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(54) A laminate, especially for use as underroofing

(57) A water vapour permeable laminate (16), especially for use as underroofing or underslating for roofs. The laminate comprises an outer layer (18) that is formed by a perforated first film or foil, and an inner layer (19) which has at least some areas formed by a second, non-perforated film of the type having a water vapour diffusion resistance, which varies in dependency of the relative humidity of air in contact therewith. Thus, the vapour diffusion resistance is reduced, when the relative humidity increases, and vice versa, and the laminate is characterised in that the water vapour diffusion resistance of the outer layer (18) substantially exceeds the maximum water vapour resistance of the second film (19).

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Description

[0001] The present invention relates to a water vapour permeable laminate, especially for use as an underroofing or underslating for roofs.

[0002] A heat insulated roof structure normally comprises an outer roof covering, such as tiles, an underslating or underroofing in the form of a substantially water impermeable plastic film or laminate, a layer of heat insulation, and an inner vapour barrier in the form of a plastic film or laminate. The purpose of the underslating is to prevent rainwater and drift snow having passed through the roof cover from penetrating into the heat insulation. Normally, small amounts of moisture are diffusing through the vapour barrier from the room under the roof structure and into the insulation layer. In order to minimise the risk of rot in the wooden structure, such moisture has to be removed. Traditionally, this is done by forming a ventilating space between the underslating and the insulation, which ventilating space communicates with the ambient atmosphere. It is also known to dispense with that ventilating space. In the latter case the underslating should fulfil two apparently contradicting conditions, namely be substantially impermeable to moisture from the outside towards the inside, but permeable to moisture from the inside towards the outside.

[0003] The present invention provides an improved water vapour permeable laminate, which is suited for use as an underroofing or underslating for roofs in a non-ventilated roof structure.

[0004] Thus, the present invention provides a water vapour impermeable laminate, especially for use as underroofing or underslating for roofs, and comprising an outer layer formed by a perforated first film or foil, and an inner layer having at least some areas formed by a second, non-perforated film of the type having a water vapour diffusion resistance, which varies in dependency of the relative humidity of air in contact therewith, such that the vapour diffusion resistance is reduced, when the relative humidity increases, and vice versa, and the laminate according to the invention is characterised in that the water vapour diffusion resistance of the outer layer substantially exceeds the maximum water vapour resistance of the second film. Preferably, the total inner layer or film is made from the same plastic material. It should be understood, however, that the inner layer could be made from mutually spaced areas of such material having a diffusion resistance, which is dependent on the relative humidity of the contacting air, and the said spaced areas could be interconnected by connecting areas of film or foil being substantially impervious to water vapour or having a diffusion resistance being less dependent on the relative humidity of the contacting air.

[0005] Such laminate prevents water stemming from for example driving rain or drift snow from penetrating there through and into the insulation layer and the roof structure. On the other hand, when the relative humidity in the room under the underslating or underroofing is high water vapour may diffuse through the second film and through the perforations of the first film or foil out into the ambient atmosphere. Thus, the laminate according to the invention functions like a one-way valve allowing moisture to pass from the inner room under the roof covering and outwards into the outer atmosphere, only.

[0006] The diffusion resistance of the outer layer in a non-perforated condition must be relatively high even when the relative humidity on the outer side thereof is high. In a preferred embodiment the diffusion resistance of the outer layer exceeds 20 m and preferably 90 m air column.

[0007] Preferably, the diffusion resistance of the inner layer is less than 18 m, 15m, 10m, 5m or 1m air column at a relative humidity of at least 80% at an exposed inner surface of the inner layer. More preferred the diffusion resistance of the inner layer is much less, namely between 0.02 and 0.6 m air column at a relative humidity of at least 80% at the exposed inner surface of the inner layer.

[0008] The outer layer or the first film is perforated in order to allow water vapour to pass outwardly from the inner space of the building into the outer atmosphere. On the other hand, the laminate according to the invention should be substantially impermeable to water, Therefore, the perforations of the first film or foil of the outer layer are preferably substantially impermeable to liquid water, but permeable to water vapour.

[0009] The perforations of the first film or foil may be substantially uniformly distributed over the area of the outer layer. Alternatively, the perforations may be concentrated in certain mutually spaced areas, which may, for example be band shaped, circular, rectangular, etc. The perforations may be made in any suitable manner, such as by punching, corona discharge, flame perforation or rendered breathable by an overload of fillers or defined between overlapping edge portions of for example band shaped parts.

