VARIABLE PERM SHEET MATERIAL, FACING, AND INSULATION ASSEMBLY

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ABSTRACT
Permeance ratings of a variable perm sheet material, facing, and faced building insulation assembly vary with ambient humidity and/or temperature. In the insulation assembly, a facing is bonded to a major surface of an insulation layer. A central field portion of the facing, as bonded to the insulation layer, has variable water vapor transmission properties that vary from a relatively low permeance when exposed to ambient conditions of low humidity to a relatively high permeance when exposed to ambient conditions of high humidity. Preferably, the facing, as part of an insulation assembly, is fungust growth-resistant and may include a bonding layer, such as a heat activated bonding layer, that bonds the facing to an insulation layer. The sheet material may be embossed to affect its water vapor transmission characteristics.
VARIABLE PERM SHEET MATERIAL, FACING, AND INSULATION ASSEMBLY


BACKGROUND OF THE INVENTION

[0002] The subject invention relates to variable perm facings for faced building insulation assemblies, such as but not limited to those insulation assemblies commonly used to insulate homes and other residential building structures; offices, stores and other commercial and industrial building structures; to the variable perm faced building insulation assemblies faced with such facings; and to reinforced variable perm sheet materials that may be used for interior applications to overlay wall, ceiling, floor, and roof cavities that are insulated with unfaced insulation and for exterior applications as a house wrap overlaying the exterior wall sheathing of a building. The variable perm facings of the subject invention, as applied to the insulation layers of the faced insulation assemblies of the subject invention, and the reinforced variable perm sheet materials of the subject invention are designed to exhibit variable rates of water vapor transmission in response to ambient humidity and preferably, to exhibit improved fungi growth-inhibiting characteristics. The variable perm facings of the subject invention may also exhibit improved aesthetics and other improved performance characteristics, such as but not limited to improved functionality to improve installer productivity.

[0003] Building insulation assemblies currently used to insulate buildings, especially fiberglass building insulations, are commonly faced with kraft paper facings, such as 30-40 lbs/3 MSF (30 to 40 pounds/3000 square feet) natural kraft paper. U.S. Pat. Nos. 5,733,624; 5,746,854; 6,191,087; and 6,357,504 disclose examples of polymeric facings for use in faced building insulation assemblies and U.S. patent application nos. US 2002/0179265 A1; US 2002/0182964 A1; and US 2002/0182965 A1 disclose examples of polymeric-kraft laminates for use in faced building insulation assemblies. In addition, European Patent no. EP 0 821 755 B1 discloses a vapor barrier for use in the heat insulation of buildings and CertainTeed Corp. markets a vapor retarder under the trade designation MemBrain™ SMART Vapor Retarder intended for use with unfaced, vapor permeable mass insulation that is made from a material whose resistance to water vapor diffusion depends on the ambient humidity.

[0004] While building insulation assemblies faced with kraft paper facings function quite well and have been used for decades, and the patents listed above disclose kraft paper facing materials as well as alternative facing materials, and vapor barriers whose resistance to water vapor diffusion depends on the ambient humidity, there has remained a need for variable perm faced building insulation assemblies that have facings with improved performance characteristics and for improved variable perm vapor retardating materials. The variable perm facings of the subject invention and the building insulation assemblies faced with the variable perm facings of the subject invention provide variable perm faced insulation assemblies that are designed to exhibit variable rates of water vapor transmission in response to ambient humidity and/or temperature conditions and preferably, improved fungi growth-inhibiting characteristics that make the variable perm faced insulation assemblies especially well suited for a wide variety of applications including but not limited to those where the variable perm faced insulation assemblies will be subjected to hot humid conditions. The variable perm facings of the subject invention may also exhibit improved pest control characteristics, exhibit other improved performance characteristics (e.g., reduced flame spread and smoke development characteristics), and/or enable improved installer productivity or other cost savings.

SUMMARY OF THE INVENTION

[0005] The variable perm facing of a variable perm faced fibrous insulation batt assembly or other variable perm building insulation assembly of the subject invention includes a central field portion that exhibits different rates of water vapor transmission in response to changes in the ambient humidity and/or temperature and may have one or more reinforcing layers such as but not limited to spunbond continuous polymeric filament mat layers; polymeric fiber mat layers, fiberglass mat layers, and/or scrim layers, or combinations thereof. The reinforced variable perm water vapor transmission retarding sheet material of the subject invention that may be used for interior applications to overlay wall, ceiling, floor, and roof cavities that are insulated with unfaced insulation and for exterior applications as a house wrap located between the exterior wall sheathing and exterior wall siding of a building exhibits different rates of water vapor transmission in response to changes in the ambient humidity and/or temperature and is reinforced with one or more reinforcing layers such as but not limited to spunbond continuous polymeric filament mat layers; polymeric fiber mat layers, fiberglass mat layers, and/or scrim layers, or combinations thereof. Preferably, the variable perm sheet material of the subject invention, the variable perm facing of the subject invention, and the variable perm facing as applied to an insulation layer of an insulation assembly of the subject invention is a fungi growth resistant facing as defined herein that exhibits no more than traces of sporulating growth, non-sporulating growth, or both sporulating and non-sporulating growth as defined herein and more preferably, exhibits no sporulating growth or non-sporulating growth as defined herein.

[0006] As used herein a water vapor transmission of one perm equals 1.00 grains/ft²-hour-inch H₂O or 5.72×10⁻⁸ grams/Pa·s·m⁻². As used herein, the term “low relative humidity” is an ambient relative humidity of 50% or less. As used herein, the term “high relative humidity” is an ambient relative humidity of 90% or more. As used in this specification and claims, the term “laminate” means two or more layers of one or more materials that are superposed and united.

[0007] When a surface of a specimen of a variable perm sheet material of the subject invention, a variable perm facing of the subject invention, or a variable perm facing of the subject invention, as bonded to an insulation layer of a variable perm faced insulation assembly of the subject invention, and a surface of a comparative specimen of a white birch or southern yellow pine wood, which are each approximately 0.75 by 6 inches (20 by 150 mm), are tested as follows, the specimen of the variable perm sheet material,
the variable perm facing, or the variable perm facing as bonded to the insulation layer of the insulation assembly of the subject invention will have less spore growth than the comparative specimen of white birch or southern yellow pine. Spore suspensions of aspergillus niger, aspergillus versicolor, penicillium funiculosum, chetoum globosum, and aspergillus flavus are prepared that each contain 1,000, 000±200,000 spores per mL as determined with a counting chamber. Equal volumes of each of the spore suspensions are blended together to produce a mixed spore suspension. The 0.75 by 6 inch surface of the specimen of the facing variable perm sheet material or facing of the subject invention and the 0.75 by 6 inch surface of the comparative specimen of white birch or southern yellow pine wood are each inoculated with approximately 0.50 mL of the mixed spore suspension by spraying the surfaces with a fine mist from a chromatography atomizer capable of providing 100, 000±20,000 spores/ inch². The specimens are immediately placed in an environmental chamber and maintained at a temperature of 86±4 F (30±2° C.) and 95±4% relative humidity for a minimum period of 28 days±8 hours from the time incubation commenced (the incubation period). At the end of the incubation period, the specimens are examined at 40x magnification. The specimen of the variable perm sheet material, the variable perm facing, or the variable perm facing as applied to the insulation assembly of the subject invention passes the test provided the specimen of the variable perm sheet material, variable perm facing, or variable perm facing as applied to the insulation assembly of the subject invention has less spore growth than the comparative specimen of white birch or southern yellow pine wood. As used in this specification and claims the term “fungi growth resistant” means the observable spore growth at a 40x magnification on the surface of the variable perm sheet material specimen of the subject invention being tested, the variable perm facing specimen of the subject invention being tested, or the variable perm facing specimen of the subject invention as bonded to the insulation layer of the insulation assembly of the subject invention being tested is less than the observable spore growth at a 40x magnification on either a white birch or southern yellow pine comparative specimen when the specimens are tested as set forth in this paragraph.

When a surface of a 50-mm by 50-mm specimen or 50-mm diameter specimen of a variable perm sheet material of the subject invention, a variable perm facing of the subject invention, or a variable perm facing of the subject invention, as bonded to an insulation layer of a variable perm faced insulation assembly the subject invention, has been tested as follows, the specimen will preferably, exhibit only microscopically observable traces of sporulating growth, non-sporeling growth or both sporeling and non-sporeling growth and, more preferably, exhibit no microscopically observable sporulating growth or non-sporeling growth. Separate spore suspensions of aspergillus niger, penicillium pinophilum, chetoum globosum, glocladium virens, and aureobasidium pullulans are prepared with a sterile nutrient-salts solution. The spore suspensions each contain 1,000,000±200,000 spores per mL as determined with a counting chamber. Equal volumes of each of the spore suspensions are blended together to produce a mixed spore suspension. A solidified nutrient-salts agar layer from 3 to 6 mm (¼ to ¼ inch) is provided in a sterile dish and the specimen is placed on the surface of the agar. The entire exposed surface of the specimen is inoculated and moistened with the mixed spore suspension by spraying the suspension from a sterilized atomizer with 110 kPa (16 psi) of air pressure. The specimen is covered and incubated at 28 to 30° C. (82 to 86° F.) in an atmosphere of not less than 85% relative humidity for 28 days. The surface of the specimen is then microscopically observed to visually examine for sporulating and/or non-sporulating growth. The magnification used for making the microscopic observations to determine both sporulating growth and non-sporulating growth is selected to enable non-sporulating growth to be observed. As used in this specification and claims the term “traces of sporulating growth, non-sporulating growth, or both sporulating and non-sporulating growth” means a microscopically observable sporulating growth, non-sporulating growth, or both sporulating and non-sporulating growth of the mixed spore suspension on the surface of the specimen being tested when the specimen is tested under the conditions set forth in this paragraph that, at the conclusion of 28 days, cover(s) less than 10% of the surface area of the surface of the specimen being tested. As used in this specification and claims the term “no sporulating growth or non-sporulating growth” means no observable sporulating growth or non-sporulating growth of the mixed spore suspension on the subject invention as bonded to the insulation layer of the variable perm faced insulation assembly of the subject invention. As used in this specification and claims the term “bonding layer” includes both an adhesive layer that does not require heat activation such as but not limited to a conventional pressure sensitive adhesive in the form of a discontinuous coating layer, a discontinuous spray on layer, a discontinuous spray on fiberized adhesive layer, or other types of discontinuous adhesive layers, and a heat activated adhesive layer such as but not limited to a discontinuous asphalt or modified-asphalt coating layer (hereinafter “asphalt coating layer”), another discontinuous polymeric film or coating layer, a discontinuous wax coating layer, a polymeric fiber mat, a polymeric fiber mesh, a discontinuous spray on adhesive, a discontinuous spray of particulate or fiberized adhesive, or another discontinuous heat activated adhesive layer. The term “bonding layer” also includes a continuous or discontinuous bonding layer that has a high water vapor transmission rating to minimize the affect of the bonding layer on the variable water vapor transmission properties of a variable perm facing. Where heat activated bonding layers are used the bonding layers have a softening point temperature sufficiently low to enable the heat activated adhesive layer to be heated to a temperature to effect a bond between the variable perm facing and a major surface of the insulation layer without negatively impacting the physical properties or visual appearance of the variable perm facing or otherwise degrading the variable perm facing. The bonding layer may be pre-applied to the variable perm facing or applied to the variable perm facing and/or major surface of the insulation layer at the point
where the variable perm facing and the insulation layer are being combined. In addition to a discontinuous asphalt coating layer other modified polymer based bonding agents such as modified polypropylene and modified polyethylene are examples of other polymers that are well suited for use in or as the heat activated bonding layer for bonding the variable perm facing of the subject invention to an insulation layer.

