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(72) Inventeurs/Inventors:
KUNZEL, HARTWIG, DE;
GROSSKINSKY, THEO, DE

(73) Propriétaire/Owner:
FRAUNHOFER-GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG E.V., DE

(74) Agent: MCFADDEN, FINCHAM

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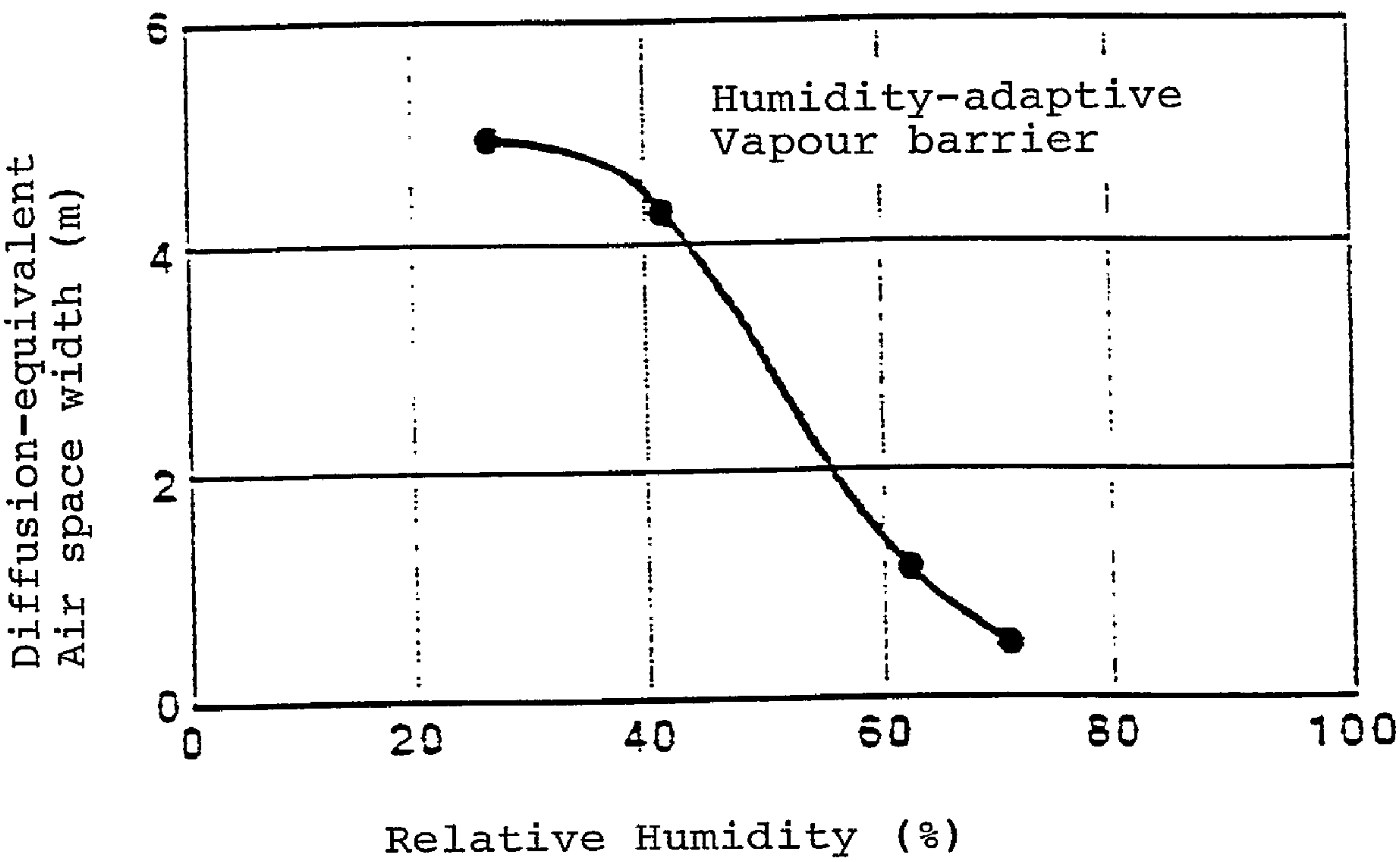

(57) Abrégé/Abstract:
The invention relates to a vapour barrier for use in the heat insulation of buildings, which can be particularly used for heat insulation measures in new buildings or in the renovation of old buildings. The vapour barrier according to the invention is here in a position to effect water vapour diffusion under different environmental conditions. This is achieved by a material being used as the essential material which has a water vapour diffusion resistance dependent on the ambient humidity and in addition has adequate tensile strength and tear resistance.

