A method of forming a panel for thermal insulation

The invention relates to a method of forming a panel for thermal insulation, which may be typically used in building applications, but is not limited to use in this area.

Most buildings are designed and built with some form of thermal insulation, for example, in floors, walls and roofs. Thermal insulation helps to prevent loss of energy and save costs. For example, in the winter, thermal insulation can help to prevent loss of thermal energy from within a building to the environment. This means that heating costs can be reduced, as less heat needs to be supplied to the building.

Similarly, in the summer, the thermal insulation can act to reduce transfer of thermal energy from the environment into a cooled environment, for example from the hot environment outside into an air conditioned building.

Thermal insulation can act to mainly prevent at least some of the three types of transfer of thermal energy, namely conduction, convection and radiation.

It is known to provide panels for insulation. These panels help to prevent convection by reducing movement of particles which transfer thermal energy. The panels need to be fairly thick, in order to provide good thermal insulation against convection. A problem with these panels can be in applications where maximising space is key. The thick panels will act to significantly reduce the space within a building. Consequently, various improvements have been developed to attempt to overcome this problem.

One such solution is the provision of a vacuum insulated panel, such as the ProTherm Quantum® or Kingspan's OPTIM-R® panel. These panels comprise an isolated core formed of a rigid, highly porous material. The core is wrapped by a membrane and subsequently air is evacuated. This leaves behind a rigid highly porous core which is vacuum packed, i.e. tightly sealed by the membrane.

Vacuum panels have an additional benefit, in that both conduction and convection can be significantly reduced by the provision of a vacuum. It should be noted that although the word “vacuum” is used, in reality, a perfect vacuum is not realistically achievable, but rather the vacuum is a “near-vacuum”, i.e. having a pressure significantly below atmospheric pressure. Since there is no (i.e. a negligible amount of) medium to transfer the thermal energy in the vacuum, then there can be no thermal energy transfer by convection and thus good insulation. Moreover, the low pressure provided by the vacuum in the panel reduces the conductivity (which is caused by collisions between particles) since the distance between particles which could collide is significantly increased by the evacuation of most of the particles capable of thermal energy transfer.

Thus, since the thermal insulation properties of vacuum panels are far superior to conventional insulation panels, there is a further benefit that much thinner panels are required than previously. For example, a 4 cm thick panel could replace a conventional 20 or 22 cm thick panel. Thus the advantages of space saving can be realised.

However, a problem with currently used vacuum insulated panels arises from the membrane used to surround the core being a thin, flexible foil. This material is beneficial for creating the vacuum, since it can tightly surround the core and follow its shape. However, it can easily be damaged if stepped on with a sharp item (such as a piece of gravel on a person’s boot on a construction site) and/or easily penetrated by sharp objects. Such damage compromises the vacuum within the panel and as such, the thermal performance of the vacuum panel is significantly reduced.

Since a compromised panel will not provide the thermal performance expected, any building with such panels may not be thermally efficient and may have a reduced thermal efficiency compared to other buildings. As a result, there will need to be more energy expenditure within a building than at present with conventional panels.

Further, if a vacuum insulated panel is damaged, there are financial losses as a result of high energy expenditure and also on replacing damaged panels, in particular because vacuum insulated panels are much more expensive than their conventional counterparts.

In order to protect the panels against damage, great care has to be taken in their transport and installation. This is not easy to do without dedicated personnel, especially with the use of forklift trucks and on construction sites.

One possible solution to this problem has been to cover the surfaces of the panel with solid sheets of rubber crumb material.

According to a first aspect of the invention, there is provided a method of forming a panel for thermal insulation comprising: coating at least one surface of a vacuum insulated panel with a liquid-applied membrane, wherein the liquid-applied membrane is a polyurethane elastomeric membrane, the coating comprising applying the liquid-applied membrane by spraying and encapsulating the vacuum insulated panel with the liquid-applied membrane~~; wherein the method comprises~~ by spraying one side of the panel, turning the panel over, and spraying the other side of the panel; wherein the method comprises combining two component parts to make a formulation which is used as the liquid applied to the vacuum insulated panel.