[0010] The bonding layer used to bond a variable perm facing of the subject invention to an insulation layer may be used to modify and reduce the water vapor permeance rating ranges of selected variable perm facings of the subject invention. The bonding layer used to bond the variable perm facing of the subject invention to an insulation layer may also include one or more fungi-growth inhibiting agents to make the variable perm facing, as bonded to the insulating layer of the insulation assembly, less susceptible to fungi growth.

[0011] The variable perm facing of the subject invention may have lateral tabs, may be tabless, or may have lateral tabs made from a sheet material that differs from the variable perm sheet material of the central field portion of the variable perm facing. The variable perm facing may have a central field portion that is sufficiently transparent to enable the insulation layer of an insulation assembly to be seen through the variable perm facing. The variable perm facing may have lateral tabs sufficiently transparent to enable framing members to be seen through the tabs, sufficiently open to enable wallboard to be directly bonded to framing members overlaid by the tabs, and/or sufficiently greater in integrality than the field portion of the variable perm facing to permit a less expensive material to be used for the field portion of the variable perm facing. The field portion of the variable perm facing may include a mineral coating (e.g. clay coating) including modifiers or polymers coating or film including modifiers to stiffen the facing, inhibit fungi growth, treat or control pests, and/or decrease the flame spread and smoke formation characteristics of the variable perm facing.

[0012] The variable perm facings of the subject invention may be separable longitudinally at spaced apart locations in the central field portions of the facings so that the variable perm facings can be applied to pre-cut longitudinally separable insulation layers and separated where the pre-cut longitudinally separable insulation layers are separable. The variable perm building insulation assemblies of the subject invention may have laterally compressible resilient insulation layers faced with variable perm facings having portions, e.g. lateral edge portions, which are or which may be separated from the insulation layers when the insulation layers are laterally compressed to form tabs. The variable perm building insulation assemblies of this paragraph may utilize any of the variable perm facing materials of the subject invention.

[0013] The variable perm faced insulation assembly of the subject invention may include an insulation assembly with a variable perm facing of the subject invention and at least one reflective sheet that radiates heat, such as but not limited to a moisture vapor transmitting foil sheet, metallized film, or other metallized sheet material (e.g. a perforated film or sheet material.

[0014] The variable perm and preferably fungi growth resistant variable perm sheet materials of the subject invention, typically in widths of about four feet or more, may be applied as vapor retarders directly to the framing members of a wall where unfaced insulation is used to insulate the wall cavities and/or as a house wrap.

[0015] The variable perm sheet materials of the subject invention, permit moisture to easily pass through the film only when excessive moisture is present. For example, a 1.3 mil thick film has an ASTM E 96-00 dry cup perm rating of about 2 and an ASTM E 96-00 wet cup perm rating of 25 or greater. The variable perm sheet materials of the subject invention provide a true air barrier and do not let air pass through the sheet materials. Since the variable perm sheet materials of the subject invention are continuous polymeric films, the sheet materials can function as a rain barrier that does not let rain or standing water penetrate. Variable perm sheet materials of the subject invention that are made of nylon, e.g. nylon 6, can be left exposed to the elements for several weeks with no significant deterioration. The variable perm sheet materials of the subject invention can be reinforced with materials such as PET spunbonds to make the materials more resistant to tearing at fastening staples and yet remains easy to cut and fold around openings, corners and obstacles.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 is a schematic perspective view of a first embodiment of the variable perm faced insulation assembly of the subject invention.

[0017] FIG. 2 is a schematic end view of the variable perm faced insulation assembly of FIG. 1.

[0018] FIG. 3 is a schematic view of the circled portion of FIG. 2 on a larger scale than FIG. 2.

[0019] FIGS. 4 and 5 are schematic views of variable perm faced insulation assemblies of FIGS. 1 to 3 installed in a wall cavity.

[0020] FIG. 6 is partial schematic view of another embodiment of the variable perm faced insulation assembly of the subject invention showing a tab strip bonded to one of the tabs of the facing of FIGS. 1 to 3.

[0021] FIG. 7 is a schematic transverse cross section though a tubular variable perm sheet material with lateral gussets that can be made into a facing of the subject invention.

[0022] FIG. 8 is a schematic transverse cross section through the tubular variable perm sheet material of FIG. 7 after the tubular variable perm sheet material has been collapsed and bonded together.

[0023] FIGS. 9 to 12 are partial schematic views of embodiments of the variable perm faced insulation assembly of the subject invention showing other tabs that may be substituted for the tabs shown on the facing of FIGS. 1 to 3. The partial schematic views of FIGS. 9 to 12 correspond to the view of FIG. 3 for the embodiment of FIGS. 1 to 3.

[0024] FIG. 13 is a schematic end view of a variable perm faced pre-cut insulation assembly with a facing of the subject invention that is longitudinally separable at each location where the insulation layer is longitudinally separable.
FIG. 14 is a schematic end view of a variable perm faced pre-cut insulation assembly with a facing of the subject invention that is longitudinally separable at each location where the insulation layer is longitudinally separable and provided with tabs at each location where the insulation layer is separable.

FIG. 15 is schematic view of the circled portion of FIG. 14 on a larger scale than FIG. 14.

FIG. 16 is a schematic end view of a variable perm faced insulation assembly of the subject invention where the facing is without preformed tabs.

FIG. 17 is a schematic view of the circled portion of FIG. 16 on a larger scale than FIG. 16.

FIG. 18 is a schematic view of a modified version of the circled portion of FIG. 16 on a larger scale than FIG. 16.

FIG. 19 is a schematic end view of a variable perm faced pre-cut insulation assembly with a facing of the subject invention that has no preformed tabs and is longitudinally separable at each location where the insulation layer is longitudinally separable.

FIG. 20 is a schematic view of the circled portion of FIG. 19 on a larger scale than FIG. 19.

FIG. 21 is a schematic view of a modified version of the circled portion of FIG. 19 on a larger scale than FIG. 19.

FIG. 22 is a schematic view of a reflective insulation made with the variable perm facing of the subject invention and a moisture vapor transmitting reflective sheet material.

FIGS. 23 and 24 are partial schematic elevations of walls insulated with unfaced insulation batts that are overlaid by any of the variable perm sheet materials of the subject invention.

FIG. 25 is a schematic transverse cross section through a variable perm sheet material of the subject invention that has longitudinally lateral edge portions with cold seal or other pre-applied adhesive layers thereon.

FIG. 26 is a partial schematic horizontal cross section through an exterior wall that includes a house wrap of the subject invention.

FIGS. 27 and 28 are partial schematic elevations of exterior building walls with the exterior siding removed and the house wrap partially peeled back to show sheathing of the external wall overlaid by house wraps of the subject invention.

FIG. 29 is a schematic transverse cross section through a variable perm faced insulation assembly of the subject invention with lateral tabs provided with cold seal adhesive layers.

FIG. 30 is a transverse schematic cross section through an encapsulated variable perm insulation assembly of the subject invention that also has a backing sheet.

FIG. 31 is a transverse schematic cross section through a variable perm faced insulation assembly of the subject invention that also has a backing sheet.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The variable perm sheet material of the subject invention is a variable perm polymeric film or modified polymeric film that, alone or as reinforced, exhibits different rates of water vapor transmission in response to changes in the ambient relative humidity and/or temperature. When the variable perm sheet material of the subject invention, alone or reinforced, is exposed to ambient conditions of low relative humidity, the variable perm sheet material exhibits low rates of water vapor transmission. As the variable perm sheet material of the subject invention, alone or reinforced, is exposed to ambient conditions of progressively increased relative humidity, the variable perm sheet material of the subject invention exhibits progressively increased rates of water vapor transmission through the variable perm sheet material. As the variable perm sheet material of the subject invention, alone or reinforced, is exposed to ambient conditions of progressively increased temperatures, the variable perm sheet material of the subject invention exhibits progressively increased rates of water vapor transmission through the variable perm sheet material. For most interior applications, the variable perm sheet material of the subject invention, when exposed to ambient conditions of low relative humidity (50% relative humidity or less) and temperatures of about 70°F to about 90°F, has a permance rating of 1 perm or less and when exposed to ambient conditions of high relative humidity (90% relative humidity or more) and temperatures of about 70°F to about 90°F, has a permance rating of 20 perms or more. Preferably, for most interior applications, for a constant ambient humidity and ambient temperatures between 50°F and 100°F, the resistance of the variable perm sheet material of the subject invention to water vapor transmission decreases as the ambient temperature increases and increases as the ambient temperature decreases. As used herein, an interior application includes an application wherein the variable perm sheet material is located on the inner side of an exterior wall, e.g. between and/or adjacent the inner sides of the wall framing members and the interior gypsum board overlying the framing members.

