

DESCRIPTION

Title of Invention

VACUUM THERMAL INSULATOR, THERMAL INSULATING BOX, AND METHOD
FOR MANUFACTURING VACUUM THERMAL INSULATOR

Technical Field

[0001]

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

Background Art

[0002]

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). In this vacuum thermal insulator, the assembly of glass fibers is plastically deformed by pressure at a temperature equal to or more than a thermal deformation temperature of the glass fibers, and the core is kept in a pressurized state. 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.

[0003]

Another conventional vacuum thermal insulator is known that includes a core obtained by solidifying and forming 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]

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

Patent Literature

[0005]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2005-220954 (paragraphs [0017], [0023], [0029], and [0059], and Fig. 1)

Patent Literature 2: Japanese Unexamined Patent Application Publication No. Hei 9-138058 (paragraph [0013], and Fig. 1)

Patent Literature 3: Japanese Unexamined Patent Application Publication No. 2007-9928 (claims 6 to 8, and Fig. 9)

Summary of Invention

Technical Problem

[0006]

The core formed of a fiber assembly becomes bulky under atmospheric pressure, and hence it may be difficult to handle the core during manufacturing of a vacuum thermal insulator. To facilitate handling the core in the conventional vacuum thermal insulator, the thickness of the core is preliminarily reduced before depressurizing and sealing.

[0007]

For example, in Patent Literature 1, the thickness of the core is reduced by subjecting the assembly of glass fibers to compression with heating. In Patent Literature 2, the thickness of the core is reduced by using a binder such as an organic binder. In Patent Literature 3, the thickness of the core is reduced by preliminarily depressurizing and sealing the core by using an inner enclosure such as a flexible

inner bag.

[0008]

However, a large amount of heat energy is wasted disadvantageously when the assembly of glass fibers is subjected to compression with heating to reduce the thickness of the core. This is because the compression with heating is performed at a temperature equal to or more than the thermal deformation temperature of the glass fibers. Another disadvantage of the conventional thermal insulator is that the glass fibers are plastically deformed due to the compression with heating, and hence the density of the glass fibers contained in the core increases, increasing the usage amount of the glass fibers to maintain a desired heat insulating thickness of the core.

[0009]

The core obtained by binding a fibrous material (fiber assembly) using a binder, such as an organic binder and the core, that accommodates an inorganic fiber polymer (fiber polymer) using an inner enclosure such as an inner bag is disadvantageous in wasting materials such as the binder and the inner enclosure to reduce the thickness of the core.

[0010]

The present invention has been made to address the above-stated disadvantages, and an object of the present invention is to provide a vacuum thermal insulator and a thermal insulating box to be manufactured while saving energy and resources, and a method for manufacturing the vacuum thermal insulator.

Solution to Problem

[0011]

According to one embodiment of the present invention, there is provided a vacuum thermal insulator, including:

a core formed of a fiber assembly; and

an enclosure hermetically enclosing the core in an inside thereof, the inside being depressurized,

the core being configured to have a compression stress of 5 kPa or less when the core is taken out of the inside of the enclosure and compressed to a thickness of 50% under atmospheric pressure.

[0012]

5 According to another embodiment of the present invention, there is provided a vacuum thermal insulator, including:

a core formed of a fiber assembly; and

an enclosure hermetically enclosing the core in an inside thereof, the inside being depressurized,

10 the core being enclosed in the enclosure, and configured to have a compression stress of 5 kPa or less when the core is taken out of the inside of the enclosure and compressed to a thickness of 50% under atmospheric pressure.

[0013]

15 According to still another embodiment of the present invention, there is provided a method for manufacturing a vacuum thermal insulator, including:

enclosing a core formed of a fiber assembly with an enclosure;

compressing, before depressurizing inside of the enclosure, the core and the enclosure integrally by an external force to bring the core into a compressed state;

20 forming a weld sealing portion at least on two opposed sides at peripheries of the enclosure in the compressed state; and

depressurizing and hermetically sealing, after forming the weld sealing portion, the inside of the enclosure to obtain a vacuum thermal insulator,

25 the core being configured to have a compression stress of 5 kPa or less when the core is compressed to a thickness of 50% under atmospheric pressure before being enclosed in the enclosure.

[0014]

30 According to yet still another embodiment of the present invention, there is provided a thermal insulating box, including the above-mentioned vacuum thermal insulator or a vacuum thermal insulator manufactured by the above-mentioned method for manufacturing.