[0010] Each of the perforations in the first film or foil may have a substantially uniform cross-sectional shape along its length transversely to the film or foil. However, in order to reduce the resistance against water vapour passing from the inner space of the building and outwardly through the underslating or laminate and still prevent liquid water on the outside of the laminate from penetrating the outer layer thereof the cross-sectional area of at least some of the perforations of the first film or foil may increase from the outer surface of the film or foil towards the inner surface thereof. This means that each of said at least some perforations are funnel-shaped from the inner surface of the film or foil towards the outer surface thereof.

[0011] In order to prevent liquid water from penetrating the laminate according to the invention from the outer side thereof the minimum dimension or diameter of each of at least the majority of the perforations of the first film or foil of the outer layer is preferably smaller

than 1.5 mm, preferably at the outer surface of the outer layer and the said minimum dimension or diameter of each of said majority of the perforations are preferably between 0.001 and 0.5 mm.

[0012] In order to allow water vapour to pass through the laminate according to the invention from the inner side thereof the resistance to diffusion of water vapour from the exposed surface of the inner layer to the outer surface of the outer layer should preferably be equal to or less than 0.6 m air column at a relative humidity of at least 80% at said exposed surface of the inner layer.

[0013] The second film of the inner layer may be made from any material having a varying diffusion resistance against water vapour as described above. According to the invention such material may be selected from the group consisting of polyamide, ethylene-vinyl alcohol copolymer, polyvinyl alcohol, polyurethane, protein derivatives, methylcellulose, cellophane, linseed oil alkyd, and bone glue.

[0014] The first film or foil of the outer layer may be made from any film or foil which in its imperforated condition is substantially impervious to water vapour. Thus, the first film or foil may be made from one or more of the materials selected from the group consisting of aluminium and other metals, polyethylene, polypropylene, polyethylene terephthalate, metallised polyethylene terephthalate, and polyvinylidene chloride.

[0015] The first and second films may be directly interconnected at their adjoining surfaces. In the preferred embodiment, however, the laminate according to the invention further comprises an intermediate layer of a water vapour transmitting material. Thus, water vapour having passed the inner layer of the laminate may distribute in the vapour transmitting or porous intermediate layer and find its way to the perforations of the perforated outer layer. Preferably, the intermediate layer is a matted material, for example spun bonded felt or spun bonded needle felt. The material of the intermediate layer preferably does not include organic material, which may support the growth of microorganisms. The material of the intermediate layer may preferably be water absorbing in order to be able to absorb possible condensed water vapour. Thus, the water absorbing material of the intermediate layer may include a hydrophilic material. The intermediate layer may, for example, comprise or consist of felt having a weight of between 10 and 100 g/m^2, preferably 20-80 and more preferred 40-60 g/m^2, in its dry condition. By way of examples the intermediate layer may comprise one or more of any of the following materials: oil hydrophilised polyethylene terephthalate fibres, polypropylene fibres, and acrylic fibres or fibres comprising hydrophilic and hydrophobic components, such as polypropylene and poly-hydroxyethyl methacrylate.

[0016] The present invention further comprises a roof structure comprising an outer roofing and an inner roofing or underroofing impervious to water, and the roof structure according to the invention is characterised in that the inner roofing comprises any of the above described embodiments of the laminate according to the invention, the outer layer of said laminate being positioned adjacent to the inner surface of the outer roofing.

[0017] The invention will now be further described with reference to the drawings, in which

Fig. 1 is a sectional view of a roof structure including an underroofing or underslating formed by a laminate according to the invention, and

Fig. 2 is a sectional view of a preferred embodiment of the laminate according to the invention.

[0018] Fig. 1 is a sectional view of a roof structure according to the invention. This roof structure of a building (not shown) includes a wooden structure comprising a plurality of upper and lower battens 10 and 11, respectively, extending between the roof ridge and the eaves, and counter battens 12 extending transversely to the battens 10 and 11. A roof covering 13 made up by tiles or other roofing plates is fastened to the upper battens 10. The roof structure further comprises an insulating layer 14, which is arranged between the upper battens 10 and the lower battens 11, and which may, for example, be made from stone wool or fibre glass. Furthermore, a ceiling lining 15 may be fastened to the bottom surfaces of the lower battens.

[0019] It is important to prevent water resulting for example from driving rain or drift snow having passed through the roof covering 13 from penetrating into the insulating layer 14, because a high humidity therein may give rise to rot and promote growth of fungi and other micro-organisms. For this reason an underroofing or underslating in the form of a laminate 16 in accordance with the invention and shown in further detail in Fig. 2 is arranged between the bottom surfaces of the upper battens 10 and the upper surface of the insulating layer 14. A further laminate or vapour barrier 17, which may be of the type disclosed in applicant's international patent application WO 00/37751 or WO 96/3332, may be arranged between the lower surface of the insulating layer 14 and the upper surfaces of the lower battens 11. The purpose of this laminate 17 is described in more detail in the above international patent application.