In at least some preferred embodiments, liquid to form a base portion of the liquid-applied membrane is sprayed onto the vacuum insulated panel from a first distance therefrom, and liquid to form a roughened surface texture of the liquid-applied membrane is sprayed onto the base portion from a second distance greater than the first distance.

The base portion may comprise a uniform base portion, such that a first uniform coating of liquid-applied membrane is formed on the panel.

~~In at least some embodiments, the liquid-applied membrane is a polyurethane elastomeric membrane.~~

~~In at least some embodiments, the method further comprises combining two component parts to make a formulation which is used as the liquid applied to the vacuum insulated panel.~~

The method of the first aspect of the invention is used to form a panel for thermal insulation comprising: a vacuum insulated panel; and a coating of liquid-applied membrane which encapsulates the vacuum insulated panel.

By coating the vacuum insulated panel, protection is provided for the panel. Intimate contact between the surface and the liquid-applied membrane can be obtained. This is not available in the known method of adhering a pre-formed solid sheet to a surface of a vacuum insulated panel.

A vacuum insulated panel comprises a core surrounded by a membrane wall. The core is evacuated of air, thereby forming a vacuum and the membrane wall seals the core, thereby maintaining the vacuum therein. The core may be formed of a porous structure which serves to support the membrane wall against atmospheric pressure. The membrane wall may be formed of a metallic foil.

The coating of liquid-applied membrane encapsulates the vacuum insulated panel.

Among the advantages of encapsulation are that all surfaces of the panel are coated. This allows the panel to be protected on all sides and thus not to be accidentally damaged on a non-protected side.

In at least some panels, the coating of liquid-applied membrane has a roughened surface texture.

By roughening the surface with a texture, a better grip of the panel can be achieved and thus damage due to the panel slipping from lack of grip and falling can be mitigated.

In at least some panels, the roughened surface texture is formed on only one surface of the panel.

By roughening only a single surface, an orientation of the panel can be established. For example, an “up-side” and a “down-side” can be defined and should a panel need to be placed in a particular configuration, this can be more easily achieved.

~~In at least some panels, the liquid-applied membrane is a polyurethane elastomeric membrane.~~

The polyurethane elastomeric membrane provides a waterproof and durable surface, ensuring that the panel can be utilised in protected environments and exposed to adverse weather conditions. The material properties also provide high impact and tear strength and sufficient elasticity to allow potentially damaging applied loads not to damage the membrane or the underlying panel. Further, the underlying core of the panel can deform slightly under an impact with a sharp object. The coating of a coated panel can deform by a comparable amount to the underlying core under applied loading. Thus, a panel with high impact and damage resistance can be realised.

~~In at least some panels, t~~The liquid-applied membrane comprises a formulation comprising two component parts which are combined.

This ensures that the membrane sets quickly, since the components are mixed and applied directly. The benefits of this are short processing time, which can be beneficial as the panels, if encapsulated or coated on opposite sides may need to be turned over without compromising the already-coated side.

The panel for thermal insulation may be used for buildings or structures, and may also be used as thermal insulation in applications such as fridges, freezers, shipping containers and the like.

According to a second aspect of the invention, there is provided a method of forming a panel for thermal insulation in accordance with the first aspect of the invention, and a method of using the panel, the method of using the panel comprising using it for thermal insulation in or on a building or structure.

Using a panel in or on a building or structure will enable more reliably improved thermal insulation properties, and thus savings in energy and cost, since the thermal efficiency of the panels will not be compromised due to accidental destruction of the vacuum.

In at least some embodiments, the method comprises using the panel for thermal insulation in or on at least one of: an external-facing surface of the building or structure; an internal-facing surface of the building or structure; a wall or roof of the building or structure; and a floor of the building or structure.

Thus, the panels of the present invention could be used to insulate many alternative surfaces of a building, both for protected surfaces and for those exposed to adverse weather conditions, birds landing, etc.

A building or structure having the provision of such a panel will realise more reliably improved thermal insulation properties, and thus savings in energy and cost, since the thermal efficiency of the panels will not be compromised due to accidental destruction of the vacuum.