For most house wrap applications, the variable perm sheet material of the subject invention, when exposed to ambient conditions of low relative humidity (50% relative humidity or less) and temperatures of about 70°F to about 90°F, has a permance rating between about 2 and about 8 perms and when exposed to ambient conditions of high relative humidity (90% relative humidity or more) and temperatures of about 70°F to about 90°F, has a permance rating of 50 perms or more. Preferably, for most house wrap applications, for a constant ambient humidity and ambient temperatures between 50°F and 120°F and more preferably for ambient temperatures between 20°F and 120°F, the resistance of the variable perm sheet material of the subject invention to water vapor transmission decreases as the ambient temperature increases and increases as the ambient temperature decreases.

The central field portions of the variable perm facings of the subject invention are made of the variable perm sheet material or reinforced variable perm sheet material of the subject invention and, as applied to the insulation layers of the variable perm faced insulation assemblies of the subject invention, also exhibit variable rates of water
vapor transmission in response to changes in the ambient relative humidity and/or temperature. When the central field portions of the variable perm facings of the subject invention, as applied to the insulation layers of the variable perm faced insulation assemblies of the subject invention, are exposed to ambient conditions of low relative humidity, the central field portions of the variable perm facings exhibit low rates of water vapor transmission. As the variable perm facings of the subject invention, as bonded to the insulation layers of the variable perm faced insulation assemblies of the subject invention, are exposed to ambient conditions of progressively increased relative humidity, the central field portions of the variable perm facings of the subject invention exhibit progressively increased rates of water vapor transmission through the central field portions of the variable perm facings. As the variable perm facings of the subject invention, as bonded to the insulation layers of the variable perm insulation assemblies of the subject invention, are exposed to ambient conditions of progressively increased temperatures, the central field portions of the variable perm facings of the subject invention exhibit progressively increased rates of water vapor transmission through the central field portions of the facings. For most interior applications, the central field portions of variable perm facings of the subject invention, when exposed to ambient conditions of low relative humidity (50% relative humidity or less) and temperatures of about 70°F to about 90°F, have a permeance rating of 1 perm or less and when exposed to ambient conditions of high relative humidity (90% relative humidity or more) and temperatures of about 70°F to about 90°F, have a permeance rating of 20 perms or more. Preferably, for most interior applications, for a constant ambient humidity and ambient temperatures between 50°F and 100°F, the resistance of the variable perm facings of the subject invention to water vapor transmission decreases as the ambient temperature increases and increases as the ambient temperature decreases.

[0044] A first preferred variable perm polymeric film for the variable perm sheet material of the subject invention is a variable perm polyamide film such as but not limited to Nylon 6 or a Nylon 6,6 film. An example of such a variable perm film is a Nylon 6 film that is marketed by M&Q Plastics Products under the trade designation Monolyn™. These variable perm nylon films provide the following properties that make these films an ideal variable perm sheet material for a variable perm faced insulation assembly, such as but not limited to a variable perm faced fiberglass batt insulation assembly of the subject invention.

[0045] 1. These nylon films have a continuous service temperature range from −100°F to +400°F. With such a service range, heat re-activated adhesives, such as but not limited to hot melt and asphalt adhesives, can be used with these nylon films as bonding layers to bond these nylon films to the insulation layers of variable perm faced insulation assemblies and these nylon films can be passed over hot rolls to reactivate pre-applied adhesives to bond these nylon films to the insulation layers of variable perm faced insulation assemblies without degrading the films.

[0046] 2. These nylon films have good abrasion resistance.

[0047] 3. These nylon films are substantially unaffected by exposure to oil, grease, and most chemicals except mineral and formic acids.

[0048] 4. These nylon films are normally clear, can be printed upon, and, if desired, can be colored. For example, a white colored film could be used for a fire resistant version of the nylon film used on certain insulation assemblies and a clear film could be used for other versions of the nylon film used on other insulation assemblies.

[0049] 5. These nylon films are easily modified with additives or topical treatments to promote adhesion or make the film heat sealable to itself.

[0050] 6. These nylon films are available in multiple thicknesses that range in thickness from 1 to 3 mils.

[0051] 7. Nylon film technology has existed since the 1950’s.

<table>
<thead>
<tr>
<th>Specimen</th>
<th>DRY CUP Average Perms Desiccant Method</th>
<th>WET CUP Average Perms Water Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.11</td>
<td>18.66</td>
</tr>
<tr>
<td>B</td>
<td>3.46</td>
<td>22.67</td>
</tr>
<tr>
<td>C</td>
<td>2.14</td>
<td>27.62</td>
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</tbody>
</table>

[0052] Three samples of Nylon 6 material were tested in accordance with ASTM Test Designation E 96-00, Desiccant Method (dry cup method) and Water Method (wet cup method). Sample A had a weight of 7.20 g/ft² and an average thickness of 0.0020 inches; Sample B had a weight of 3.95 g/ft² and an average thickness of 0.0018 inches; and Sample C had a weight of 3.38 g/ft² and an average thickness of 0.0013 inches. The dishes used in the test were 5¼ inches in diameter and the cabinet was maintained at 90°F and 50% relative humidity.

[0053] A second preferred variable perm polymeric film for the variable perm sheet material of the subject invention is a variable perm Nylon 6 film with a nano-clay filler. The inclusion of a nano-clay filler in the Nylon 6 film can increase the stiffness of the Nylon 6 film, make the Nylon 6 film more dimensionally stable, increase the gas transmission retarding characteristics of the Nylon 6 film, and increase the flame resistance of the Nylon 6 film. The presence of a nano-clay filler in the Nylon 6 film increases the gas transmission retarding characteristics of the film by creating a maze or more tortuous path through the film for the water vapor or other gas molecules that slows the progress of the gas molecules through the thickness of the matrix resin film. It is expected that a Nylon 6 film with a nano-clay filler will permit the variable perm sheet material to made of thinner gauge films while still retaining a dry cup method perm rating of less than 1 and a wet cup method perm rating of more than 15 to thereby reduce the cost of the variable perm sheet material while retaining the desired water vapor transmission properties of the variable perm sheet material. An example of a Nylon 6 film with a nano-clay filler is a nylon film marketed by Honeywell International Inc. under the trade designation Aegis NC nano-nylon. It is claimed that a nylon 6 film with 2% by weight nano-clay filler reduces the oxygen transmission rate through the nylon 6 film by a factor of 3 and that a nylon 6 film with 4% by weight nano-clay filler reduces the oxygen transmission rate through the nylon 6 film by a factor of 6.

[0054] A third preferred variable perm polymeric film for the variable perm sheet material of the subject invention
(referred to in the industry as a chemically interrupted film as opposed to a mechanically interrupted film) is a variable perm polymeric film with a nylon particle filler. Examples of polymeric films with a nylon particle filler that may be used as the variable perm sheet material are polymeric films such as but not limited to low density polyethylene films (LDPE films), high density polyethylene films (HDPE), polypropylene films (PP films) or combinations thereof. Where the variable perm sheet material is a polymeric film laminate of the above polymeric films, the polymeric film layers may be cast or coextruded to form the laminate or heat welded or otherwise bonded together. The variable perm polymeric film with a nylon particle filler may be transparent, translucent or opaque. Preferably, these variable perm polymeric films would have between 2% and 20% by weight nylon particles and the particles would be between about 5 and about 50 micrometers in diameter.

Any of first, second, or third preferred variable perm polymeric films for the variable perm sheet material of the subject invention may include a mineral coating, such as but not limited to calcium carbonate, on a major surface that is to be the outer major surface of the central field portion of the variable perm sheet material to provide the polymeric film with a less plastic like and a more paper like feel and to enhance the flame spread resistance of the polymeric film.

Any of first, second, or third preferred variable perm polymeric films for the variable perm sheet material of the subject invention may be reinforced with a lightweight nonwoven polymeric filament or fiber mat (e.g. a lightweight spunbond nonwoven continuous polyester, polypropylene or polyethylene filament mat or a lightweight nonwoven staple polyester, polypropylene or polyethylene fiber mat) or a lightweight nonwoven fiberglass mat. An example of a lightweight spunbond nonwoven polymeric filament mat that may be used as the reinforcement for the polymeric film is a lightweight spunbond nonwoven continuous polyester filament mat having a weight between 15 and 30 grams per square meter (15 to 30 gpm), such as a spunbond nonwoven polyester mat sold by Johns Manville International, Inc., under the designation type 488/15, type 488/20, or type 488/30. An example of a lightweight nonwoven fiberglass mat that may be used as the reinforcement for the polymeric film is a lightweight nonwoven fiberglass mat having a weight between 20 and 80 grams per square meter, such as a nonwoven fiberglass mat sold by Johns Manville International, Inc., under the trade designation Dura-Glass® style 3011 mat. These mats typically have a water vapor permeance rating of 40 perms or greater dry cup method.

The water vapor transmission rates and the range of water vapor transmission rates through any of the first, second or third variable perm polymeric films can also be modified to provide the films with desired performance characteristics by embossing the films. Any of the films can be embossed, e.g. with a dimple pattern, to stretch and thin the film at numerous locations, e.g. each of the dimple points, relative to the remainder of the film and significantly increase the wet cup perm rating for the film. For example, a 2 mil thick nylon 6 film provides dry cup method and wet cup method perm ratings of about 1 and 15 and a 1.5 mil thick nylon 6 film provides dry cup method and wet cup method perm ratings of about 2 and 30. By embossing these films, the overall wet cup method perm ratings for these films can be increased to greater than 50 perms while the film still remains air and liquid water tight.

Various bonding agents may be used as the bonding layers to bond the central field portions of the variable perm facings of the subject invention to at least one of the major surfaces of the insulation layers of the variable perm faced insulation assemblies of the subject invention, such as but not limited to asphalt and amorphous polypropylene, and these bonding agents may be applied by different methods. For example, as the variable perm faced insulation assembly is being manufactured, the bonding agent could be applied to the inner major surface of the variable perm facing immediately prior to applying the variable perm facing to the insulation layer by: printing the bonding agent on the inner major surface of the variable perm facing, applying the bonding agent to the inner major surface of the variable perm facing using a particulate or fiberized hot melt spray, or by applying a water based or other bonding agent to the inner major surface of the variable perm facing by roll coating. Alternatively, for a variable perm facing of the subject invention made with the first or second variable perm sheet material of the subject invention, a heat activated bonding agent can be preapplied to the inner major surface of the variable perm facing using the same methods set forth immediately above when the variable perm facing is manufactured and rolled in long lengths into rolls. The heat activated bonding agent preapplied to the variable perm facing can then be reactivated when the rolls of facing are unwound, e.g. by passing the variable perm facing over a heated roll, and adhered to the major surface of the insulation layer.

