Title: FLEXIBLE VACUUM INSULATION PANEL AND METHOD OF MANUFACTURE

Abstract: A flexible vacuum insulation panel (5), and a method of manufacturing the same, comprising at least two substantially coplanar cores (1) of thermal insulation material arranged substantially side-by-side, a compressible insert (3) extending intermediate the at least two cores (1), and an envelope (9) enclosing the at least two cores (1) of thermal insulation material and the compressible insert (3). The panel (5) is capable of flexing along a line extending in the longitudinal direction of the compressible insert (3).
FLEXIBLE VACUUM INSULATION PANEL AND
METHOD OF MANUFACTURE

This invention relates to flexible vacuum insulation panels and their manufacture.

Vacuum insulation panels are of great interest for providing highly efficient thermal insulation performance particularly at low temperatures in the range -50 degrees Celsius to +50 degrees Celsius. Their use in refrigerators and freezers provides a means of reducing energy consumption of these appliances without the need to invest in major changes in manufacturing techniques. A vacuum panel normally consists of a lightweight core in the form of a rigid foamed plastics or a compacted powder or fibrous material. One or more of these materials is contained within a low permeability envelope which is evacuated and sealed to form a rigid panel.

The thermal conductivity of such panels can be four times lower than traditional polyurethane foams most commonly used in refrigerators.

Special envelope materials have been developed to inhibit penetration by gases and water vapour which would otherwise soften the vacuum and diminish the insulation efficiency.
These envelope materials, or barrier bags, are usually in the form of a laminate construction with each layer fulfilling a particular function.

Some applications require vacuum insulation panels which need to cover a large surface area but still be made with a thin core section. Vacuum panels of this type would be too fragile or flexible for the assembly stage of manufacture if they were made from a single core. It is known therefore to place a number of separate cores inside a single barrier bag.

It is generally necessary to condition the core in a drying oven prior to placing the core in a barrier bag. The use of a number of smaller separate cores also enables the drying oven used to condition the cores to be smaller, and therefore more energy efficient, than would be required to process a single large core. This is especially beneficial if the manufacture of large vacuum insulation panels forms only a small part of the size range produced.

The use of multiple cores within a single envelope introduces the possibility of hinge lines along the butting edges of the cores enabling a slatted construction of vacuum insulation panel to be produced with the potential to produce right angle bends along the hinge lines.
This ability to flex the panels enables vacuum insulation panels to be used to insulate corner features on building facades, the inside, or outside, of rectangular ducting or hollow structural sections, or the compressor compartment in refrigerators and freezers.

If the cores are arranged too closely in contact, however, during the manufacture of such a panel, excessive interference can occur making it impossible to attain the required degree of bend.

It is therefore an object of the present invention to provide a flexible vacuum insulation panel and method of manufacture which overcomes or minimises these problems.

According to one aspect of the present invention there is provided a flexible vacuum insulation panel comprising: at least two substantially coplanar cores of thermal insulation material arranged substantially side-by-side, a compressible insert extending intermediate the at least two cores, and an envelope enclosing the at least two cores and the compressible insert, whereby the panel is capable of flexing along a line extending in the longitudinal direction of the compressible insert.
According to another aspect of the present invention there is provided a method of manufacturing a flexible vacuum insulation panel comprising the steps of: arranging at least two substantially coplanar cores of thermal insulation material substantially side-by-side, arranging a compressible insert to extend intermediate the at least two cores, enclosing the at least two cores and the compressible insert in an envelope, and evacuating the envelope, whereby the panel is capable of flexing along a line extending in the longitudinal direction of the compressible insert.

The compressible insert may be a foamed material.

The at least two cores of thermal insulation material may comprise one or more materials selected from powders, fibres, substantially rigid foams, moulded insulation materials and pre-cast insulation shapes. The powders may be in the form of compacted powders.

The powders may include a microporous matrix. The microporous matrix may include an opacifier and may be reinforced with fibres.

The at least two cores may comprise finely divided silica having a large surface area.
The finely divided silica may be compacted to a density sufficient to withstand air pressure applied to a surface of the panel.

The at least two cores of thermal insulation material may be formed to have an angled, mitred edge.

The envelope may be in the form of a laminate construction and may be manufactured from more than one laminate construction.

For a better understanding of the present invention and to show more clearly how it may be carried into effect reference will now be made, by way of example, to the accompanying drawings in which:

Figure 1 is a cross-sectional view of an embodiment of a flexible vacuum insulation panel according to the present invention and showing an arrangement of components prior to evacuation of an outer envelope;

Figure 2 is cross-sectional view of the flexible vacuum insulation panel of Figure 1 showing the arrangement of components after evacuation of the outer envelope and subsequent exposure to atmospheric pressure; and
Figure 3 is cross-sectional view of the flexible vacuum insulation panel shown in Figure 2 in a flexed configuration.

Although the figures show the cores shaped such that the linear dimension of one face of the core is greater than the opposite face, thus forming an angled or mitred (chamfered) edge, it should be understood that the cores could be produced such that they have substantially square or radiused edges.