[0020] Fig 2 is a cross-sectional view of an embodiment of the laminate 16 according to the invention. This laminate 16 comprises an upper or outer layer 18, which may be in the form of a plastic film or a metal foil, a lower or an inner layer or plastic film 19, and an internnediate layer 20 of a porous, felt-like material.

[0021] The upper layer 18 is made from a material, which is not only impermeable to liquid water, but also substantially impermeable to water vapour. However, in order to allow water vapour to pass through the upper layer 18 it is provided with a great plurality of small through openings or perforations 21. The diameter of each of these perforations 21 is so small that liquid water

cannot pass through the perforations from the outer surface of the upper layer. The perforations may be distributed uniformly over the total area of the upper layer or be arranged in mutually spaced groups as shown in Fig. 2. The lower or inner layer 19 is a non-perforated plastic film of the type having a water vapour diffusion resistance, which is reduced when the relative humidity of the air in contact therewith increases, and vice versa. Preferably, the water vapour diffusion resistance of the inner layer 19 is between 0.02 and 0.6 m air column at a relative humidity of at least 80% at the inner surface thereof. The intermediate layer 20 may, for example, be made from an inorganic felt material.

[0022] The underroofing 16 in accordance with the present invention prevents liquid water from passing there through, and the water vapour diffusion resistance of the of the material from which the film or foil is made is high. Therefore, no or negligible amounts only of water vapour will pass inwardly through the outer layer 18. If, however, for some reason the humidity of the insulating layer and of the air around the wooden roof structure remains high for a longer period of time, detrimental micro-organisms may attack the wooden roof structure. Therefore, it is important that the humidity of the air in the space defined between the upper laminate 16 and the lower laminate 17 is kept below a certain upper limit.

[0023] This may be obtained by the laminate or underroofing 16 according to the invention. When the humidity of the air enclosed in the space between the laminates 16 and 17 increases the water vapour diffusion resistance of the lower or inner layer 19 of the laminate 16 decreases so that water vapour may pass into the porous and possibly water absorbing intermediate layer 20 of the laminate 17. From the intermediate layer 20 the humidity may pass out into the ambient atmosphere via the perforations 21 in the outer layer 18. Preferably, the resistance to diffusion of water vapour from the exposed surface of the inner layer 19 to the outer surface of the outer layer 18 of the laminate 16 is equal to or less than 0.6 m air column at a relative humidity of at least 80% at inner surface of the inner layer 19.

[0024] It should be understood that var ous modifications and changes of the embodiments of the laminate and of the roof structure described above could be made without departing from the scope of the present invention as defined in the attached claims.

Claims

1. Water vapour permeable laminate (16), especially for use as underroofing, and comprising

   an outer layer (18) formed by a perforated first film or foil, and

   an inner layer (19) having at least some areas formed by a second, non-perforated film of the type having a water vapour diffusion resistance, which varies in dependency of the relative humidity of air in contact therewith, such that the vapour diffusion resistance is reduced, when the relative humidity increases, and vice versa

   characterised in that the water vapour diffusion resistance of the outer layer (18) substantially exceeds the maximum water vapour resistance of the second film (19).

2. A laminate according to claim 1, wherein the diffusion resistance of the outer layer (18) in a non-perforated condition exceeds 20 m and preferably 90 m air column.

3. A laminate according to claim 1 or 2, wherein the diffusion resistance of the inner layer (19) is less than 18 m air column at a relative humidity of at least 80% at an exposed inner surface of the inner layer.

4. A laminate according to claim 3, wherein the diffusion resistance of the inner layer (19) is between 0.02 and 0.6 m air column at a relative humidity of at least 80% at the exposed inner surface of the inner layer.

5. A laminate according to any of the claims 1-4, wherein the perforations (21) of the first film or foil of the outer layer (18) are substantially impermeable to liquid water, but permeable to water vapour.

6. A laminate according to any of the claims 1-5, wherein the perforations (21) of the first film or foil (18) are concentrated in certain mutually spaced areas.

7. A laminate according to any of the claims 1-6, wherein the cross-sectional area of at least some of the perforations (21) of the first film or foil (18) is increasing from the outer surface of the film or foil towards the inner surface thereof.

8. A laminate according to any of the claims 1-7, wherein the minimum dimension or diameter of each of at least the majority of the perforations (21) of the first film or foil of the outer layer (18) is smaller than 1.5 mm, preferably at the outer surface of the outer layer.