The heat activated adhesives used with the variable perm facings made of the first and second variable perm sheet materials of the subject invention preferably have a softening point temperature that is relatively low when compared to the softening point temperature of the variable perm polymeric film layer forming the variable perm sheet material (e.g. a softening point temperature that is lower by 60° F. or more and preferably about 300° F. or less so that the inner heat activated bonding layer can be used as a heat activated adhesive to bond the variable perm facing to the insulation layer without negatively impacting the physical properties or the visual appearance of the variable perm facing or otherwise degrading the variable perm facing. Examples of such heat-activated adhesives are asphalt, and other hot melt adhesives such as but not limited to Bostik Findley H1367 adhesive. Other adhesives that are not heat activated, such but not limited to Bostik Findley H2279 adhesive, Bostik Findley HX2986-01 adhesive (an adhesive that contains a biocide), and JM LAWX235 water based adhesive, may also be used to bond the variable perm
facings made with the variable perm sheet materials of the subject invention to the insulation layer 24.

[0061] To minimize and/or control the effect of the bonding layer on the variable water vapor transmission properties of a variable perm facing made of the variable perm sheet material of the subject invention, the adhesive forming the bonding layer may be applied as a discontinuous layer such as but not limited to: a series of longitudinally and/or transversely extending spaced apart beads or strips that are themselves continuous or discontinuous and of a width or widths to achieve the adequate bonding of the central field portion of the variable perm facing to the insulation layer without substantially affecting the variable water vapor transmission properties of the central field portion of the variable perm facing, a pattern or random pattern of spaced apart adhesive dots or fibers of any of a variety of spacings, sizes and shapes to achieve the adequate bonding of the variable perm facing to the insulation layer without substantially affecting the variable water vapor transmission properties of the facing, etc. The variable perm facing made with the variable perm sheet material may also be bonded to the insulation layer with a continuous or discontinuous adhesive layer that has a high water vapor transmission rating to minimize affect of the bonding layer on the variable water vapor transmission properties of a variable perm facing made of the variable perm sheet material. An example of an adhesive that could be used for such a layer is a hot melt coating disclosed in United States Patent Application 20040092596 A1, Vedula, Ravi Ram et al, published May 13, 2004.

[0062] In the variable perm facing assemblies of the subject invention, the central field portion of the facing sheet can be bonded to the first major surface of the insulation layer, e.g. by a discontinuous bonding and/or by a high water vapor transmitting bonding layer, to leave the water vapor transmission properties of the central field portion of the central field portion of the sheet substantially unaffected. As an alternative, the central field portion of the facing sheet can be bonded to the first major surface of the insulation layer, e.g. by a discontinuous bonding and/or a high water vapor transmitting bonding layer, to affect the water vapor transmission properties of the central field portion of the sheet but leave the water vapor transmission properties of the central field portion of the facing sheet within a selected permeance rating range.

[0063] Preferably, the variable perm sheet material of the subject invention is fungus growth resistant; preferably exhibits no more than traces of sporulating growth, non-sporulating growth, or both sporing and non-sporulating growth; and more preferably, exhibits no sporulating or non-sporulating growth. The variable perm sheet material may include a fungus growth-inhibiting agent that is incorporated into the variable perm sheet material and/or applied topically to the variable perm sheet material.

[0064] Preferably, each variable perm facing of the subject invention, as bonded to an insulation layer, is fungus growth resistant; preferably exhibits no more than traces of sporulating growth, non-sporulating growth, or both sporulating and non-sporulating growth and more preferably, exhibits no sporulating or non-sporulating growth. The variable perm facings of the subject invention may have a fungus growth-inhibiting agent that is included in the variable perm sheet material of the variable perm facing by being incorporated into or topically applied to the variable perm sheet material of the variable perm facing; that is included only in the bonding layer bonding the central field portion of the variable perm facing to the first major surface of the insulation layer; or that is included in both the variable perm sheet material of the variable perm facing and the bonding layer bonding the central field portion of the variable perm facing to the first major surface of the insulation layer.

[0065] An example of a fungus growth-inhibiting agent is the fungicide resistance additive 2-(4-Thiazolyl) Benzimidazole, also known as “TBZ”. Multiple forms of TBZ are available for specific applications in asphalts and other polymers, adhesives, coatings and additives. One example of the fungicide resistance additive is available from Ciba Specialty Chemicals under the trade designation Ingaguard F-3000 fungicide growth resistance additive. It is believed that the inclusion of the Ingaguard F-3000 fungicide growth resistance additive in amounts between 0.05% and 0.5% by weight of the materials in the polymeric films, polymeric coatings, mineral coatings, ink coatings, and continuous polymeric films of the variable perm sheet material will effectively inhibit fungal growth. Examples of other antimicrobial, biocide fungicide growth-inhibiting agents that may be used are silver zeolite fungicide growth inhibiting agents sold by Rohm & Haas Company under the trade designation Kathon fungicide growth-inhibiting agent, by Angus Chemical Company under the trade designation AMICAL-48 fungicide growth-inhibiting agent, and by Healthfield Technologies, Inc. under the trade designation HEALTHSHIELD fungicide growth-inhibiting agent. Sodium pyrithione and zinc pyrithione, which are commonly available, may also be used as fungicide growth-inhibiting agents in the subject invention; and where the variable perm sheet material includes an asphalt coating layer, zinc oxide in amounts between 3% and 20% by weight may be used as a filler in the asphalt to make the asphalt fungicide growth resistant or to at least enhance the fungicide growth inhibiting characteristics of the asphalt. It should also be noted that the fungicide growth-inhibiting agent used in the subject invention may comprise one fungicide growth-inhibiting agent or a combination or blend of two or more fungicide-growth inhibiting agents to provide a broader or more efficacious fungal growth resistance for the variable perm sheet materials of the subject invention.

[0066] Preferred variable perm sheet materials and facings of the subject invention either contain between 200 and 2000 ppm (parts per million), more preferably between 300 and 700 ppm, and most preferably between 400 and 600 ppm of the fungicide growth-inhibiting agent 2-(4-Thiazolyl) Benzimidazole (a chemical also known as “TBZ”) or are coated on one or both major surfaces with a suspension containing between 200 and 2000 ppm, more preferably between 300 and 700 ppm, and most preferably between 400 and 600 ppm of the fungicide growth-inhibiting agent TBZ.

[0067] A preferred bonding agent for bonding the central field portion of the variable perm facing of the subject invention to an insulation layer is a hot melt bonding agent, e.g. an asphalt, wax, or other polymeric bonding agent (e.g. a hot melt bonding agent such as Bostik Findley H1367 adhesive) that is fiberized, sprayed applied, or line applied at 1 to 2 grams/ft$^2$ dry or a water based bonding agent that is fiberized, sprayed applied or line applied at 1 to 2 grams/ft$^2$. 2
dry and that contains between 200 and 2000 ppm, more preferably between 300 and 700 ppm, and most preferably between 400 and 600 ppm of the fungi growth-inhibiting agent TBZ.

[0068] The variable perm variable perm sheet material of the subject invention may include a pesticide. An example of one type of pesticide that may be used in the subject invention is a termiticide that contains fipronil as the active ingredient. This termiticide is non-repellent to termites and lethal to termites through ingestion, contact and/or transfer. Aventis Environmental Science USA of Montvale, N.J. sells such a termiticide under the trade designation “TER-MIDOR”. Since the termites do not smell, see or feel this termiticide, the termites continue to pass freely through the treated area picking up the termiticide and carrying the termiticide back to the colony nest. In the colony nest, other termites that contact the contaminated termites through feeding or grooming or through cannibalizing the termites killed by the termiticide become carriers of the termiticide thereby spreading the termiticide throughout the colony and exterminating the termites.

[0069] Preferably, each of the faced insulation assemblies of the subject invention has a composite flame spread and smoke developed rating equal to or less than 25/50 as measured by the ASTM E 84-01 tunnel test method, entitled “Standard Test Method for Surface Burning Characteristics of Building Materials”, published July 2001, by ASTM International of West Conshohocken, Pa. Preferably, each variable perm sheet material of the subject invention and each facing of the subject invention, as bonded to the insulation layer, passes the ASTM fungi test C 1338-00, entitled “Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings”, published Summer 2000, by ASTM International of West Conshohocken, Pa. Preferably each variable perm sheet material of the subject invention and each facing of the subject invention, as bonded to the insulation layer, has a rating of 1 or less and more preferably 0, as rated by the ASTM fungi test G 21-96 (Reapproved 2002), entitled “Standard Practice for determining Resistance of Synthetic Polymeric Materials to Fungi”, published September 1996 by ASTM International of West Conshohocken, Pa.

[0070] FIGS. 1 and 2 show a typical variable perm faced insulation assembly 20 of the subject invention. The variable perm faced insulation assembly 20 includes a variable perm facing 22 of the subject invention and an insulation layer 24. The insulation layer 24 has first and second major surfaces 26 and 28, which are defined by the length and width of the insulation layer, and a thickness. The variable perm facing 22 of the variable perm faced insulation assembly 20 is formed of a variable perm sheet material that has a central field portion 32 and a pair of lateral tabs 34 that are typically between 0.25 and 1.5 inches in width. The lateral tabs 34 can be unfolded and extended beyond the lateral surfaces of the insulation layer 24 of the faced insulation assembly 20 (typically extended between 0.25 and 1.5 inches beyond the lateral surfaces of the insulation layer) to overlap the framing members forming a cavity being insulated by the variable perm faced insulation assembly, to overlap the lateral tabs of or be overlapped by the lateral tabs of adjacent variable perm faced insulation assemblies and the framing members forming a cavity being insulated by the variable perm faced insulation assembly, and/or for attachment to framing members forming a cavity being insulated by the variable faced insulation assembly. The central field portion 32 of the sheet has a first outer major surface and a second inner major surface. The central field portion 32 of the sheet overlays and is bonded, typically by a bonding layer 36 on the inner major surface of central field portion 32 of the sheet, to the major surface 26 of the insulation layer 24.