Referring to Figures 1, 2 and 3, a flexible vacuum insulation panel 5 comprises two thermal insulation cores 1 in a substantially coplanar configuration, with a compressibly deformable insert 3 positioned between the cores, the cores 1 and the insert 3 all being contained within an envelope 9.

The thermal insulation cores 1 are arranged in a coplanar configuration with facing edges 2 of the cores being separated by a predetermined distance due to the thickness of the deformable insert 3.

Figure 1 shows the construction of the vacuum insulation panel before it is evacuated and sealed. Where mitred edged cores are used in the construction of a panel 5, it is
preferable that the cores are arranged such that the longer sides of the cores are adjacent. Due to the angled, mitred shape of the facing edges of the cores, a void 7 is present between the insert 3 and the cores 1.

The panel 5 is then evacuated and sealed using standard techniques and apparatus (not shown) well known to the skilled person.

Figure 2 shows the construction of the vacuum insulation panel 5 after evacuation and sealing.

The action of the evacuation process and the subsequent exposure to atmospheric pressure causes the insert 3 to be compressed to a minimal thickness whilst still maintaining the required separation between the cores 1.

Figure 3 shows how the region of the panel 5 containing the minimally thick insert 3 can be used as a hinge line such that flexing the panel 5 along a line passing through the body of the insert 3 enables the panel to obtain an angled configuration. In practice the majority of applications will require the panel to be flexed to substantially ninety degrees.
The cores 1 of thermal insulation material may comprise any of the well known materials such as powders, fibres, substantially rigid foams, compacted powders, moulded insulation materials and pre-cast insulation shapes. The powders and compacted powders may comprise organic or inorganic materials and may include a microporous matrix which may also include an opacifier. Such opacifier may be in powder, particulate or platelet form.

The compacted powders may be reinforced with fibres.

A particularly advantageous material for the core 1 is finely divided silica having a large surface area and which can act as a getter for water and gas molecules. The finely divided silica is compacted to a density sufficient to withstand air pressure applied to a surface of the panel.

Another particularly suitable material comprises finely divided carbon particles. Such a material provides a core structure with opacification and is also very effective when combined with silica or other materials.

The core 1 may also be formed from fibres, which may be organic or inorganic and either natural or synthetic. A bonding agent may be used with such fibres.
The core 1 may also comprise a substantially rigid foam material, particularly polyurethane foam. However other foam materials may be used which are either organic or inorganic in nature and comprising, for example, ceramic or carbon.

The compressible insert 3 is preferably manufactured from a compressible foamed material, for example polyurethane.

In order to achieve the most efficient evacuation of air from within the foamed insert 3 the foamed material is preferably of the open-celled variety.

The envelope 9 is of a form well known to the skilled person, that is the envelope is of a laminate construction with each layer fulfilling a particular purpose. A typical construction for the envelope 9 is an outer layer of polyethylene terephthalate (PET) providing an abrasion resistant surface, a second layer of aluminium which inhibits permeation of water vapour and other gases, a third layer of nylon to give tear resistance and a fourth layer of polyethylene to allow heat sealing. The layers are bonded to one another by an adhesive so that the laminate construction handles as a single film.
The present invention is particularly advantageous in the manufacture of large surface area vacuum insulation panels.

The control of the gap size left between the facing edges of adjacent cores, by the use of the foam inserts in accordance with the present invention, ensures that the panels can be flexed to allow substantially ninety degree angles without excessive interference between the adjacent cores.

The ability to flex vacuum insulation panels to produce substantially ninety degree angles results in the panels being easier to fit inside, or around, ducting, compartments and other cavities. The panels can be applied in a shallow corrugated form to insulate in variable spacings between structural members.
CLAIMS

1. A flexible vacuum insulation panel (5) characterised in that the panel (5) comprises at least two substantially coplanar cores (1) of thermal insulation material arranged substantially side-by-side, a compressible insert (3) extending intermediate the at least two cores (1), and an envelope (9) enclosing the at least two cores (1) of thermal insulation material and the compressible insert (3), whereby the panel (5) is capable of flexing along a line extending in the longitudinal direction of the compressible insert (3).

2. A panel as claimed in claim 1, characterised in that the compressible insert (3) is a foamed material.

3. A panel as claimed in claim 1 or 2, characterised in that the at least two cores (1) of thermal insulation material comprise one or more materials selected from powders, fibres, substantially rigid foams, moulded insulation materials and pre-cast insulation shapes.

4. A panel as claimed in claim 4, characterised in that the powders are in the form of compacted powders.
5. A panel as claimed in claim 3 or 4, characterised in that the powders include a microporous matrix.

6. A panel as claimed in claim 5, characterised in that the microporous matrix includes an opacifier.

7. A panel as claimed in claim 4, 5 or 6, characterised in that the compacted powders are reinforced with fibres.

8. A panel as claimed in any one of claims 3 to 7, characterised in that the at least two cores (1) of thermal insulation material comprise finely divided silica having a large surface area.

