034]

In the present Embodiment, the vacuum thermal insulator 1 that is inexpensively available is used, and hence the thermal insulating box 2 is manufactured at low cost. Further, in the Embodiment, the vacuum thermal insulator 1 having heat insulating performance higher than that of the urethane foam thermal
10 insulator 62 or the like is used, and hence the thermal insulating box 3 having high heat insulating performance can be obtained as compared to a thermal insulating box using only a urethane foam thermal insulator as a thermal insulator. Thus, the power consumption can be reduced in a refrigerator including the thermal insulating box 3.

15 [0035]

Note that, in the thermal insulating box 3 according to the present Embodiment, the vacuum thermal insulator 1 is in close contact with the outer wall surface of the inner box 60, but the vacuum thermal insulator 1 may be in close contact with the inner wall surface of the outer box 61. Further, the vacuum thermal insulator 1 may
20 be arranged in the space between the inner box 60 and the outer box 61 so as not to be in close contact with any of the inner box 60 and the outer box 61 by using a spacer or the like.

[0036]

Other Embodiments.

25 The present invention can be variously modified without being limited to the above-mentioned embodiments.

For example, according to Embodiment 3 described above, the vacuum thermal insulator 1 and 2 is used for the thermal insulation box 3 of the refrigerator having a heat source for cooling. However, the present invention is not limited to
30 this. The present invention is applicable to a thermal insulation box of thermo-

keeping container having a heat source for heating, and a thermal insulation box not having any heat source, that is, cooling or heating heat source (this may be exemplified by a cooler box).

[0037]

5 Further, the vacuum thermal insulators 1, 2 can also be used as a heat insulating member of cooling equipment or heating equipment in, for example, an air-conditioner, an air-conditioner for vehicles, and a hot water dispenser, as well as the thermal insulating box. Further, the vacuum thermal insulators 1, 2 can also be used in a heat insulating bag including an outer bag and an inner bag that can deform
10 freely and other heat insulating containers, as well as a box having a predetermined shape such as a thermal insulating box.

[0038]

Also, the above respective embodiments and modifications can be reduced in practice in any combination with each other.

15 Reference Signs List

[0039]

1, 2 vacuum thermal insulator 3 thermal insulating box 10 core 20, 21 enclosure (enclosure films) 30 moisture adsorbent 40 weld sealing portion 50 processing device 51 compression mechanism 52a, 52b welding mechanism 60
20 inner box 61 outer box 62 urethane foam thermal insulator

CLAIMS

[Claim 1]

A method of manufacturing a vacuum thermal insulator, the method comprising:

- 5 directly enclosing a core formed of a fiber assembly with an enclosure formed of a laminate film having a gas barrier property;
- compressing integrally the core and the enclosure by an external force;
- forming a weld sealing portion along at least two sides facing each other of a periphery of the enclosure in a compressed state;
- 10 ceasing the compressing after the weld sealing portion is formed; and
- depressurizing and sealing the inside of the enclosure after the compressing is ceased.

[Claim 2]

- The method of claim 1, wherein in the compressed state, the core has a
- 15 thickness of 1/10 or less of the thickness before compressing.

[Claim 3]

The method of claim 1 or 2, wherein the weld sealing portion is formed such that a distance from the core is 5 mm or less.