[0071] FIGS. 4 and 5 show variable perm faced insulation assemblies 20 installed in a wall cavity defined on three sides by two spaced apart framing members 38 (e.g. wooden 2x4 or 2x6 studs) and a sheet of sheathing 40. As shown in FIG. 4, the lateral tabs 34 of the variable perm faced insulation assemblies 20 are secured to the end surfaces of the framing members 38 by staples 42. While the variable perm faced insulation assemblies 20 are shown installed in wall cavities, the variable perm faced insulation assemblies 20 may also be installed between framing members in other building cavities such as but not limited to ceiling, floor, and roof cavities. While, as shown, the lateral tabs 34 are stapled to the end surfaces of the framing members 38, the lateral tabs 34 of the variable perm insulation assembly 20 may be stapled to the side surfaces of the framing members 38 or the side surfaces of the framing members 38, may overlap end surfaces of the framing members 38 without being secured to the framing members, may overlap the lateral tabs of or be overlapped by the lateral tabs of and be bonded to the lateral tabs of adjacent variable perm faced insulation assemblies and overlap the framing members 38, may have one lateral tab overlapping and bonded to a lateral tab of an adjacent insulation assembly and have the other lateral tab overlapped by and bonded to a lateral tab of an adjacent variable perm faced insulation assembly and overlap the framing members 38, or, if desired, may be left in their initial folded configuration.

[0072] FIG. 6 shows a partial cross section of the variable perm facing 22 of variable perm insulation assembly of FIGS. 1 to 3 that corresponds to FIG. 3 wherein the lateral tabs 34 include tab strips 44. The lateral tabs 34 each have a tab strip 44 that overlaps, is coextensive or essentially coextensive with, and is bonded to one surface of the lateral tab 34. The tab strips 44 provide the lateral tabs 34 with increased integrity relative to central field portion 32 of the variable perm facing sheet 22 for handling and stapling and may be selected to have sufficient integrity to enable the use of thinner and/or less expensive variable perm sheet materials for the variable perm facing sheet 22. In addition, the tab strips 44 may also function as release liners overlying layers or coatings 46 of pressure-sensitive adhesives on the lateral tabs 34 that may be used to secure the lateral tabs 34 to framing members 38.

[0073] While the insulation layers faced with the variable perm facings of the subject invention may be made of other materials, such as but not limited to foam insulation materials, preferably, the insulation layers of the variable perm faced insulation assemblies of the subject invention are resilient fibrous insulation blankets and, preferably, the faced conventional uncut resilient fibrous insulation blankets and the faced pre-cut resilient fibrous insulation blan-
kets of the subject invention are made of randomly oriented, entangled, glass fibers and typically have a density between about 0.3 pounds/ft\(^2\) and about 1.6 pounds/ft\(^2\). Examples of fibers other than glass fibers that may be used with or in place of glass fibers to form the faced resilient insulation blankets of the subject invention are mineral fibers, such as but not limited to, rock wool fibers, slag fibers, and basalt fibers; organic fibers such as but not limited to polypropylene, polyester and other polymeric fibers; natural fibers such as but not limited to cellulose, wood, flax and cotton fibers; and combinations thereof. The fibers in the faced resilient insulation blankets of the subject invention may be bonded together at their points of intersection for increased integrity, e.g. by a binder such as but not limited to polycarboxy polymers, polyacrylic acid polymers, urea phenol formaldehyde or other suitable bonding materials, or the faced resilient fibrous insulation blankets of the subject invention may be binder-less provided the blankets possess the required integrity and resilience.

[0074] While the variable perm faced resilient fibrous insulation blanket assemblies of the subject invention may be in roll form (typically in excess of 117 inches in length), for most applications, such as the insulation of walls in homes and other residential structures, the variable perm faced resilient fibrous insulation blanket assemblies of the subject invention are in the form of balts about 46 to about 59 inches in length (typically about 48 inches in length) or 88 to about 117 inches in length (typically about 93 inches in length). Typically, the widths of the resilient fibrous insulation blankets of the variable perm insulation assemblies are substantially equal to or somewhat greater than standard cavity width of the cavities to be insulated, for example: about 15 to about 15½ inches in width (a nominal width of 15 inches) for a cavity where the center to center spacing of the wall, floor, ceiling or roof framing members is about 16 inches (the cavity having a width of about 14½ inches); and about 23 to about 23½ inches in width (a nominal width of 23 inches) for a cavity where the center to center spacing of the wall, floor, ceiling or roof framing members is about 24 inches (the cavity having a width of about 22½ inches). However, for other applications, the resilient fibrous insulation blankets of the variable perm faced insulation assemblies may have different initial widths determined by the standard widths of the cavities to be insulated by the variable perm faced insulation assemblies.

[0075] The amount of thermal resistance or sound control desired and the depth of the cavities being insulated by the variable perm faced insulation assemblies determine the thicknesses of the variable perm faced insulation assemblies of the subject invention, e.g. faced resilient fibrous insulation blankets. Typically, the variable perm faced insulation assemblies are about three to about ten or more inches in thickness and approximate the depth of the cavities being insulated. For example, in a wall cavity defined in part by nominally 2x4 or 2x6 inch studs or framing members, a variable perm faced pre-cut resilient fibrous insulation blanket will have a thickness of about 3½ inches or about 5½ inches, respectively.

[0076] For certain applications, the variable perm sheet material that may be used for the facing 22 of the faced insulation assembly 20 and for the other facings of the other faced insulation assemblies of the subject invention may be a collapsed tubular variable perm sheet material that includes first and second lateral gusset portions. The variable perm sheet material would be made of any of the first, second, or third preferred variable perm polymeric films with or without a mineral coating and/or reinforcement as set forth in the preceding two paragraphs. As shown in FIGS. 7 and 8, which show the tubular variable perm sheet material 48 prior to and after the sheet has been collapsed to form the facing, the tubular variable perm sheet material has first and second central portions 50 and 52 extending between and joining the two lateral gusset portions 54 and 56. The central portions 50 and 52 of the collapsed tubular variable perm sheet material are bonded together to form the central field portion of the facing sheet. As shown the lateral gusset portions 54 and 56 each include four layers while the central portion of the collapsed tubular variable perm sheet material includes two layers. By including an additional lateral gusset or gussets, the lateral gusset portions could each include six or more layers. The inclusion of additional layers in each of the lateral gusset portions 54 and 56 of the collapsed tubular variable perm sheet material enables the formation of lateral tabs on the facing of increased integrity and tear through resistance while using a thinner or less expensive variable perm sheet material to form collapsed tubular variable perm sheet material.

[0077] FIGS. 9 to 22 show additional embodiments of the variable perm faced insulation assembly of the subject invention. The elements of the faced insulation assemblies of FIGS. 9 to 22 that correspond to those of FIGS. 1 to 3 will have corresponding reference numerals in the hundreds with the same last two digits as the reference numerals used for those elements in FIGS. 1 to 3. Unless otherwise stated the elements of FIGS. 9 to 22 identified with reference numerals having the same last two digits as the reference numerals referring to those elements in FIGS. 1 to 3 are and function the same as those of FIGS. 1-3.

[0078] FIG. 9 shows a partial cross section of a variable perm faced insulation assembly 120 of the subject invention with a facing sheet 122 that has Z-folded tabs 158 (only one of which is shown) and FIG. 10 shows a partial cross section of a faced insulation assembly 220 with of the subject invention that has C-folded tabs 260 (only one of which is shown) that can be unfolded and extended beyond the lateral surface of the insulation layer 224 for attachment to and/or to overlay framing members. The Z-folded tabs 158 and C-folded tabs 260 are substituted for the tabs 34, are typically between about 0.5 and about 2.0 inches in width, and typically can be extended beyond the lateral surfaces of the insulation layers 224 and 224 between about 0.25 and about 1.5 inches. Like the central field portion 32 and lateral tabs 34 of facing 22, the central field portion 32 and lateral tabs 158 of facing 122 and the central field portion 232 the lateral tabs 260 of the facing 222 are made from the same piece of variable perm sheet material.

[0079] FIGS. 11 and 12 show partial cross sections of additional embodiments 320 and 420 of the variable perm faced insulation assembly of the subject invention. In the facings 322 and 422 of the embodiments 320 and 420, lateral tabs 364 and 466 are substituted for the lateral tabs 34 of facing 22. The tabs 364 and 466 are made of materials that differ from the material used to form the central field portions 332 and 432 of the facings 322 and 422, are bonded by adhesive layers 368 and 470, by ultra sonic welding or by
other bonding means to the upper surface of lateral edge portions of the central field portion 332 and 432 of the facings 322 and 422; and are typically between about 0.5 and about 2.0 inches in width. The tab 364 of the faced insulation assembly 320 is like the tab 34 of the faced insulation assembly 20. The tab 466 of the faced insulation assembly 420 of FIG. 12 is a Z-folded tab. The tabs 364 and 466 can be unfolded and extended beyond the lateral surfaces of the insulation layers 324 and 424 (typically extended between 0.25 and 1.5 inches beyond the lateral surfaces of the insulation layers) for attachment to or to overlay framing members. By way of example, the materials used to form the central field portions 332 and 432 of the facings 322 and 422 and the lateral tabs 364 and 466 of the facings 332 and 432 may differ in thickness (e.g. a 1.0 mil thick films form the central field portions 332 and 432 of the facings while a 1.5 mil thick films form the tabs 364 and 466) and/or in composition (e.g. the central field portions 332 and 432 of the facings may be made from polypropylene films while the tabs 364 and 466 are formed from polyester films). The central field portions 332 and 432 of the facings may be made of single layers while the tabs 364 and 466 are each a laminate of multiple layers for greater integrity. The central field portions 332 and 432 of the facings may be made of laminates containing a certain number of layers while the tabs 364 and 466 are made of laminates containing a different number of layers and typically more layers for increased tab integrity. The layers of the laminates may include both layers of variable perm sheet materials (e.g. film, mat, or paper materials) and coating materials. The central field portions of the facings each may have one or more layers of a film, a coated film, a fiberglass or spunbond polymeric filament or fiber mat, or a coated fiberglass or spunbond polymeric filament or fiber mat while the tabs are made of an open spunbond polymeric filament or fiber mat or an open mesh that is sufficiently open to permit adhesive to pass through the tabs to bond wallboard directly to framing members through the tabs.