Abstract

The invention relates to a vapour barrier for use in the heat insulation of buildings, which can be particularly used for heat insulation measures in new buildings or in the renovation of old buildings. The vapour barrier according to the invention is here in a position to effect water vapour diffusion under different environmental conditions. This is achieved by a material being used as the essential material which has a water vapour diffusion resistance dependent on the ambient humidity and in addition has adequate tensile strength and tear resistance.

Vapour Retarder for Use in Heat Insulation of Buildings

The invention relates to a vapour barrier, arranged room-oriented, for use in heat insulation of buildings, especially for heat insulation measures in new buildings and in the renovation of old buildings.

In order to reduce the carbon dioxide emission which occurs due to heating of buildings, heat insulation measures are carried out in the construction of new buildings and in the renovation of old buildings. For economic reasons which constantly have to be considered by the owner of the building, the question of costs also has to be taken into account here. Moreover, the outer appearance of the building is here a significant factor which likewise represents a limit to what can actually be done. Thus, for example, heat insulation measures of this kind can only be carried out on buildings which have a framework visible through insulation layers lying on the inside. The acceptable amount of moisture in the framework wood must also be ensured especially under winter conditions by the possible diffusion of vapour and also by the vapour barrier room-oriented. In contract to this, the rain moisture penetrating in the summer months through the joints between the wooden posts and the nogging must be able to dry out towards the inside as well, in order to guarantee long life for the wood used in the framework.

Similar difficulties also arise in the subsequent complete rafter insulation on high-pitched roofs with a vapour-tight front covering (e.g. roofing fabric on planking). Thus tests carried out by the Fraunhofer Institut für Bauphysik showed that where vapour barriers were applied inside with a water vapour diffusion resistance (S_d-value) which is smaller than 10 m diffusion-equivalent air space width, especially on roofs oriented towards the north, the extent to which the planking dries out in summer is not sufficient to achieve a wood moisture situation which is harmless. Thus vapour barriers which are applied room-oriented can no longer to an adequate extent carry away moisture accumulations which are caused by convection, for example.

Proceeding from these known advantages, it is one feature of the invention, in preferred forms, to create a vapour barrier arranged room-oriented which is in a position, under different conditions, variable in use, to guarantee a water vapour diffusion between the space air and the interior of a building component such as will to as large an extent as possible prevent damage of the building material used being caused by moisture.

In accordance with an embodiment of the present invention, there is provided, a water vapor exchange system for use in building insulation comprising (i) a fiber insulation and (ii) a vapor retarder selected from (a) a film comprising polyamide with a thickness of 20µm to 100µm and (b) a polymer coating applied to a carrier material; the film or the coating having a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding the vapor retarder in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air-layer thickness.

In accordance with another embodiment of the present invention there is provided vapour retarder for use in water vapor exchange systems used in building insulation, the vapor retarder comprising a film comprising polyamide or a polymer coating applied to a carrier material having a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding the vapor retarder in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air layer thickness.

In accordance with a further embodiment of the present invention there is provided a water vapor exchange system comprising (i) thermal insulation and (ii) a film or a polymer coating applied to a carrier having a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding the vapor retarder in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air layer thickness.

In accordance with a yet further embodiment of the present invention there is provided a method for providing a vapor barrier to a building, comprising installing a film or a polymer coating applied to a carrier on at least a part of the building, wherein the film has a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding the vapor retarder in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air layer thickness.

In accordance with one embodiment of the present invention there is provided in a method of building construction or renovation, the improvement comprising applying a film to a structure of the building, wherein the film has a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding the vapor retarder in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air layer thickness.

In accordance with another embodiment of the present invention there is provided a building structure, comprising a film attached to the building structure, wherein the film has a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding the vapor retarder in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air layer thickness.

In accordance with a further embodiment of the present invention there is provided a roof of a building, comprising a film attached to the roof of the building, wherein the film has a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding the vapor retarder in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air layer thickness.

The film, in a preferred embodiment, is selected from the groups consisting of nylon-6, nylon-4 and nylon-3.

In another preferred embodiment, the material of the vapour barrier is a support material having a polymer coating applied thereto. The polymer coating can be selected from the group consisting of polyvinyl alcohol, a synthetic-polymer dispersion, methylcellulose, linseed oil alkyd, bone glue and protein derivatives.

