

Insulation

Field of the Invention

This invention relates to insulation, and more particularly insulation sheeting.

The invention has been devised particularly, although not necessarily solely, for
5 insulating buildings and other structures. Accordingly, the invention also relates
to a building construction incorporating the insulating sheeting.

Background Art

There are various types of insulation currently available for buildings, including
thermo-reflective insulating sheeting. An example of thermo-reflective insulation
10 sheeting is disclosed in the Applicant's Australian Innovation patent 2003100663.
Such insulating sheeting comprises a single layer closed cell structure interposed
between two outer layers, at least one of which comprises reflective foil. This
insulation sheeting has proved to be a particularly effective barrier in reducing
energy transfer, the closed cell structure serving to reduce the amount of heat
15 transferred through convection and conduction, and the reflective foil layer
serving to reduce heat transfer through radiation.

The single layer closed cell structure comprises a plurality of plastic membranes
bonded together to form a plurality of air cells therebetween. The air cells are of
generally cylindrical construction each of a diameter between eight millimetres
20 and twenty five millimetres, and a depth of between about three millimetres and
ten millimetres.

The dimensions of the air cells were selected to provide the necessary insulation
characteristics without the need to rely upon a double layer cell structure which
was previously used in the prior art.

25 However, insulation sheeting comprising a single layer cell structure defined by
membranes bonded together may have some limitations.

Accordingly, the present invention seeks to provide insulation sheeting which does not require a closed cell structure defined by membranes bonded together.

Disclosure of the Invention

According to a first aspect of the invention there is provided insulation sheeting
5 comprising a cell structure interposed between two outer layers, the cell structure comprising a closed cell foam structure.

Preferably, the closed cell foam structure is flexible and resiliently compressible.

Preferably the closed cell foam structure comprises polyethylene foam. More preferably, the closed cell foam structure comprises cross-linked low density
10 polyethylene (LDPE) foam.

The foam structure is advantageous as it provides resistance to moisture absorption and thereby enhances resistance to development of mould.

The LDPE foam is advantageous as it provides the insulation sheeting with enhanced thermal and acoustic insulation characteristics as well as greater
15 resistance to heat and flame.

Preferably, at least one of the two outer layers comprises reflective foil. More preferably, both outer layers comprise reflective foil.

Preferably, the reflective foil comprises aluminium foil. The aluminium foil may comprise 99.5 percent pure aluminium reflective foil.

20 Preferably, at least one of the outer layers is reinforced for tear resistance. The reinforcement may be provided by a scrim bonded to the foil layer for reinforcement to provide strength and tear resistance. Preferably, the scrim comprises high density polyethylene weave laminated to the aluminium foil. Other types of scrim can also be used, one example being polypropylene weave.

Preferably, one of the reflective layers may be treated for glare reduction. The layer may be treated in any appropriate way, such as by applying a surface treatment such as colouring thereto. Suitable colours for the surface treatment comprise red, blue, green or orange tones.

- 5 The treatment for glare reduction is designed to provide a reduction of glare to provide greater comfort and protection against glare blindness while still providing a low enough emittance to provide thermal resistance by way of an upper reflective air space ideally within a range of $E=0.08$ to $E=0.14$

- 10 The close cell foam structure is preferably provided with fire retardancy. This may be achieved by the addition of an appropriate quantity of a fire retardant substance to the resin from which the foam structure is formed.

Preferably, antioxidant is added to the foam to provide durability. Preferably, UV protection is also provided to the insulation sheeting.

- 15 The insulation sheeting is advantageous as it can compress under load for fixing while still affording worthwhile insulation benefits. This is because of the presence of the closed cell foam structure.

For certain applications, the outer layers may be perforated for air and water vapour permeability through the insulation sheeting.

- 20 Preferably, the perforations are of a size, spacing and number to provide permeability to water vapour in accordance with achieving a low classification for resistance to water vapour transmission under Australian and New Zealand standard AS/NZS4200.1. Such permeability will allow the building to "breathe" through the insulation sheeting and also minimises the build up of condensation attributable to the barrier effect of the insulation sheeting.