[0080] FIG. 13 shows an embodiment 520 of the variable perm faced insulation assembly of the subject invention wherein both the facing 522 and the insulation layer 524 are longitudinally separable to form faced insulation sections 572 having lesser widths than the faced insulation assembly 520. The insulation layer 524 has one or more longitudinally extending series of cuts and separable connectors, schematically represented by lines 574, which enable the insulation layer 524 to be pulled apart or separated by hand into the insulation sections 572 of lesser widths than the insulation layer 524. For each such series of cuts and separable connectors 574 in the insulation layer 524, the field portion 532 of the sheet forming the facing 522 has a line of weakness 576 therein that is longitudinally aligned with the series of cuts and separable connectors so that the facing can also be separated or pulled apart by hand at each series of cuts and separable connectors. The line of weakness 576 may be formed as a perforated line, as an etched score line that reduces the thickness of the variable perm sheet material along the line, or the line may be otherwise weakened to facilitate the separation of the facing sheet by hand along the line 576. Other than the one or more series of cuts and separable connectors 574 in the insulation layer 524 and the one or more lines of weakness 576 in the facing 522, the faced insulation assembly 520 of FIG. 13 is the same as the faced insulation assembly 20.

[0081] FIGS. 14 and 15 show an embodiment 620 of the variable perm faced insulation assembly of the subject invention wherein both the facing 622 and the insulation layer 624 are longitudinally separable to form faced insulation sections 678 having lesser widths than the faced insulation assembly 624. The insulation layer 624 has one or more longitudinally extending series of cuts and separable connectors, schematically represented by lines 680, which enable the insulation layer 624 to be pulled apart or separated by hand into the insulation sections 678 of lesser widths than the insulation layer 624. For each such series of cuts and separable connectors 678 in the insulation layer 624, the field portion 632 of the sheet forming the facing 622 has a fold 682 therein that is longitudinally aligned with the series of cuts and separable connectors. A separable pressure sensitive or other separable bonding adhesive 684 separably bonds the two segments of each fold 682 to each other and, typically, the fold line 686 joining the segments of each fold 682 will be perforated, scored, or otherwise weakened to permit the fold to be pulled apart or separated by hand at the fold line 686 to form tab segments. Preferably, each segment of each fold 682 is between about 0.25 and about 1.5 inches in width. Other than the one or more series of cuts and separable connectors 680 in the insulation layer 624 and the one or more folds 682 in the facing 622 with weakened fold lines 686, the faced insulation assembly 620 of FIGS. 14 and 15 is the same as the faced insulation assembly 20.

[0082] FIGS. 16, 17 and 18 show a variable perm faced insulation assembly 720 of the subject invention that is faced with a facing 722 of the subject invention without preformed tabs. The faced insulation assembly 720 of FIGS. 16, 17 and 18 includes the facing 722 and an insulation layer 724. Preferably, the insulation layer 724 is made of a resilient insulation material, such as but not limited to a fiberglass insulation, that can be compressed in the direction of its width, e.g. laterally compressed an inch or more, and, after the compressive forces are released, will recover or substantially recover to its initial width. The insulation layer 724 has first and second major surfaces 726 and 728, which are defined by the length and width of the insulation layer, and a thickness. The facing 722 of the faced insulation assembly 720 is formed by a variable perm sheet material that has a central field portion 732, that is substantially coextensive with the first major surface of the insulation layer 724, but has no preformed tabs. The central field portion 732 of the facing 722 has a first outer major surface and a second inner major surface. The central field portion 732 of the facing 722 overlays and is bonded, typically by a bonding layer 736 on the inner major surface of central field portion 732 of the facing, to the major surface 726 of the insulation layer 724. As best shown in FIG. 17, in a preferred form of this embodiment the bonding layer 736 bonding the central field portion 732 of the facing to the first major surface 726 of the insulation layer 724 does not extend to the lateral edges of either the insulation layer 724 or the facing 722 so that the lateral edge portions 788 of the facing 722 (e.g. portions about 0.25 to about 1.5 inches in width) are not directly bonded to the major surface 726 of the insulation layer. When the insulation layer 724 is compressed laterally to fit between a pair of framing members that are spaced apart a distance less than the width of the faced insulation assembly 720, this facilitates the separation of the lateral edge portions 788 of the facing 722 from the insulation layer 724 so that the lateral edge portions 788 of the facing 722 can extend
beyond the lateral surfaces of the laterally compressed insulation layer 724 (e.g., between 0.25 and 1.5 inches) to form lateral tabs. However, as shown in FIG. 18, the bonding layer 736 bonding the central field portion 732 of the facing 722 to the first major surface 726 of the insulation layer 724 may extend to the lateral edges of the insulation layer 724 and the facing 722 so that the bond between the lateral edge portions 788 of the facing 722 and the major surface 726 of the insulation layer must be broken before the lateral edge portions 788 of the facing 722 can be separated from the major surface 726 of the insulation layer 724 and extended beyond the insulation layer to form the lateral tabs. With the embodiment of FIG. 18, if the installer does not desire to form lateral tabs on the facing 722 that extend laterally beyond the insulation layer when the insulation layer is compressed laterally, the installer can leave the lateral edge portions 788 of the facing 722 bonded to the lateral edge portions of the major surface 726 of the insulation layer.

[0083] FIGS. 19, 20 and 21 show an embodiment 820 of the variable perm faced insulation assembly of the subject invention wherein both the facing 822 and the insulation layer 824 are longitudinally separable to form faced insulation sections 890 having lesser widths than the faced insulation assembly 820. Like the faced insulation assembly 720 of FIGS. 16, 17 and 18, the facing of faced insulation assembly 820 does not have preformed tabs and the insulation layer 824 is preferably made of a resilient insulation material, such as but not limited to a fiberglass insulation, that can be compressed in the direction of its width, e.g., laterally compressed an inch or more, and, after the compressive forces are released, will recover or substantially recover to its initial width. The insulation layer 824 has one or more longitudinally extending series of cuts and separable connectors, schematically represented by lines 892, which enable the insulation layer 824 to be pulled apart or separated by hand into the insulation sections 890 of lesser widths than the insulation layer 824. For each such series of cuts and separable connectors 892 in the insulation layer 824, the field portion 832 of the sheet forming the facing 822 has a line of weakness 894 therein that is longitudinally aligned with the series of cuts and separable connectors and can be pulled apart or separated by hand. The line of weakness 894 may be formed as a perforated line, as an etched score line that reduces the thickness of the variable perm sheet material along the line, or the line may be otherwise weakened to facilitate the separation of the facing sheet along the line 894.

[0084] Preferably, as shown in FIG. 19, the bonding layer 836 bonding the central field portion 832 of the facing sheet to the first major surface 826 of the insulation layer 824 does not extend to the lateral edges of either the insulation layer 824 or the facing 822 so that the lateral edge portions 896 of the facing sheet are not directly bonded to the major surface 826 of the insulation layer. Preferably, the bonding layer 836 will extend from about 0.25 to about 1.5 inch from the lateral edges of the facing sheet 822 and the insulation layer 824 so that the width of the unbonded lateral edge portions 896 is between about 0.25 and about 1.5 inches. Preferably, as shown in FIGS. 19 and 20, the bonding layer bonding the central field portion 832 of the facing sheet to the first major surface 826 of the insulation layer 824 is also omitted from portions 898 of the facing located adjacent each series of cuts and separable connectors 892 in the insulation layer 824 so that the facing is not directly bonded to the insulation layer along each series of cuts and separable connectors 892. Preferably, the bonding layer 836 will be omitted for a spacing of about 0.25 to about 1.5 inches from each side of each series of cuts and separable connectors in the insulation layer 824 and the lines 894 of weakness in the facing sheet 822 so that the widths of the unbonded facing portions 898 are between about 0.25 and about 1.5 inches. The omission of bonding agent from adjacent the lateral edges of the faced insulation assembly 820 facilitates the separation of the lateral edge portions 896 of the facing sheet from the insulation layer 824 so that the lateral edge portions 896 of the facing 822 can be extended as tabs beyond the lateral surfaces of the laterally compressed insulation layer 824 or extended as tabs beyond the lateral surfaces of compressed insulation sections 890 that have been separated from the insulation layer 824. The omission of bonding agent from adjacent the cuts and separable connectors 892 facilitates the separation of the portions 898 of the facing sheet from the insulation layer 824 adjacent each series of cuts and separable connectors 892 so that the portions 898 of the facing sheet can be extended as tabs beyond the lateral surfaces of the laterally compressed insulation sections 890. However, the bonding layer 836 bonding the central field portion 832 of the facing to the first major surface 826 of the insulation layer 824 may extend to the lateral edges of the insulation layer 824 and the facing sheet (e.g., as shown in FIG. 18) so that the lateral edge portions 896 of the facing sheet must be separated from the major surface 826 of the insulation layer 824 to form the lateral tabs and, as shown in FIG. 21, the facing may be directly bonded to the major surface 826 of insulation layer 824 adjacent each series of cuts and separable connectors 892 so that the portions 898 of the facing sheet must be separated from the major surface 826 of the insulation layer 824 to form tabs.