In a further preferred embodiment, the material used for the vapour barrier is applied as a coating on a support material with a low water-vapour diffusion resistance.

In another preferred embodiment, the material is placed so as to form a sandwich between two layers of a support material with low water-vapour diffusion resistance. Preferably, the support material is selected from fiber-reinforced cellulose materials.

The vapour barrier according to the invention, which can also be termed "humidity-adaptive vapour barrier" uses as an essential material one that has a water vapour diffusion resistance dependent on the ambient humidity and has sufficient tensile and compressive strength to be used in buildings as they are being built.

The material used for the vapour barrier, in the form of a film or as a coating on a carrier material, should have, with a relative humidity of the atmosphere surrounding the vapour barrier between 30% and 50%, a water vapour diffusion resistance value (S_d-value) of 2 to 5 m of a diffusion-equivalent air space width, and with a relative humidity in the region of 60% to 80%, such as is typical for the summer months, for example, a water vapour diffusion resistance (S_d-value) which is smaller than 1 m diffusion-equivalent air space width.

This leads to a higher water vapour diffusion resistance being achieved under winter conditions than under summer conditions. In this way, the drying out process in the summer can be favoured without the moisture supply under winter conditions being able to assume a value which can cause damage to the materials used and to the building itself.

In addition to the applications already mentioned with the disadvantages of the state of the art, the invention can also be used on metal roofs or timber post constructions and there, too, can lead, in addition to an improvement in the heat insulation, to a reduction of the building costs.

As a material for the vapour barrier having the desired properties it is possible to use, for instance a polyamide 6, a polyamide 4 or polyamide 3, as they are known in particular from BIEDERBICK, K., "Kunststoffe - kurz und bündig", Vogel-Verlag Würzburg. These polyamides are inserted as films and inherently have the required characteristics in relation to water vapour diffusion resistance. Moreover, they have the strengths necessary for use in buildings, and can thus be used without any additional outlay. The thickness of the films can be in the region of 10 μm to 2 mm, preferably in the region of 20 μm to 100 μm.

However, other materials may also be used which do not have adequate strength and may be applied to suitable carrier materials. The carrier materials here preferably have a low water vapour diffusion resistance and the required characteristics of the vapour barrier according to the invention are essentially provided by the coating.

Fibre reinforced cellulose materials, such as paper webs, films made of synthetic fibre spun fabrics or even perforated polyethylene films, for example, may be used as materials for the carrier or carriers.

The material can also be present as a coating on a carrier material. The coating can here be applied to one side of the carrier material but also in special cases be received between two layers of carrier material like a sandwich. In the latter case, the coating material is effectively protected from both sides against being worn away mechanically and can therefore guarantee the desired water vapour diffusion over a long period of time. A plurality of layer constructions can also be constructed, laid one above the other.

Different substances and materials can be used for the coating of the carrier material. Thus polymers, such as, for example, modified polyvinyl alcohols, can be applied with appropriate coating processes. Here the water vapour diffusion resistance varies, measured according to DIN 52615, by more than the power of ten between a dry and a damp environment.

However, dispersed synthetic resins, methyl cellulose, linseed oil alkyd resin, bone glue or protein derivatives can also be used as coating material for the carrier.

Where the carrier material is coated on one side, this coating can be applied on the side on which no protection, or only very little, is required against mechanical influences. The mounting of the vapour barrier according to the invention can in this case be done in such a way that the protective carrier material shows towards the side facing the space or towards the side turned away from the space.

The invention is to be described in greater detail below by means of an example.

The vapour barrier according to the invention is here formed solely from a film which consists of polyamide 6. Experiments were carried out with a film thickness of 50 μm. The polyamide 6 films used are currently manufactured by the firm MF-Folien GmbH in Kempten, Germany.

Hygroscopic Behaviour in the Laboratory Test

The water vapour diffusion resistance of the humidity-adaptive vapour barrier was determined according to DIN 52 615 in the dry region (3/50 % relative humidity (relative humidity)) and in the damp region (50/93 % relative humidity) as well as in two damp regions lying in between (33/50 % and 50/75 relative humidity). The result for the diffusion-equivalent air space width (s_d-value) of the vapour barrier with a thickness of 50 µm is represented in Figure 1 in dependence on the average relative humidity prevalent in the test. The difference between the s_d - value in the dry region and that in the damp region is more than the power of ten, so that under practical space air conditions which move between 30 % and 50 % in winter and between roughly 60 % and 70 % in summer it can be expected that the diffusion streams can be clearly controlled by the vapour barrier.