- 25 Preferably, the perforations are formed after construction of the insulation sheeting. In one arrangement, the perforations may extend not only through the two outer layers but also entirely through the closed cell foam structure located

therebetween. In another arrangement, the perforations may extend through the two outer layers and partly through the closed cell foam structure located therebetween. In the latter arrangement, the perforations may extend into the closed cell foam structure from one outer layer and terminate within the closed
5 cell foam structure inwardly of the other outer layer. With this arrangement, the perforations may comprise holes extending through said one outer layer and into the closed cell foam structure to terminate inwardly of the other outer layer, the holes opening onto said one outer layer at openings therein and there being corresponding opening in the other outer layer.

- 10 The perforations in the outer layers and the central closed cell foam structure are preferably in alignment to assist air and moisture vapour transmission through the sheeting. The perforations may be generated by perforating the sheeting with a perforating device comprising a set of sharp end extrusions designed to perforate the sheeting at a variety of predetermined intervals.
- 15 According to a second aspect of the invention there is provided a building construction comprising a frame, cladding attached to the frame, and insulation between the frame and the cladding, the insulation comprising insulation sheeting according to the first aspect of the invention.

Brief Description of the Drawings

- 20 The invention will be better understood by reference to the following description of several specific embodiments thereof as shown in the accompanying drawings in which:

Figure 1 is a schematic fragmentary elevational view of insulation sheeting according to a first embodiment, with part of an outer layer of the sheeting
25 removed to reveal the inner closed cell foam structure;

Figure 2 is a fragmentary side elevational view of the insulation sheeting of Figure 1;

Figure 3 is a fragmentary perspective view of a building construction in which insulation sheeting according to the first embodiment is installed;

Figure 4 is a fragmentary sectional view of the building construction shown in Figure 3;

- 5 Figure 5 is a schematic fragmentary elevational view of insulation sheeting according to a second embodiment, with part of an outer layer of the sheeting removed to reveal the inner closed cell foam structure;

Figure 6 is a fragmentary side elevational view of the insulation sheeting of Figure 5; and

- 10 Figure 7 is a fragmentary side elevational view of insulation sheeting according to a third embodiment.

Best Mode(s) for Carrying Out the Invention

- Referring to Figures 1 and 2 of the drawings, there is shown insulation sheeting 10 according to the first embodiment. The insulation sheeting 10 comprises two
15 outer layers 11, 12 and a closed cell structure 13 bonded therebetween. Each outer layer 11, 12 has an outer surface 14.

- The sheeting 10 is of a thickness between the outer surfaces 14 which allows the sheeting to be disposed in a rolled configuration and also unrolled to assume a substantially flat configuration. The thickness can be up to about 12mm for
20 typical applications. In one typical application the thickness is about 4mm and in another typical application it is about 8-9mm.

- The outer layers 11, 12 each comprises reinforced reflective aluminium foil. The reflective aluminium foil comprises 99.5 % pure aluminium reflective foil reinforced with high density polyethylene scrim. The reinforcement enhances the
25 tensile strength of the insulation sheeting 10, allowing it to be installed over large

spans in a building construction. The reinforcement also provides greater tear strength.

The outer layers 11, 12 can be applied to the closed cell foam structure in any appropriate way. One particularly suitable way involves a hot melt lamination
5 process.

The closed cell foam structure 13 comprises flexible light gauge foam which is compressible with at least some resiliency. In this embodiment, the closed cell foam structure 13 comprises cross-linked LDPE foam. The polyethylene foam incorporates UV protection, fire retardancy and an antioxidant. The fire
10 retardancy is such as to provide compliance with AS1530.2. Indeed, the fire retardant may provide a Fire Index of less than or equal to five under AS1530.2. Antioxidant protection is such as to afford a minimum 15 year product life when installed.