9. A laminate according to claim 8, wherein the said minimum dimension or diameter of each of said majority of the perforations (21) are between 0.001 and 0.5 mm.

10. A laminate according to any of the claims 1-9, wherein the resistance to diffusion of water vapour from the exposed surface of the inner layer (19) to the outer surface of the outer layer (18) is equal to or less than 0.6 m air column at a relative humidity of at least 80% at said exposed surface of the inner

layer.

11. A laminate according to any of the claims 1-10, wherein the second film (19) of the inner layer is made from a material selected from the group consisting of polyamide, ethylene-vinyl alcohol-copolymer, polyvinyl alcohol, polyurethane, protein derivatives, methylcellulose, cellophane, linseed oil alkyd, and bone glue.

12. A laminate according to any of the claims 1-11, wherein the first film or foil of the outer layer (18) is made from one or more of the materials selected from the group consisting of aluminium and other metals, polyethylene, polypropylene, polyethylene terephthalate, metallised polyethylene terephthalate, and polyvinylidene chloride

13. A laminate according to any of the claims 1-12, further comprising an intermediate layer (20) of a water vapour transmitting material, such as felt.

14. A roof structure comprising an outer roofing (13) and an inner roofing (16) impervious to water, **characterised in that** the inner roofing comprises a laminate (16) according to any of the claims 1-13, the outer layer (18) of said laminate being positioned adjacent to the inner surface of the outer roofing (13).

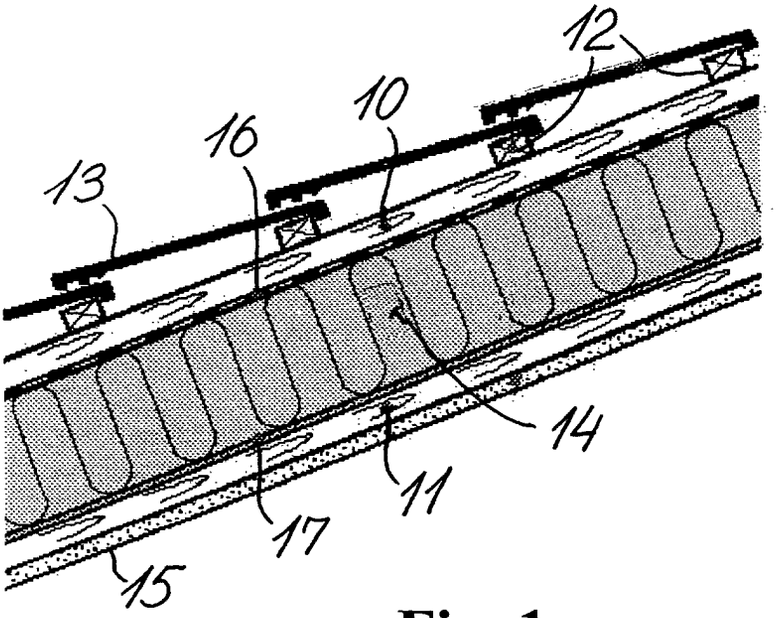

Fig. 1

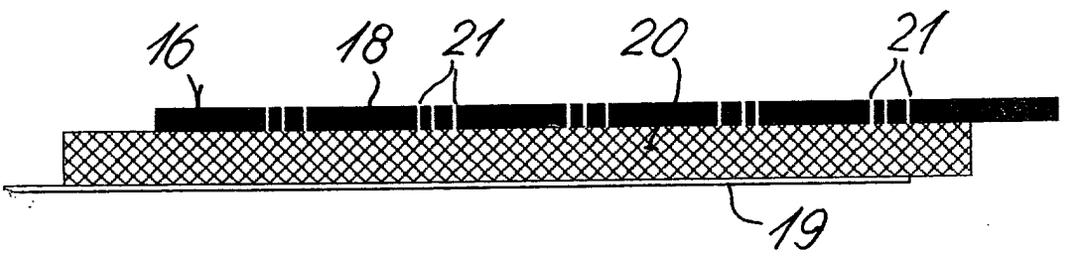

Fig. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 61 0119

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A,D	WO 00 37751 A (HARDER SVEN ;ICOPAL AS (DK)) 29 June 2000 (2000-06-29) * abstract *	1	E04D12/00
A	US 4 567 080 A (KORSGAARD VAGN) 28 January 1986 (1986-01-28) * claims 1,6; figures 1,2 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

E04D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 March 2001	Hendrickx, X

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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E : earlier patent document, but published on, or after the filing date
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 61 0119

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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12-03-2001

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