~~At least in the preferred embodiments of the invention, t~~The coating of liquid-applied membrane on a surface of a vacuum insulated panel produces a protective layer which is bonded to the surface at all parts thereof. By using a spraying coating step, both bonding to and coverage of the surface is achieved by that step. The resulting coated surface can maintain flexibility, and the material of the surface, such as metal foil, can flex together with the coating if subject to external forces, producing a resilient combination. In particular, the material of the surface is protected from being pierced by sharp objects. The coating can thus improve the puncture resistance of a vacuum insulated panel.

Further aspects, embodiments and features of the invention will now be described, by way of example only, according to the following numbered drawings. It should be noted that the Figures are schematic only and not to scale.

Figure 1 shows a perspective view of a vacuum insulated panel as known from the prior art;

Figure 2 shows a cross section along the line A-A of the known vacuum insulated panel of Figure 1;

Figure 3 shows a perspective view of a panel of the present invention according to a first embodiment;

Figure 4 shows a cross section along the line B-B of the panel of Figure 3;

Figure 5 shows a perspective view of a panel of the present invention according to a second embodiment;

Figure 6 shows a cross section along the line C-C of the panel of Figure 5;

Figure 7 shows a perspective view of the vacuum insulated panel of Figure 1, having a liquid-applied membrane being applied by spraying at a first distance from the panel; and

Figure 8 shows a perspective view of the panel of Figure 3, having a textured surface being applied by spraying liquid-applied membrane from a second distance from the panel.

Figures 1 and 2 show a vacuum insulated panel 1 as known from the prior art. The vacuum insulated panel 1 comprises a core 3 and a membrane wall 2. The core 3 is a rigid, highly porous structure which can support its shape against the atmospheric pressure on the membrane wall 2 when air is evacuated from the core 3 to form a vacuum. The membrane wall 2 surrounds the core 3 and is sealed, thereby maintaining the vacuum within the core 3.

The core 3 may for example be formed of materials such as fumed silica, aerogel, perlite or glass fibre.

The membrane wall 2 is typically formed of a metallic foil.

Figures 3 and 4 show a panel 10 according to a first embodiment. The panel 10 comprises a prior art vacuum insulated panel 1 which has been coated on ~~at least one~~all surfaces by a liquid-applied membrane 4. Thus a coated vacuum insulated panel 10 is obtained.

The liquid-applied membrane 4 provides an extra layer on top of the foil membrane wall 2 of the panel 10, thereby forming a thicker, more damage-resistant outer layer. The application of the liquid-applied membrane 4 as a coating provides intimate contact between the membrane wall and the liquid-applied membrane. This is a more intimate contact than can be achieved by adhering a pre-formed solid sheet to the membrane wall.

The application of the membrane 4 as a liquid can be carried out to provide an even and uniform coating over the surface of the panel 10.

The coating of liquid-applied membrane 4 encapsulates the vacuum insulated panel as can be envisaged from Figures 3 and 4. The panel is coated on its upper and lower surfaces, its side surfaces and also at its edges and corners. The use of a liquid-applied membrane can provide such encapsulation, providing all round protection for the vacuum insulated panel 1. The use of pre-formed solid sheets, even if applied to all the surfaces of a vacuum insulated panel 1, would not provide encapsulation.

The liquid-applied membrane 4 ~~may be~~is a polyurethane elastomeric membrane, for example, the VERDISEAL™ Membrane which is part of the DOW® VERDISEAL™ liquid-applied roof waterproofing system by the DOW® Chemical Company.

The liquid-applied membrane 4 ~~may~~ comprises a formulation comprising two component parts which are combined. Thus once applied, the formulation will quickly set.

Figures 5 and 6 show a panel 20 according to a second embodiment. At least one surface 5 of the coating of liquid-applied membrane 4 has a roughened surface texture 6. By roughening only the top surface 5 of the panel 20 as shown, the panel can be provided with a “non-slip” surface. In addition, an orientation of the panel can be established. For example, textured surface 5 could be designated as an “up-side” or upwards-facing surface, while the opposite facing surface could be designated as a “down-side” or downwards-facing surface. These designations could allow easy placing of the panel.

In Figures 2, 4 and 6, the membrane wall 2 is shown much thicker than it would be in practice, for purposes of illustration. Similarly, in Figures 4 and 6, the liquid-applied membrane 4 is shown thicker than it would be in practice. In the embodiments, enough liquid is applied to form the membrane as a complete coating without gaps.