The cross-linked structure of the closed cell foam structure 13 provides
15 enhanced thermal and acoustic insulation characteristics, as well as greater resistance to heat and flame, in comparison to the prior art insulation sheeting referred to previously. Specifically the closed cell foam structure 13 produced from cross-linked LDPE foam allows construction of insulation sheeting which is thinner than the prior art sheeting referred to previously because of inherent
20 stiffness in the foam arising from the cross-linking. Further, the closed cells within the cross-linked LDPE foam are much smaller in size than the air cells in the prior art sheeting. Indeed, the closed cells in the foam structure 13 comprise micro-encapsulated air cells, typically of a cross-sectional size less than 0.1mm. With this arrangement, the air cells are generally evenly distributed within the
25 foam structure 13, so affording better fire resistance. This is because there are no relatively large bubbles of air to support combustion, as exist in the prior art insulation referred to previously. The even distribution of micro-encapsulated air cells also provides resistance to thermal and acoustic energy transfer.

In this embodiment, the reflective foil has a thickness of about 6.5µm and the
30 scrim comprises high density polyethylene scrim with a 6mm by 6mm weave.

The outer surface 14 of one of the layers 11, 12 is treated to provide some glare reduction while retaining heat reflective characteristics. Glare reduction can be particularly desirable on construction sites where the sheeting may be exposed for some time so creating a glare problem for persons in the vicinity. In this embodiment, the treatment comprises colouring. In this embodiment, the colouring comprises an orange pigment.

The insulating sheeting according to the first embodiment has a material thermal resistance of $R0.20\text{m}^2\text{K/W}$ ($\pm 0.25\text{ m}^2\text{K/W}$).

In addition to providing a barrier to heat transfer, the sheeting 10 according to the first embodiment also provides a barrier to air and water vapour.

The insulation sheeting 10 is advantageous as it can compress under load for fixing while still affording worthwhile insulation benefits. This is because of the presence of the closed cell foam structure.

The insulation sheeting is suitable for use in building construction involving a frame and cladding attached to the frame, where the insulation sheeting can be installed between the frame and the cladding. The cladding may comprise wall cladding or roof cladding.

The insulation sheeting is particularly suitable for installation steel frame building construction, where it may be necessary to a thermal break between the steel framing and the wall cladding to reduce thermal bridging and conductivity the framing and the cladding. A typical example of such an installation is shown in Figures 3 and 4. The installations comprise the sheeting 10 installed between a wall frame 15 and cladding 16 of a building construction 17. The wall frame 15 comprises wall frame elements such as studs 18 and noggings 19. The cladding 16 is attached to the wall frame 15 at appropriate locations 20, with the insulation sheeting 10 compressed therebetween. Spacers 21 (known as spacer biscuits) provided on the insulation sheeting 10 to maintain the insulation sheeting in spaced apart relation to the cladding 16 to establish a gap 23 therebetween

(other than at locations where the insulation sheeting 10 is compressed between the cladding 16 and the wall frame elements).

The insulation sheeting according to this embodiment can function as a thermal break, insulation and vapour barrier. It is waterproof and unaffected by water in normal applications. Accordingly, it is particularly suitable for humid climates and can afford protection against water damage. It will not promote growth of fungi or bacteria and does not provide a nesting medium for rodents and insects.

There are certain situations where it is desirable that insulation sheeting have some permeability to air and water vapour so as to reduce the risk of moisture damage due to condensation. The insulation sheeting according to a second embodiment seeks to provide such insulation sheeting.

Referring now to Figures 5 and 6, the insulation sheeting according to the second embodiment is similar in many respects to the insulation sheeting according to the first embodiment and so corresponding reference numerals are used to identify corresponding parts.

In the second embodiment, however, the insulation sheeting is provided with permeability to air and water vapour. In this regard, the insulation sheeting has a plurality of perforations 25 extending through the sheeting 10 between the two outer surfaces 14. The perforations 25 comprise holes 27 formed by piercing the sheeting 10 with a perforating tool. The holes 27 not only extend through the outer layers 11, 12 to open on to the outer surface 14 thereof at openings 28 but also extend through the closed cell foam structure 13. The perforations 25 are not apparent in the closed cell foam structure 13 owing to the compressible nature of the foam. Even though collapsed within the closed cell foam structure 13, the perforations 25 do provide a transmission path through the sheeting 10 for air and water vapour.