[0085] When the insulation layer 824 of faced insulation assembly 820 is compressed in the direction of its width to fit between a pair of framing members that are spaced a distance less than the width of insulation layer 824, the lateral edge portions 896 of the facing sheet separate or can be separated from the major surface 826 of the insulation layer and extended as tabs beyond the lateral surfaces of the laterally compressed insulation layer 824 to provide, if desired, a vapor retarding barrier between the facing and the framing members and/or for attachment to the framing members. When an insulation section 890 of faced insulation assembly 820 is compressed in the direction of its width to fit between a pair of framing members that are spaced a distance less than the width of insulation section 890, the portions of the facing sheet adjacent the lateral surfaces of the compressed insulation section 890 (portions 896 and/or 898) separate or can be separated from the major surface 826 of the insulation layer and extended as tabs beyond the lateral surfaces of the laterally compressed insulation section 890 to provide a vapor retarding barrier between the facing and the framing members and/or for attachment to the framing members. Where the central field portion 832 of the facing 822 is bonded to the major surface 826 of the insulation layer 824 across their entire widths, the installer may choose to leave the facing 822 bonded to the major surface of the insulation layer so that no lateral tabs are formed on the insulation layer or sections of the insulation layer when they are compressed laterally.
FIG. 22 shows an embodiment 920 of the variable perm faced insulation assembly of the subject invention. The variable perm faced insulation assembly 920 includes a facing 922 made of one of the variable perm sheet materials of the subject invention described above in this specification and a reflective sheet 912 that radiates heat, e.g., a foil sheet material, a metized film, or a metalized variable perm sheet material. The facing 922 of the faced insulation assembly 920 is formed of a variable perm sheet material that has a central field portion 932 extending between a pair of lateral edge portions 933 that are typically between 0.25 and 1.5 inches in width. Preferably, for a constant ambient humidity and ambient temperatures between 50°F and 120°F and more preferably for ambient temperatures between -20°F and 120°F, the resistance of the central field portion 932 to water vapor transmission decreases as the ambient temperature increases and increases as the ambient temperature decreases. The reflective sheet 912 has a water vapor transmitting, e.g., perforated, central field portion 914 extending between a pair of lateral edge portions 916 that are typically between 0.25 and 1.5 inches in width. The central field portion 932 of the facing 922 and the central field portion 914 of the reflective sheet 912 are spaced from each other (e.g. spaced from each other between 0.25 and 0.50 inches) to form an insulating air space between the central field portion 932 of the facing 922 and the central field portion 914 of the reflective sheet 912. In addition, there may be a spacer or spacers (e.g. paperboard spacers not shown) between the central field portion 932 of the facing 920 and the central field portion 914 of the reflective sheet 912 to assure that a spacing is maintained between the central field portion of the facing and the central field portion of the reflective sheet. The lateral edge portions 933 of the facing 922 and the lateral edge portions 916 of the reflective sheet 912 are bonded together to form the lateral tabs 934 of the faced insulation assembly 920 that extend laterally beyond the insulating portion of the faced insulation assembly, e.g. to overlap framing members (e.g. furring strips 938 or other framing members) forming a cavity being insulated by the faced insulation assembly and/or for attachment to framing members forming a cavity being insulated by the faced insulation assembly.

The variable perm faced insulation assembly 920 is typically about 15 to 16 or 23 to 24 inches in width for application to cavities defined by framing members located on 16 inch or 24 inch centers and is typically cut to the length of a cavity, e.g. to a length of about eight feet, from a longer length of the faced insulation assembly. The faced insulation assembly 920 is typically packaged, stored, shipped, and handled prior to application in roll form with the facing 922 and the reflective sheet 912 of the faced insulation assembly collapsed together. When installed in a cavity, the faced insulation assembly 920 is cut to a desired length and the tabs 934 of the assembly are pulled laterally to expand the faced insulation assembly and separate the facing 922 and the reflective sheet 912 from each other to create an air space between the facing and the reflective sheet that is typically between 0.25 and 0.50 inches in width.

FIGS. 23 and 24 show hollow building walls 1110 with cavities that are insulated with unfaced insulation batts 1112, e.g. unfaced fiberglass insulation batts. The wall cavities are each defined by: a wall covering 1113 (such as but not limited to sheathing or gypsum board that is shown where the insulation batts 1112 are broken away); spaced-apart vertically extending framing members 1114 (e.g. studs); and horizontally extending framing members 1116 (e.g. wall plates). Preferably, the variable perm vapor retard- ing sheets 1118 and 1120, when made of unreinforced variable perm sheet materials of the subject invention, have thicknesses between 1 and 3 mils. Preferably, the variable perm vapor retard ing sheets 1118 and 1120 when made of reinforced variable perm sheet materials of the subject invention are each made of a 1-3 mil thick variable perm sheet material and a reinforcing mat such as a 12 to 120 grammes per square meter (12 to 120 gspms) PET spunbond mat that is laminated to the sheet material. Preferably, for a constant ambient humidity and ambient temperatures between 50°F and 100°F, the resistance of the sheets 1118 and 1120 to water vapor transmission decreases as the ambient temperature increases and increases as the ambient temperature decreases. The sheets 1118 or 1120 may made of a width and length to be substantially coextensive with the wall or the sheets can be formed in smaller widths and applied as discussed below in connection with FIGS. 23 and 24.

In FIG. 23, upper and lower variable perm vapor retard ing sheets 1118, which are partially peeled back to show the insulation batts 1110, overlay the unfaced insulation batts 1112. The sheets 1118 may be made of any of the reinforced and/or fungi growth resistant variable perm sheet materials described above in this specification. As applied to the framing members 1114 and 1116, the longitudinal centerlines of the sheets 1118 extend horizontally with the lower lateral edge portion of the upper sheet and upper lateral edge portion of the lower sheet overlapping each other so that the sheets 1118 form a vapor retard ing layer of the wall. The sheets 1118 may be unrolled from rolls of the variable perm sheet material, cut to desired lengths, and secured to the framing members 1114 and 1116 by staples, beads of adhesive preapplied to the framing members, or by other securing means. Preferably, the sheets 1118 have widths that enable the sheets: to be overlapped by an inch or more, to preferably be adhesively or otherwise sealed together, and to extend together for the entire height and length of the wall, e.g. for a eight foot high wall the sheets 1118 may each be about fifty inches in width and about twenty to about one hundred feet long. By bonding or otherwise securing and sealing the longitudinally extending lateral edge portions of the sheets 1118 together, an integral variable perm wall layer can be formed in situ that extends for both the length and the height of the wall.

In FIG. 24, side-by-side variable perm vapor retard ing sheets 1120, which are partially peeled back to show the insulation batts and framing structure of the wall 1110, overlay the unfaced insulation batts 1112. The sheets 1120 may be of any of the reinforced and/or fungi growth resistant variable perm sheet materials described above in this specification. As applied to the framing members 1114 and 1116, the longitudinal centerlines of the sheets 1120 extend vertically with the lateral edge portions of adjacent sheets 1120 being secured to the same vertical frame members 1114 or overlapping each other so that the sheets 1120 form a vapor retard ing layer of the wall. The sheets 1120 may be unrolled from rolls of the variable perm sheet material, cut to desired lengths, and secured to the framing members 1114 and 1116 by staples, beads of adhesive preapplied to the framing members, or by other securing means. The sheets 1120 may have widths equal to the
standard center to center spacing of the vertical frame members 1114 in a wall, e.g. 16 or 24 inch widths, so that the sheets each can overlie a single wall cavity and have lateral longitudinally extending edge portions that can be bonded or otherwise secured together and/or secured to the vertical frame members defining the cavity. However, preferably, the sheets 1120 have widths that are multiples of the standard cavity widths for a wall e.g. 32, 48, 64, 72, 84, or 96 inch widths that enable the sheets to overlie a plurality of wall cavities and have longitudinally extending lateral edge portions that can be bonded or otherwise secured together and/or secured to vertical frame members 1114 of the wall. By bonding or otherwise securing and sealing the longitudinally extending lateral edge portions of the sheets 1120 together, an integral variable perm wall layer can be formed in situ that extends for both the length and the height of the wall.

The variable perm vapor retarding sheets 1118 and 1120 may be made of a variable perm sheet material of the subject invention such as the sheet material 60 shown in FIG. 25 wherein a first lateral longitudinally extending edge portion of the sheet material on a first major surface of the sheet material has a first cold seal adhesive layer 62 and a second lateral longitudinally extending edge portion of the sheet material on a second major surface of the sheet material has a second cold seal adhesive layer 64. With the use of cold seal adhesives no release sheets are required to overlay the adhesive layers 62 and 64 to keep the adhesive from adhering to surfaces other than another cold seal adhesive surface and by pressing the overlapping lateral edge portions of two sheets 60 together the sheets can be sealed together. When the variable perm vapor retarding sheets 1118 and 1120 are made of the sheet material 60, overlapping lateral edge portions of variable perm vapor retarding sheets 1118 or 1120 can be sealed together to form, in situ, an integral variable perm sheet extending for both the height and length of the wall.

FIGS. 26, 27 and 28 show a house wrap 1130 made of any of the reinforced and/or fungi growth resistant variable perm sheet materials described above in this specification. Preferably, for a constant ambient humidity and ambient temperatures between 50°F and 120°F and more preferably for ambient temperatures between −20°F and 120°F, the resistance of the house wrap 1130 to water vapor transmission decreases as the ambient temperature increases and increases as the ambient temperature decreases. As shown in FIG. 26, the house wrap 1130 is typically located between the outer sheathing 1132 of an outer wall and the exterior siding 1134 of the outer wall. Preferably, the variable perm vapor retarding sheets 1138 and 1140 of the house wrap 1130, when made of unreinforced variable perm sheet materials of the subject invention, have thicknesses between 1 and 3 mils. Preferably, the variable perm vapor retarding sheets 1138 and 1140 of the house wrap 1130, when made of reinforced variable perm sheet materials of the subject invention, each include a 1-3 mil thick variable perm sheet material and a reinforcing mat such as a 12 to 120 grams per square meter (12 to 120 gsm) PET spunbond mat that is laminated to the sheet material. The variable perm vapor retarding sheets 1138 and 1140 of the house wrap 1130 may be made of a width and length to be substantially coextensive with the outer sheathing 1132 of the exterior wall or the variable perm vapor retarding sheets 1138 and 1140 can be formed in smaller widths and applied as discussed below in connection with FIGS. 27 and 28.

As shown in FIG. 27, the variable perm vapor retarding sheets 1138 of the house wrap 1130 can be applied to the outer sheathing 1132 of the exterior wall with the longitudinal centerlines of the variable perm vapor retarding sheets 1138 extending horizontally and with the lower lateral edge portion of the upper sheet and upper lateral edge portion of the lower sheet overlapping each other so that the sheets 1138 form a variable perm vapor retarding layer of the wall to regulate water vapor transmission through the wall. The variable perm vapor retarding sheets 1138 may be unrolled from rolls of the variable perm sheet material, cut to desired lengths, and secured to the sheathing 1132 of the outer wall by staples, beads of adhesive preapplied to the sheathing, or by other securing means. Preferably, the variable perm vapor retarding sheets 1138, which also function as air transmission barriers and liquid water transmission barriers, have widths that enable the sheets to be overlapped by an inch or more, to be adhesively or otherwise sealed together, and to extend together for the entire height and length of the wall, e.g. for a eight foot high wall the sheets may each be about fifty inches in width and about twenty to about one hundred feet long. By bonding or otherwise securing and sealing the longitudinally extending lateral edge portions of the variable perm vapor retarding sheets 1138 together, an integral variable perm house wrap wall layer can be formed in situ that extends for both the length and the height of the exterior wall and that also functions as an air transmission barrier and liquid water transmission barrier.