Advantageous Effects of Invention

[0015]

According to the embodiments of the present invention, the core density can be decreased by using the above-mentioned core having a compression stress of 5 kPa or less, as compared to those of the conventional vacuum thermal insulators using the core subjected to compression with heating and the core subjected to binding with a binder, and hence the usage amount of the glass fibers can be reduced. Further, according to the embodiments of the present invention, the heat energy and materials for reducing the thickness of the core are not used during manufacturing of the vacuum thermal insulator. Thus, a vacuum thermal insulator to be manufactured while saving energy and resources can be obtained.

Brief Description of Drawings

[0016]

[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 manufacturing process of the vacuum thermal insulator 1 according to Embodiment 1 of the present invention.

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

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

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

Description of Embodiments

[0017]

Embodiment 1

A vacuum thermal insulator 1 according to Embodiment 1 of the present

invention and a method for 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.

[0018]

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 a vacuum degree in the inner space of the enclosure 20, 21. 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 a weld sealing portion 40. The vacuum thermal insulator 1 has a substantially rectangular plate shape as a whole.

[0019]

The core 10 has such a configuration that a fiber assembly such as glass wool is laminated. In general, the fiber assembly is produced by a centrifugation method in the case where the fiber assembly is formed of glass wool, and is produced by a spunbonding method in the case where the fiber assembly is formed of resin fibers. There is no particular limitation on a method of producing the fiber assembly.

[0020]

In the vacuum thermal insulator 1 according to Embodiment 1, the heat energy and materials for reducing the thickness of the core 10 are not used. For example, the fiber assembly forming the core 10 is not subjected to compression with heating, hermetic sealing with an inner enclosure, or binding with a binder.

[0021]

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.

[0022]

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.

[0023]

In the vacuum thermal insulator 1 according to Embodiment 1, an entire inner surface of the enclosure films 20, 21 defining the inner space of the enclosure films 20, 21 is in direct contact with an entire surface of the core 10. That is, the core 10 is not enclosed in another member (for example, an inner enclosure).

[0024]

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.

[0025]

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 more and 100 mm or less. 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.

[0026]

The material characteristics of the core 10 in the vacuum thermal insulator 1 according to Embodiment 1 are described. The core 10 was taken out of the inside of the enclosure 20, 21 of the vacuum thermal insulator 1 according to Embodiment 1, and a load per unit area, when the core 10 taken out of the inside under atmospheric pressure was compressed to a thickness of 50% with respect to an initial thickness, that is, a compression stress (hereinafter referred to as "50% compression stress") was measured. The measurement was conducted by compressing the core 10 cut out to a dimension of 100 mm in length and width at a test speed of 10 mm/min by using a universal tester satisfying the conditions specified under ISO 5893. The thickness of the core 10 taken out of the inside under atmospheric pressure was defined as h_0 . The test was started from an interval of compression plates of the universal tester, which was sufficiently larger than h_0 (for example, h_0+100 mm), and the thickness, when the compression stress reached 0.01 kPa, was defined as an initial thickness h_1 . The test was continued, and the 50% compression stress, when the core 10 was compressed by 50% with respect to the initial thickness h_1 , that is, the thickness of the core 10 became $h_1 \times 0.5$, was measured.

[0027]

In the core 10 of the vacuum thermal insulator 1 according to Embodiment 1 having a thickness of 20 mm, h_0 and h_1 became 150 mm and 148 mm, respectively, and the 50% compression stress became about 0.5 kPa. By contrast, in a core of a conventional vacuum thermal insulator subjected to compression with heating having a thickness of 20 mm, h_0 and h_1 became 50 mm and 49.6 mm, respectively, and the 50% compression stress became about 11 kPa.

[0028]

The core 10 is enclosed in the enclosure films 20, 21 in a state in which the core 10 has a compression stress of 0.05 kPa or more and 5 kPa or less when the core 10 is taken out of the inside of the enclosure 20, 21 and compressed to a thickness of 50% under atmospheric pressure. The fact that the core 10 is enclosed in the enclosure films 20, 21 in such a state can be confirmed by taking the core 10

out of the inside of the enclosure 20, 21 and measuring a compression stress when the core 10 is compressed to a thickness of 50% under atmospheric pressure as described above. The core 10 is not subjected to compression with heating or binding with a binder before being enclosed in the enclosure films 20, 21. Therefore, the core 10 can be compressed to a thickness of 50% with a force of 0.05 kPa or more and 5 kPa or less under atmospheric pressure even after being taken out of the inside of the enclosure 20, 21.

[0029]

Next, a method for 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 closely 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.