An Example of a Practical Application

Mathematical tests have shown that high-pitched roofs with vapour-tight secondary roofs, after the installation of a complete inter-rafter insulation made of mineral fibre 10 cm to 20 cm thick, can become so damp within a few years despite a vapour barrier room-oriented that damage is unavoidable. The situation is particularly critical with high space air humidities which vary, for example between 50 %

relative humidity in January and 70 % relative humidity in July when at the same time the short-wave radiation gain through northerly orientation is relatively low. The influence of the humidity-adaptive vapour barrier on the long-term moisture balance of such constructions under the climatic conditions of Holzkirchen is therefore estimated below with the aid of a method which has already been verified several times in experiments.

Proceeding from an non-insulated high-pitched roof (28° pitch) orientated towards the north and with planking, bituminized felt and tile covering, which roof is in hygroscopic equilibrium with its surroundings, the behaviour of the humidity after the installation of inter-rafter insulation with a traditional vapour barrier and with the humidity-adaptive vapour barrier room-oriented is shown in Fig. 2. The course of the overall humidity in the roof is indicated above and the course of the wood moisture of the planks is indicated below, over a period of ten years. Whilst the humidity in the roof with the traditional vapour barrier quickly rises with seasonal fluctuations, with wood moisture values (> 20 M.-%) giving cause for concern long-term already occurring in the first year, in the roof with the humidity-adaptive vapour barrier no moisture accumulation can be detected. In the summer the wood moisture falls constantly below 20 M-%

there, such that no moisture damage is to be feared here.

The humidity-adaptive vapour barrier thus opens up the possibility of insulating high-pitched roofs on old buildings without great risk of damage.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A water vapor exchange system for use in building insulation comprising (i) a fiber insulation and (ii) a vapor retarder selected from (a) a film comprising polyamide with a thickness of 20µm to 100µm and (b) a polymer coating applied to a carrier material; the film or the coating having a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding the vapor retarder in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air-layer thickness.

2. The system according to claim 1, wherein the vapor retarder is a polyamide film.

3. The system according to claim 1 or 2, wherein the film is selected from the group consisting of polyamide 6, polyamide 4 and polyamide 3.

4. The system according to claim 1, wherein the polymer for the polymer coating is selected from the group consisting of polyvinyl alcohol, dispersed synthetic resin, methyl cellulose, linseed oil alkyd resin, bone glue and protein derivatives.

5. The system according to claim 1 or 4, wherein the carrier material has a low water vapor diffusion resistance.

6. The system according to any one of claims 1 to 5, wherein the film or the polymer coating is received like a sandwich between two layers of the carrier material with a low water vapor diffusion resistance.

7. The system according to any one of claims 1 to 6, wherein the carrier material is chosen from a fiber reinforced cellulose material.

8. The system according to any one of claims 1 to 6, wherein the carrier material is a film made of synthetic fiber-spun fabrics or a perforated film made of polyethylene.

9. The system according to any one of claims 1 to 8, wherein the fiber insulation is made of mineral fibers.

10. Vapor retarder for use in water vapor exchange systems used in building insulation, said vapor retarder comprising a film comprising polyamide or a polymer coating applied to a carrier material having a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding the vapor retarder in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air layer thickness.

11. The vapor retarder according to claim 10, wherein the vapor retarder is a polyamide film.

12. The vapor retarder according to claim 10 or 11, wherein the film is selected from the group consisting of polyamide 6, polyamide 4 and polyamide 3.

13. The vapor retarder according to claim 10, wherein the polymer for the polymer coating is selected from the group consisting of polyvinyl alcohol, dispersed synthetic resin, methyl cellulose, linseed oil alkyd resin, bone glue and protein derivatives.

14. The vapor retarder according to claim 10 or 13, wherein the carrier material has a low water vapor diffusion resistance.

15. The vapor retarder according to any one of claims 10 to 14, wherein the film or the polymer coating is received like a sandwich between two layers of the carrier material with a low water vapor diffusion resistance.

16. The vapor retarder according to any one of claims 10 to 15, wherein the carrier material is chosen from a fiber reinforced cellulose material.

17. The vapor retarder according to any one of claims 10 to 15, wherein the carrier material is a film made of synthetic fiber-spun fabrics or a perforated film made of polyethylene.

18. A water vapor exchange system comprising (i) thermal insulation and (ii) a film or a polymer coating applied to a carrier having a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding said film or polymer coating in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air layer thickness.