9. A panel as claimed in claim 8, characterised in that the finely divided silica is compacted to a density sufficient to withstand air pressure applied to a surface of the panel (5).

10. A panel as claimed in any preceding claim, characterised in that the at least two cores (1) of thermal insulation material are formed to have an angled, mitred edge (2).
11. A panel as claimed in any preceding claim, characterised in that the envelope (9) is in the form of a laminate construction.

12. A panel as claimed in claim 11, characterised in that the envelope (9) is manufactured from more than one laminate construction.

13. A method of manufacturing a flexible vacuum insulation panel (5) characterised by the steps of: arranging at least two substantially coplanar cores (1) of thermal insulation material substantially side-by-side, arranging a compressible insert (3) to extend intermediate the at least two cores (1), enclosing the at least two cores (1) and the compressible insert (3) in an envelope (9), and evacuating the envelope (9), whereby the panel (5) is capable of flexing along a line extending in the longitudinal direction of the compressible insert (3).

14. A method according to claim 13, characterised in that the compressible insert (3) is a foamed material.

15. A method according to claim 13 or 14, characterised in that the at least two cores (1) of thermal insulation material comprise one or more materials selected from
powders, fibres, substantially rigid foams, moulded insulation materials and pre-cast insulation shapes.

16. A method according to claim 15, characterised in that the powders are in the form of compacted powders.

17. A method according to claim 15 or 16, characterised in that the powders include a microporous matrix.

18. A method according to claim 17, characterised in that the microporous matrix includes an opacifier.

19. A method according to claim 16, 17 or 18, characterised in that the compacted powders are reinforced with fibres.

20. A method according to any one of claims 15 to 19, characterised in that the at least two cores (1) of thermal insulation material comprise finely divided silica having a large surface area.

21. A method according to claim 20, characterised in that the finely divided silica is compacted to a density sufficient to withstand air pressure applied to a surface of the panel (5).
22. A method as claimed in any one of claims 13 to 21, characterised in that the at least two cores (1) of thermal insulation material are formed to have an angled, mitred edge (2).

23. A method as claimed in any one of claims 13 to 22, characterised in that the envelope (9) is in the form of a laminate construction.

24. A method as claimed in claim 23, characterised in that the envelope (9) is manufactured from more than one laminate construction.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 E04B1/80 F16L59/06 F25D23/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 E04B F16L F25D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<thead>
<tr>
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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>A</td>
<td>US 5 273 801 A (KIRBY DAVID B ET AL) 28 December 1993 (1993-12-28) column 4, line 36 - column 4, line 44; figures 9,10</td>
<td>1-24</td>
</tr>
<tr>
<td>A</td>
<td>US 4 794 748 A (SCHILF LOTHAR) 3 January 1989 (1989-01-03) column 3, line 9 - column 4, line 38; figure 1</td>
<td>1-24</td>
</tr>
<tr>
<td>A</td>
<td>US 4 791 773 A (TAYLOR LAWRENCE H) 20 December 1988 (1988-12-20) claim 1; figure 9</td>
<td>1-24</td>
</tr>
<tr>
<td>A</td>
<td>DE 199 15 311 A (WOLFF WALDRODE AG ;BAYER AG (DE)) 5 October 2000 (2000-10-05) page 6, line 29 - page 6, line 34; figure 1</td>
<td>1-24</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of box C.

X Patent family members are listed in annex.

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Date of the actual completion of the International search

15 July 2003

Date of mailing of the international search report

04/08/2003

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<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>US 5273801 A</td>
<td>28-12-1993</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT 58941 T</td>
<td>15-12-1990</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 1295267 C</td>
<td>04-02-1992</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 3766585 D1</td>
<td>17-01-1991</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GR 3001172 T3</td>
<td>30-06-1992</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 63096395 A</td>
<td>27-04-1988</td>
</tr>
<tr>
<td>US 4791773 A</td>
<td>20-12-1988</td>
<td>NONE</td>
<td></td>
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<tr>
<td>DE 19915311 A</td>
<td>05-10-2000</td>
<td>DE 19915311 A1</td>
<td>05-10-2000</td>
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<td>AU 3292100 A</td>
<td>23-10-2000</td>
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<td>BR 0009545 A</td>
<td>26-12-2001</td>
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<td></td>
<td>CA 2367996 A1</td>
<td>12-10-2000</td>
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<td>CN 1345394 T</td>
<td>17-04-2002</td>
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<td></td>
<td>WO 0060184 A1</td>
<td>12-10-2000</td>
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<td></td>
<td>EP 1169525 A1</td>
<td>09-01-2002</td>
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<td>HU 0200652 A2</td>
<td>29-07-2002</td>
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<td></td>
<td>JP 2002541393 T</td>
<td>03-12-2002</td>
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<tr>
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<td>PL 350763 A1</td>
<td>27-01-2003</td>
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<td></td>
<td>TR 200102830 T2</td>
<td>21-03-2002</td>
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