[0030]

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 5 times or more as large as the thickness of the vacuum thermal insulator 1 (or the thickness of the core 10) after completion. Further, the 50% compression stress of the core 10 at this time is 5 kPa or less.

[0031]

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 1/5 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.

[0032]

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 more and 100 mm or less. 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.

[0033]

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.

[0034]

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.

[0035]

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 A from the core 10 becomes 5 mm or more and 10 mm or less. Through the above-mentioned steps, the vacuum thermal insulator 1 is obtained.

[0036]

Next, the effect of Embodiment 1 is described. The vacuum thermal insulator 1 according to Embodiment 1 has such a configuration that the core 10 formed of a fiber assembly is in direct contact with the enclosure 20, 21, and the 50% compression stress of the core 10 taken out of the inside of the enclosure 20, 21 is 5 kPa or less. Thus, in Embodiment 1, the heat energy and materials for reducing the thickness of the core 10 are not used during manufacturing of the vacuum thermal insulator 1, and hence the vacuum thermal insulator 1 while saving energy and resources can be obtained.

[0037]

For example, the comparison between the vacuum thermal insulator 1 according to Embodiment 1 and the conventional vacuum thermal insulator in which the core is subjected to compression with heating is considered. In this case, the weight of the core of each vacuum thermal insulator is assumed to be 5 kg, and the thermal deformation temperature for compression with heating is assumed to be 400 degrees centigrade. In the conventional vacuum thermal insulator, this heat energy of 2,000 kJ is consumed, whereas in the vacuum thermal insulator 1 according to Embodiment 1, 2,000 kJ of heat energy can be saved.

[0038]

Further, the density of the core 10 of the vacuum thermal insulator 1 according to Embodiment 1 is about 240 kg/m^3 , whereas the density of the core of the conventional vacuum thermal insulator is as high as about 246 kg/m^3 due to plastic deformation. As a result, in order to maintain the same heat insulating thickness as that of the vacuum thermal insulator 1 according to Embodiment 1 in the conventional vacuum thermal insulator, glass fibers in a larger amount than that in the core 10 of the vacuum thermal insulator 1 are consumed.

[0039]

In contrast, in the vacuum thermal insulator 1 according to Embodiment 1, the usage amount of glass fibers can be reduced as compared to that of the conventional vacuum thermal insulator. For example, in the case where the vacuum thermal

insulator 1 according to Embodiment 1 has a width of 600 mm, a length of 1,700 mm, and a thickness of 22 mm, the usage amount of the core 10 can be reduced by about 150 g as compared to that of the conventional vacuum thermal insulator.

[0040]

5 Thus, according to Embodiment 1, the vacuum thermal insulator 1 while saving energy and resources can be obtained.

[0041]

10 Further, the vacuum thermal insulator 1 according to Embodiment 1 is not subjected to compression with heating or binding with a binder. Thus, in the core 10 taken out of the inside, the glass fibers are not subjected to thermal deformation and do not contain components other than the glass fibers (for example, components of the binder), and hence the glass fibers in the used vacuum thermal insulator 1 can be reused as recycled resources or a recycled material.

[0042]

15 Further, the vacuum thermal insulator 1 according to Embodiment 1 does not contain an inner enclosure or a binder, and hence the amount of the raw material for the vacuum thermal insulator 1 can be reduced.

[0043]

20 Further, in the vacuum thermal insulator 1 according to Embodiment 1, when the distance A between the end portions of the core 10 and the weld sealing portions 40 of the enclosure 20, 21 is set to 5 mm or more and 100 mm or less, the volume reduced state, that is, the compressed state of the core 10 can be maintained even when the pressurization by the compression mechanism 51 is cancelled. Thus, the vacuum thermal insulator 1 in the manufacturing process (for example, before the
25 drying step, before the depressurizing and sealing step) can be stored temporarily in a smaller space, and hence a packaging volume can be reduced.

[0044]

30 Further, the method for manufacturing the vacuum thermal insulator 1 according to Embodiment 1 does not include the step of subjecting the core 10 to compression with heating in formation thereof, the step of hermetically sealing the

core 10 with an inner enclosure, or the step of binding the core 10 with a binder.
Thus, according to Embodiment 1, the vacuum thermal insulator 1 can be
manufactured more efficiently at lower cost.

[0045]

5 Embodiment 2

A thermal insulating box 2 according to Embodiment 2 of the present invention
is described. In Embodiment 2, the thermal insulating box 2 manufactured while
saving energy and resources can be obtained by using the vacuum thermal insulator
1 according to Embodiment 1 in the thermal insulating box 2. Fig. 5 is a sectional
10 view illustrating a schematic configuration of the thermal insulating box 2 according to
Embodiment 2. In Embodiment 2, a thermal insulating box of a refrigerator is
described as an example.