19. The system according to claim 18, wherein the film is a polyamide film.

20. The system according to claim 18 or 19, wherein the film is selected from the group consisting of polyamide 6, polyamide 4 and polyamide 3.

21. The system according to claim 18, wherein the polymer for the polymer coating is selected from the group consisting of

polyvinyl alcohol, dispersed synthetic resin, methyl cellulose, linseed oil alkyd resin, bone glue and protein derivatives.

22. The system according to any one of claims 18 to 21, wherein the carrier material has a low water vapor diffusion resistance.

23. The system according to any one of claims 18 to 22, wherein the film or the polymer coating is received like a sandwich between two layers of the carrier material with a low water vapor diffusion resistance.

24. The system according to any one of claims 18 to 23, wherein the carrier material is chosen from a fiber reinforced cellulose material.

25. The system according to any one of claims 18 to 23, wherein the carrier material is a film made of synthetic fiber-spun fabrics or a perforated film made of polyethylene.

26. The system according to any one of claims 18 to 25, wherein the thermal insulation is made of mineral fibers.

27. The system according to any one of claims 1 to 9 and 18 to 26 applied to a building.

28. A method for providing a vapor barrier to a building, comprising installing a film or a polymer coating applied to a carrier on at least a part of the building, wherein the film has a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding the vapor retarder in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air layer

thickness.

29. The method according to claim 28, wherein the carrier material is a fiber-reinforced cellulose material.

30. The method according to claim 28 or 29, wherein the film is sandwiched between two layers of carrier material, the two layers of carrier material having a low water vapor diffusion resistance.

31. The method according to any one of claims 28 to 30, wherein the film comprises polyamide.

32. The method according to claim 31, wherein the polyamide is selected from the group consisting of polyamide 6, polyamide 4, and polyamide 3.

33. The method according to claim 32, wherein the polyamide is polyamide 6.

34. The method according to any one of claims 28 to 33, wherein the film has a thickness of 10 μm to 2 mm.

35. The method according to any one of claims 28 to 33, wherein the film has a thickness of 20 μm to 100 μm.

36. The method according to any one of claims 28 to 35, wherein the film is attached to an inner wall surface of the building.

37. The method according to any one of claims 28 to 35, wherein the film component is installed onto a wall of the building.

38. The method according to any one of claims 28 to 35, wherein the film is installed onto a roof of the building.

39. The method according to any one of claims 28 to 35, wherein the film is installed onto a wall and a roof of the building.

40. In a method of building construction or renovation, the improvement comprising applying a film to a structure of said building, wherein the film has a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding the vapor retarder in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air layer thickness.

41. The method according to claim 40, wherein a carrier material is attached to the film.

42. The method according to claim 41, wherein the carrier material is a fiber-reinforced cellulose material.

43. The method according to any one of claims 40 to 42, further comprising at least two layers of a carrier material, wherein the film is sandwiched between two layers of carrier material.

44. The method according to any one of claims 40 to 43, wherein the film comprises polyamide.

45. The method according to claim 44, wherein the polyamide is selected from the group consisting of polyamide 6, polyamide 5, and polyamide 3.

46. The method according to claim 45, wherein the polyamide is polyamide 6.

47. The method according to any one of claims 40 to 46, wherein the film has a thickness of 10 µm to 2 mm.

48. The method according to any one of claims 40 to 46, wherein the film has a thickness of 20 µm to 100 µm.

49. The method according to any one of claims 40 to 48, wherein the film is applied to a wall of a building.

50. The method according to any one of claims 40 to 48, wherein the film is applied to a roof of a building.

51. The method according to any one of claims 40 to 48, wherein the film is applied to a roof and a wall of a building.

52. A building structure, comprising a film attached to the building structure, wherein the film has a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding the vapor retarder in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air layer thickness.

53. The building structure according to claim 52, which further comprises a carrier material attached to the film.

54. The building structure according to claim 53, wherein the carrier material is a fiber-reinforced cellulose material.

55. The building structure according to any one of claims 52 to 54, further comprising at least two layers of a carrier material, wherein the film is sandwiched between two layers of carrier material.

56. The building structure according to any one of claims 52 to 55, wherein the film comprises polyamide.

57. The building structure according to claim 56, wherein the polyamide is selected from the group consisting of polyamide 6, polyamide 4, and polyamide 3.