Figures 5 and 6 show the roughened surface texture 6 formed on only one surface 5 of the panel 20; however it is envisaged that any number of sides of the panel can be provided with a surface texture. Irrespective of how many surfaces have a roughened surface texture, the texture provides improved grip of the panel, thereby mitigating damage of the panel due to slippage and dropping.

Figures 7 and 8 respectively show embodiments for manufacturing a panel 10 according to the first embodiment and a panel 20 according to the second embodiment. Figure 7 shows a uniform base coat of liquid-applied membrane 4 being sprayed from a spray nozzle 7 onto the surface of a vacuum insulated panel 1 from a first distance D_1. The spray nozzle 7 is moved following the surface of the panel 1 such that a base portion is formed. The base portion is a uniform coating of liquid-applied membrane on the panel and is an even and uniform base coat on the top and side surfaces of the panel. Once this has been done, if the panel 1 is to be encapsulated, the panel is left to set for a short time and then turned over. The same spray-process is applied to the other side of the panel, from the first distance D_1 from the panel. The side surfaces, edges and corners of the panel are also coated by the spray-processes. Thus, the panel 10 according to the first embodiment is created.

If a roughened surface texture 6 is desired, then once the uniform base coat has been applied as described above in relation to Figure 7, a quick spray is given from a distance D_2 from the panel which is greater than a distance D_1. By increasing the distance, the drops of the liquid-applied membrane 4 become more sparsely spaced and thus the surface texture 6 comprises droplets of the liquid-applied membrane 4.

While the above applications of the coating were described in terms of spray distances D_1, D_2, it is envisaged that such effects could also be obtained by other means, for example, by the use of different nozzles 7 and/or different pressures applied to the nozzles 7.

The panel may be used for thermal insulation in a building or structure. Such applications could include but are not limited to external-facing surfaces, internal-facing surfaces, walls, roofs or floors of the building or structure.

While the invention has been shown and described with reference to embodiments, those skilled in the art will readily appreciate that changes and/or modifications may be made thereto without departing from the scope of the invention as set out in the claims.

Claims:

1. A method of forming a panel for thermal insulation comprising:

coating all surfaces of a vacuum insulated panel with a liquid-applied membrane, wherein the liquid-applied membrane is a polyurethane elastomeric membrane, the coating comprising applying the liquid-applied membrane by spraying and encapsulating the vacuum insulated panel with the liquid-applied membrane~~;~~

~~wherein the method comprises~~ by spraying one side of the panel, turning the panel over, and spraying the other side of the panel;

wherein the method comprises combining two component parts to make a formulation which is used as the liquid applied to the vacuum insulated panel.

2. A method as claimed in claim 1, wherein liquid to form a base portion of the liquid-applied membrane is sprayed onto the vacuum insulated panel from a first distance therefrom, and liquid to form a roughened surface texture of the liquid-applied membrane is sprayed onto the base portion from a second distance greater than the first distance.

3. A method as claimed in claim 1 or 2, wherein the ~~liquid-applied membrane is a polyurethane elastomeric membrane~~coating comprises leaving the liquid-applied membrane to set after applying the liquid to the vacuum insulated panel.

4. A method as claimed in claim 1, 2 or 3, ~~comprising combining two component parts to make a formulation which is used as the liquid applied to the vacuum insulated panel~~wherein the coating comprises spraying the side surfaces, edges and corners of the panel.

5. A method of forming a panel for thermal insulation as claimed in any of claims 1 to 4, and a method of using the panel, the method of using the panel comprising using it for thermal insulation in or on a building or structure.

6. A method as claimed in claim 5, comprising using the panel for thermal insulation in or on at least one of:

an external-facing surface of the building or structure;

an internal-facing surface of the building or structure;

a wall or roof of the building or structure; and

a floor of the building or structure.

7. A method as claimed in any of claims 1 to 6, wherein the vacuum insulated panel comprises a rigid, porous core and a foil membrane wall.

Abstract

A panel for thermal insulation

A panel for thermal insulation comprising a vacuum insulated panel 1 and a coating of liquid-applied membrane 4 on at least one surface of the vacuum insulated panel.

[Fig. 6]