Referring now to Figure 7, the insulation sheeting according to the third embodiment is similar in many respects to the insulation sheeting according to

the second embodiment and so corresponding reference numerals are used to identify corresponding parts.

In the third embodiment, the perforations 25 extend through the two outer layers 11, 12 and partly through the closed cell foam structure 13 located therebetween.

- 5 More particularly, the perforations comprise holes 27 which extend into the closed cell foam structure 13 from outer layer 11 and terminate within the closed cell foam structure inwardly of the other outer layer 12. The perforations comprise openings 28 in the two outer layers 11, 12 as was the case with the second embodiment. The holes 27 extend from corresponding openings 28 in
10 outer layer 11 and terminate inwardly of openings 28 in outer layer 12 to define spaces 29 therebetween.

- It should be appreciated that the scope of the invention is not limited to the scope of the three embodiments described. For example, it is not necessary that both outer layers 11, 12 be reflective foil. One of the outer layers could be reflective
15 foil (preferably treated for glare reduction) and the other layer could comprise a membrane of any appropriate type including for example polyethylene film.

Modifications and changes can be made without departing from the scope of the invention.

- Throughout the specification, unless the context requires otherwise, the word
20 "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

- 5 1. Insulation sheeting comprising a cell structure interposed between two outer layers, each bonded directly to the cell structure, the cell structure comprising a closed cell cross-linked low density foam structure, wherein at least one of the two outer layers comprises reflective foil.
- 10 2. Insulation sheeting according to claim 1, wherein the closed cells are micro-encapsulated air cells.
3. Insulation sheeting according to claim 2, wherein the micro-encapsulated air cells are substantially of a cross-sectional diameter of less than about 0.1 mm.
- 15 4. Insulation sheeting according to any one of the preceding claims, wherein the closed cell foam structure comprises polyethylene foam.
5. Insulation sheeting according to claim 4, wherein the closed cell foam structure comprises cross-linked low density polyethylene (LDPE) foam.
- 20 6. Insulation sheeting according to any one of the preceding claims, wherein both outer layers comprise reflective foil.
7. Insulation sheeting according to claim 6, wherein the reflective foil comprises aluminium foil.
- 25 8. Insulation sheeting according to claim 7, wherein the aluminium foil comprises 99.5 percent pure aluminium reflective foil.
- 30 9. Insulation sheeting according to any one of the preceding claims, wherein at least one of the outer layers is reinforced for tear resistance, the reinforcement comprising a scrim bonded to the outer layer.

10. Insulation sheeting according to claim 9, wherein the scrim comprises high density polyethylene weave laminated to the outer layer.
- 5 11. Insulation sheeting according to any one of the preceding claims, wherein at least one of the reflective layers is treated for glare reduction.
- 10 12. Insulation sheeting according to any one of the preceding claims, wherein the closed cell foam structure is provided with fire retardency and/or incorporates an antioxidant for durability.
- 15 13. Insulation sheeting according to any one of the preceding claims, wherein the closed cell foam structure has UV protection.
14. Insulation sheeting according to any one of the preceding claims, wherein the outer layers are perforated for air and water vapour permeability through the insulation sheeting.
- 20 15. Insulation sheeting according to claim 14, wherein the perforations are formed after construction of the insulation sheeting.
16. Insulation sheeting according to claim 14 or claim 15, wherein the perforations extend through the two outer layers and the closed cell foam structure located therebetween.
- 25 17. Insulation sheeting according to claim 14 or claim 15, wherein the perforations comprise holes extending through one outer layer and into the closed cell foam structure to terminate inwardly of the other outer layer.
- 30 18. Insulation sheeting according to claim 17, wherein the holes open onto said one outer layer at openings therein and wherein there are corresponding opening in the other outer layer.

19. Insulation sheeting according to any one of claims 16 to 18, wherein the perforations in the outer layers and the closed cell foam structure are in alignment to assist air and moisture vapour transmission through the sheeting.

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20. A building construction comprising a frame, cladding attached to the frame, and insulation between the frame and the cladding, the insulation comprising insulation sheeting as defined according to according to any one of the preceding claims.

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