58. The building structure according to claim 57, wherein the polyamide is polyamide 6.

59. The building structure according to any one of claims 52 to 58, wherein the film has a thickness of 10 µm to 2 mm.

60. The building structure according to any one of claims 52 to 58, wherein the film has a thickness of 20 µm to 100 µm.

61. A roof of a building, comprising a film attached to the roof of the building, wherein the film has a water vapor diffusion resistance (s_d-value) at a relative humidity of an atmosphere surrounding the vapor retarder in the region of 30% to 50% of 2 to 5 meters diffusion-equivalent air layer thickness, and, at a relative humidity in the region of 60% to 80% which is < 1 meter diffusion-equivalent air layer thickness.

62. The roof of a building according to claim 61, which further comprises a carrier material attached to the film.

63. The roof of a building according to claim 62, wherein the carrier material is a fiber-reinforced cellulose material.

64. The roof of a building according to any one of claims 61 to 63, further comprising at least two layers of a carrier material, wherein the film is sandwiched between two layers of carrier material.

65. The roof of a building according to any one of claims 62

to 64, wherein the film comprises polyamide.

66. The roof of a building according to claim 65, wherein the polyamide is selected from the group consisting of polyamide 6, polyamide 4, and polyamide 3.

67. The roof of a building according to claim 66, wherein the polyamide is polyamide 6.

68. The roof of a building according to any one of claims 61 to 67, wherein the film has a thickness of 10 µm to 2 mm.

69. The roof of a building according to any one of claims 61 to 67, wherein the film has a thickness of 20 µm to 100 µm.

FIG. 1

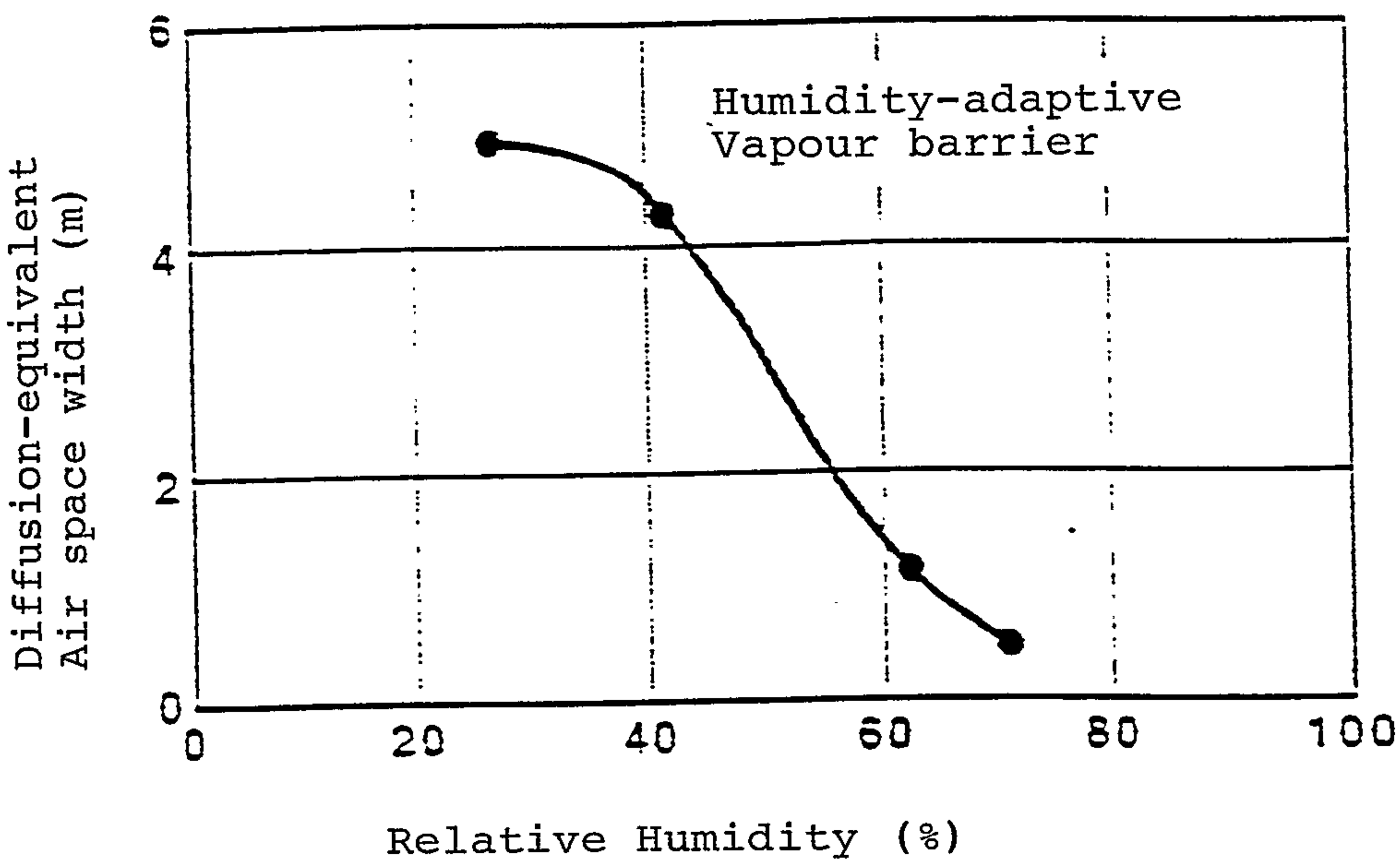

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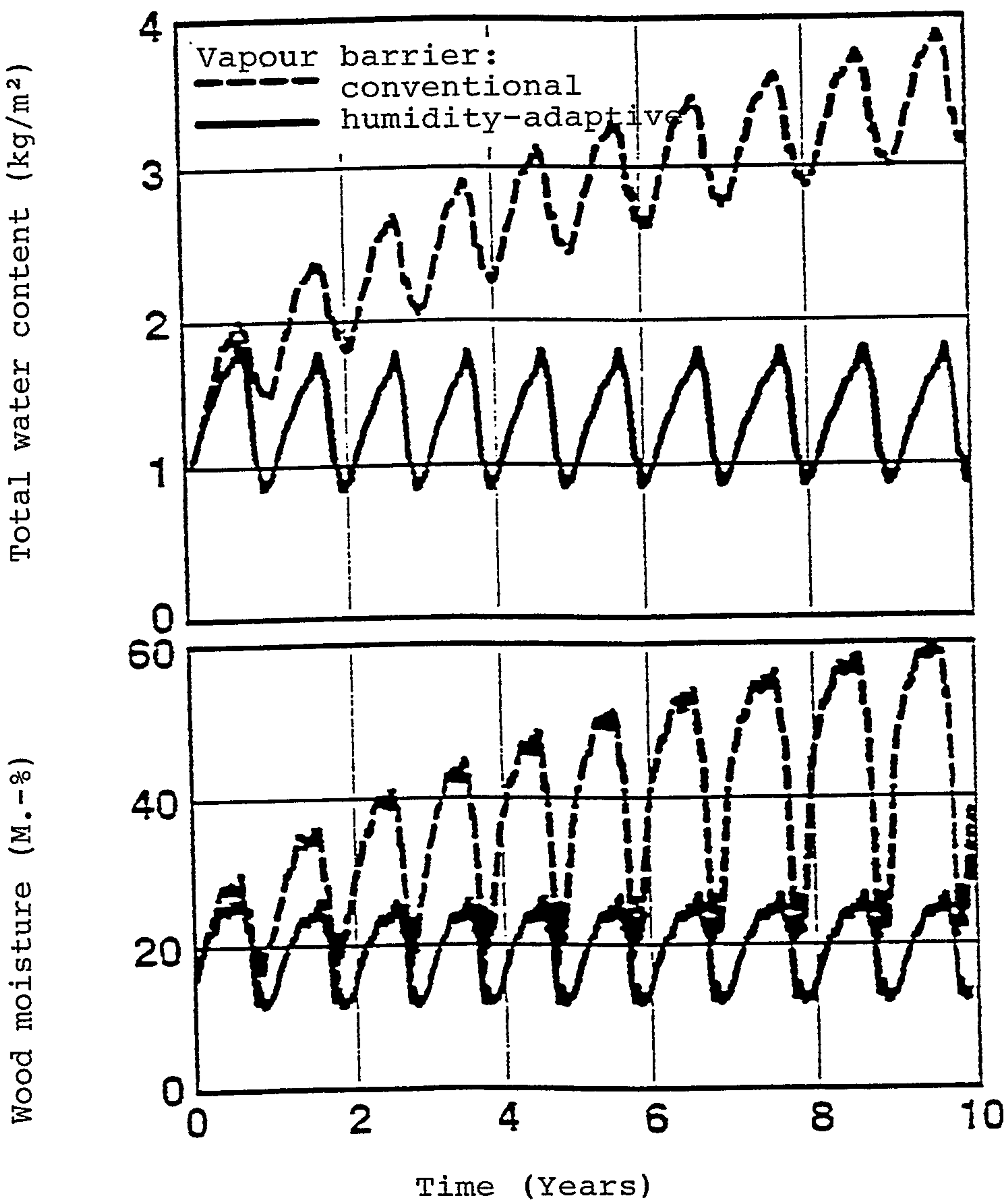
FIG. 2