[0046]

As illustrated in Fig. 5, the thermal insulating box 2 includes an inner box 60
15 and an outer box 61. The vacuum thermal insulator 1 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
20 other area of the thermal insulating box 2 is the same as a general thermal insulating
box of a refrigerator, and hence the illustration and description are omitted.

[0047]

In Embodiment 2, the vacuum thermal insulator 1 manufactured while saving
energy and resources is used, and hence the thermal insulating box 2 manufactured
25 while saving energy and resources can be obtained. Further, in Embodiment 2, the
vacuum thermal insulator 1 having heat insulating performance higher than that of the
urethane foam thermal insulator 62 or the like is used, and hence the thermal
insulating box 2 having high heat insulating performance can be obtained as
compared to a thermal insulating box using only a urethane foam thermal insulator as
30 a thermal insulator. Thus, the power consumption can be reduced in a refrigerator

including the thermal insulating box 2.

[0048]

Note that, in the thermal insulating box 2 according to Embodiment 2, 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 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.

[0049]

Other Embodiments

The present invention can be variously modified without being limited to the above-mentioned embodiments. For example, in the above-mentioned method for manufacturing the vacuum thermal insulator 1 according to Embodiment 1, the core 10 is placed in the processing device 50 (compression mechanism 51) in a state of being processed into a required width and length, but the core 10 may be preliminarily compressed at least once to a thickness of about from 10% to 40% before being placed in the processing device 50 in order to adjust the surface state of the core 10.

[0050]

Further, in Embodiment 2, the configuration in which the vacuum thermal insulator 1 is used in the thermal insulating box 2 of a refrigerator including a cooling source is given as an example, but the present invention is not limited thereto. The vacuum thermal insulator 1 can also be used in a thermal insulating box of a heat retention tank including a heating source or a thermal insulating box (such as a cooler box) not including a cooling source or a heating source.

[0051]

Further, the vacuum thermal insulator 1 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 insulator 1 can also be used in

a heat insulating bag including an outer bag and an inner bag that can deform freely and other heat insulating containers, as well as a box having a predetermined shape such as a thermal insulating box.

[0052]

5 Further, the embodiments described above and the modifications may be carried out in various combinations.

Reference Signs List

[0053]

10 1 vacuum thermal insulator 2 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 inner box 61 outer box 62 urethane foam thermal insulator

CLAIMS

[Claim 1]

A vacuum thermal insulator, comprising:

a core formed of a fiber assembly; and

an enclosure hermetically enclosing the core in an inside thereof, the inside being depressurized,

the core being configured to have a compression stress of 5 kPa or less when the core is taken out of the inside of the enclosure and compressed to a thickness of 50% under atmospheric pressure.

[Claim 2]

A vacuum thermal insulator, comprising:

a core formed of a fiber assembly; and

an enclosure hermetically enclosing the core in an inside thereof, the inside being depressurized,

the core being enclosed in the enclosure, and configured to have a compression stress of 5 kPa or less when the core is taken out of the inside of the enclosure and compressed to a thickness of 50% under atmospheric pressure.

[Claim 3]

The vacuum thermal insulator of claim 1 or 2, wherein the fiber assembly is formed of glass wool.

[Claim 4]

The vacuum thermal insulator of any one of claims 1 to 3, wherein the fiber assembly is formed free from binding with a binder.

[Claim 5]

The vacuum thermal insulator of any one of claims 1 to 4, wherein the fiber assembly is formed free from compression with heating.

[Claim 6]

The vacuum thermal insulator of any one of claims 1 to 5, wherein a distance between an end portion of the core and a weld sealing portion of the enclosure is 5 mm or more and 100 mm or less.

[Claim 7]

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

enclosing a core formed of a fiber assembly with an enclosure;
compressing, before depressurizing inside of the enclosure, the core and the enclosure integrally by an external force to bring the core into a compressed state;
forming a weld sealing portion at least on two opposed sides at peripheries of the enclosure in the compressed state; and
depressurizing and hermetically sealing, after forming the weld sealing portion, the inside of the enclosure to obtain a vacuum thermal insulator,
the core being configured to have a compression stress of 5 kPa or less when the core is compressed to a thickness of 50% under atmospheric pressure before being enclosed in the enclosure.

[Claim 8]

A thermal insulating box comprising the vacuum thermal insulator of any one of claims 1 to 6.