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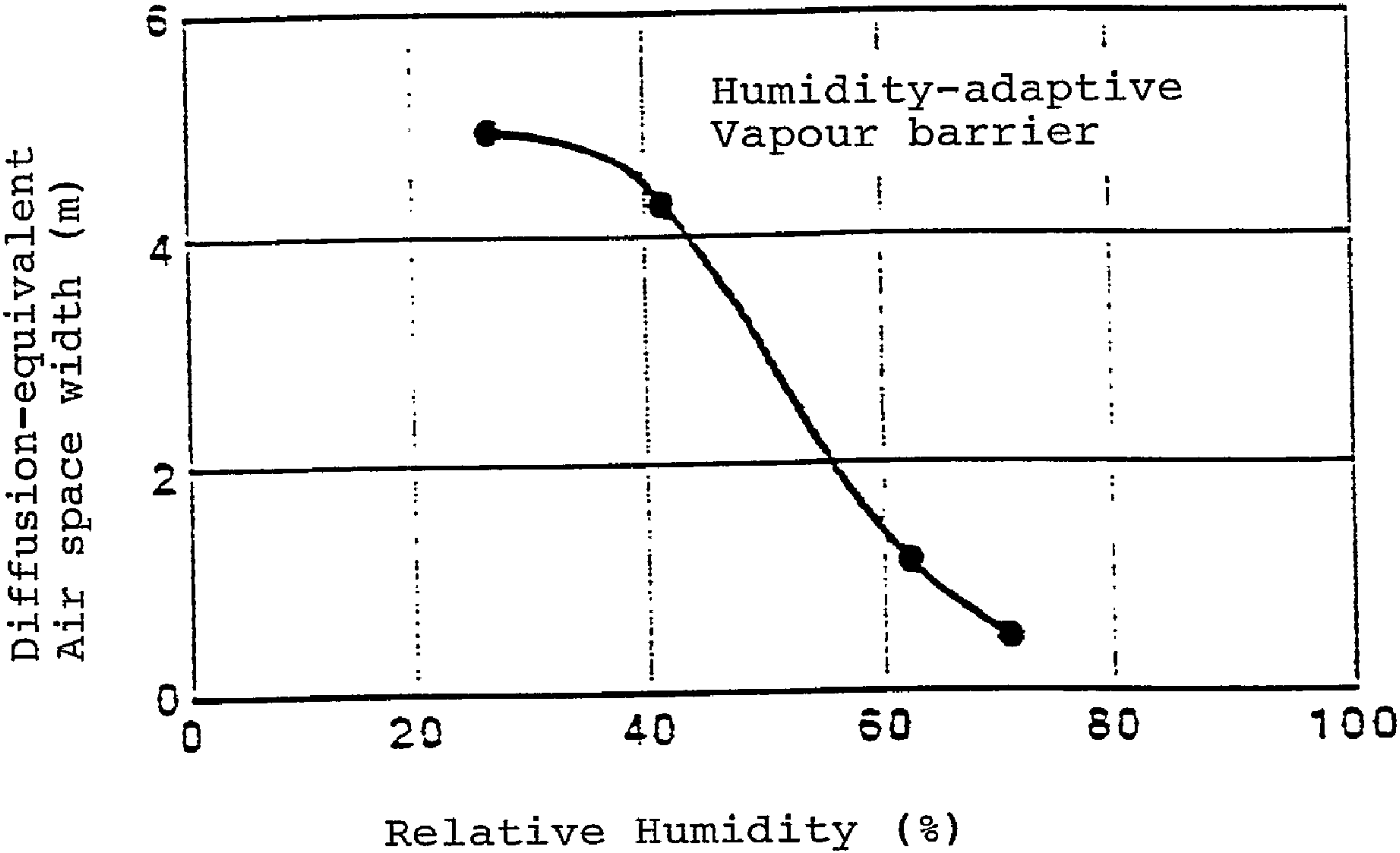

Humidity-adaptive
Vapour barrier
Diffusion-equivalent
Air space width (m)
6
4
2
0
0
20
40
60
80
100
Relative Humidity (%)