As shown in FIG. 28, the variable perm vapor retarding sheets 1140 of the house wrap 1130 can be applied to the outer sheathing 1132 of the exterior wall with the longitudinal centerlines of the sheets extending vertically and with the lateral edge portions of adjacent sheets overlapping each other so that the sheets form a variable perm vapor retarding wall layer to regulate water vapor transmission through the wall. The variable perm vapor retarding sheets 1140 may be unrolled from rolls of the variable perm sheet material, cut to desired lengths, and secured to the outer sheathing of the exterior wall by staples, beads of adhesive preapplied to the sheathing, or by other securing means. The variable perm vapor retarding sheets 1140 may have widths that make the sheets easy to handle, e.g. widths of from 3 to 6 feet and have longitudinally extending lateral edge portions that can be bonded or otherwise secured together to form, in situ, an integral variable perm vapor retarding housing wrap wall layer that extends for both the length and the height of the exterior wall and that also functions as an air transmission barrier and liquid transmission barrier.

The variable perm vapor retarding sheets 1138 and 1140 may be made of a variable perm sheet material 60 such as that shown in FIG. 25 wherein a first lateral longitudinally extending edge portion of the sheet material on a first major surface of the sheet material has a first cold seal adhesive layer 62 and a second lateral longitudinally extending edge portion of the sheet material on a second major surface of the sheet material has a second cold seal adhesive layer 64. With this adhesive, no release sheets are required to overlay the adhesive layers to keep the adhesive from adhering to surfaces other than another cold seal adhesive
surface and by pressing the overlapping lateral edge portions of the sheets 1138 and 1140 together, the overlapping lateral edge portions of the sheets can be sealed together to form, in situ, an integral variable perm sheet extending for the both the height and length of the wall. It is also contemplated that one variable perm vapor retarding sheet could be used to form the house wrap 1130 rather than the two sheets 1138 and 1140 and that such a sheet would be about eight feet in width for an eight-foot high wall.

[0096] FIG. 29 shows a cross section of the variable perm facing 22 of variable perm faced insulation assembly 20 of FIGS. 1 to 3 wherein the lateral tabs 34 have cold seal adhesive layers or coatings 37 for bonding the lateral tabs of the insulation assembly to the lateral tabs of adjacent variable perm insulation assemblies. The cold seal adhesive layers 37 will bond to each other when pressed together but will not readily adhere to other surfaces and do not require the use of a release liner. As shown, a first cold seal adhesive layer is located on a first surface of one of the lateral tabs 34 and a second cold seal adhesive layer is located on a second opposite surface of the other lateral tab 34. Thus, one of the lateral tabs 34 can overlap and be bonded to a lateral tab of a like variable perm insulation assembly that has the cold seal adhesive layer on the opposite surface of the tab and the other lateral tab 34 can be overlapped by and bonded to lateral tab of another like variable perm insulation assembly that has the cold seal adhesive layer on the opposite surface of the tab.

[0097] FIG. 30 shows a variable perm faced insulation assembly 66 that has a variable perm facing 68 bonded to a first major surface of the insulation layer 70 of the variable perm faced insulation assembly and a variable perm backing sheet 72 bonded to a second major surface of the insulation layer 70. The variable perm facing 68 and backing sheet 72 may be made of any of the reinforced or unreinforced variable perm sheet materials of the subject invention and may exhibit the same or different water vapor transmission properties as well as other properties that are the same or different from each other. The variable perm facing 68 may have longitudinally extending lateral tabs 74 or be tableless and the facing has lateral tabs the tabs may each have a cold seal adhesive layer 76 thereon; may each have a pressure sensitive adhesive and release liner thereon; or may have no adhesive thereon. With this structure the variable perm faced insulation assembly 66 can vent or dry out through both major surfaces of the assembly. In addition, the use of a variable perm facing 68 on one major surface and a variable perm backing sheet 72 on the other major surface of the insulation assembly 66 can provide the variable perm faced insulation assembly, as a whole, with an average perm rating that is significantly lower than the perm ratings of either the facing or backing sheet individually. For example, a 1.3 mil thick nylon 6 facing 68 and a 1.3 mil thick nylon 6 backing sheet 72 which each have a perm rating of less than 3 as measured by the dry cup method and greater than 25 as measured by the wet cup method combine to provide a variable perm faced insulation assembly 66 with an average dry cup perm rating of approximately 1.

[0098] FIG. 31 shows a variable perm encapsulated insulation assembly 80 that is encapsulated within a film envelope 82 that at least overlays both major surfaces and both lateral surfaces of the insulation assembly. As shown, the film envelope 82 is made of a variable perm facing 84 that overlays the first major surface of the insulation layer 86 and a backing sheet 88 that overlays the second major surface and the lateral surfaces of the insulation layer 86. The variable perm encapsulated insulation assembly 80 may have a variable perm facing 84 and a backing sheet 88 has a substantially fixed perm rating or the variable perm encapsulated insulation assembly 80 may have a variable perm facing 84 and a variable perm backing sheet 88. Where the variable perm facing 84, alone, or the variable perm facing 84 and the backing sheet 88 are both made of variable perm sheet materials, the variable perm facing 84 and the variable perm backing sheet 88 may be made of any of the reinforced or non-reinforced variable perm sheet materials of the subject invention and may exhibit the same or different water vapor transmission properties as well as other properties that are the same or different from each other. The variable perm facing 84 may have longitudinally extending lateral tabs 90 or be tableless and where the facing has lateral tabs the tabs may each have a cold seal adhesive layer 92 thereon; may each have a pressure sensitive adhesive and release liner thereon; or may have no adhesive thereon. When both the facing 84 and the backing sheet 88 are made of a variable perm sheet material, the variable perm encapsulated insulation assembly 80 can’t be incorrectly installed since the assembly 80 can vent or dry out through both major surfaces of the assembly. In addition, the use of a variable perm facing 84 on one major surface and a variable perm backing sheet 88 on the other major surface of the insulation assembly 80 can provide the variable perm faced insulation assembly, as a whole, with an average perm rating that is significantly lower than the perm ratings of either the facing or backing sheet individually. For example, a 1.3 mil thick nylon 6 facing 84 and a 1.3 mil thick nylon 6 backing sheet 88 which each have a perm rating of less than 3 as measured by the dry cup method and greater than 25 as measured by the wet cup method combine to provide a variable perm faced insulation assembly 80 with an average dry cup perm rating of approximately 1.

[0099] In describing the invention, certain embodiments have been used to illustrate the invention and the practices thereof. However, the invention is not limited to these specific embodiments as other embodiments and modifications within the spirit of the invention will readily occur to those skilled in the art on reading this specification. Thus, the invention is not intended to be limited to the specific embodiments disclosed, but is to be limited only by the claims appended hereto.

What is claimed is:

1. A variable perm faced building insulation assembly, comprising:

an insulation layer; the insulation layer having a length, a width and a thickness; the insulation layer having first and second major surfaces defined by the length and width of the layer; and

a facing comprising a sheet having a central field portion overlaying and substantially coextensive with the first major surface of the insulation layer; the central field portion of the sheet having a first outer major surface and a second inner major surface bonded to the first major surface of the insulation layer; the central field portion of the sheet having a resistance to water vapor transmission that changes when ambient relative
humidity changes with the resistance of the central field portion of the sheet to water vapor transmission decreasing as the ambient humidity increases and increasing as the ambient humidity decreases.

2. The variable perm faced building insulation assembly according to claim 1, wherein:

the central field portion of the facing sheet is embossed to stretch and thin the central field portion of the facing sheet at numerous locations and thereby affect the water vapor transmission characteristics of the central field portion of the facing sheet.

3. The variable perm faced insulation assembly according to claim 1, wherein:

the central field portion of the facing sheet is bonded to the first major surface of the insulation layer by a discontinuous bonding layer that leaves the water vapor transmission properties of the central field portion of the sheet substantially unaffected.

4. The variable perm faced insulation assembly according to claim 1, wherein:

the central field portion of the facing sheet is bonded to the first major surface of the insulation layer by a bonding layer having a resistance to water vapor transmission that affects the water vapor transmission properties of the central field portion of the sheet but leaves the water vapor transmission properties of the central field portion of the sheet within a selected permeance rating range.

5. The variable perm faced insulation assembly according to claim 1, wherein:

the central field portion of the facing sheet is bonded to the first major surface of the insulation layer by a heat activated bonding layer.

6. The variable perm faced insulation assembly according to claim 1, wherein:

the central field portion of the facing sheet has a permeance rating of 1 perm or less as measured by the ASTM E 96-00 dry cup method and a permeance rating of 10 perms or more as measured by the ASTM E 96-00 wet cup method.

9. The variable perm faced insulation assembly according to claim 1, wherein:

the central field portion of the facing sheet, as bonded to the insulation layer, is fungi growth resistant.

10. The variable perm faced building insulation assembly according to claim 1, wherein:

the central field portion of the facing sheet, as bonded to the insulation layer, exhibits no more than traces of sporulating growth, non-sporulating growth, or both sporulating and non-sporulating growth.

11. The variable perm faced building insulation assembly according to claim 1, wherein:

the central field portion of the facing sheet, as bonded to the insulation layer, exhibits no sporulating growth or non-sporeulating growth.

12. The variable perm faced building insulation assembly according to claim 1, wherein:

the sheet has first and second lateral tabs extending for the length of the sheet that are separated from each other by the central field portion of the sheet.

14. The variable perm faced building insulation assembly according to claim 1, wherein:

the insulation layer is resilient and separable longitudinally by hand at a location spaced inwardly from lateral edge surfaces of the insulation layer; and

the central field portion of the sheet is separable longitudinally by hand at a location that is aligned longitudinally with the separable location in the insulation layer to facilitate separation by hand of the insulation layer and sheet into faced insulation sections.

15. The variable perm faced building insulation assembly, according to claim 1, including:

a backing sheet comprising a sheet having a central field portion overlying and substantially coextensive with the second major surface of the insulation layer; the central field portion of the sheet having a first outer major surface and a second inner major surface; the central field portion of the sheet having a resistance to water vapor transmission that changes when ambient relative humidity changes with the resistance of the
The variable perm facing for a variable perm faced building insulation assembly according to claim 18, wherein:

- the central field portion of the sheet to water vapor transmission decreasing as the ambient humidity increases and increasing as the ambient humidity decreases; and for a constant ambient humidity and ambient temperatures between 50°F and 100°F, the resistance of the central field portion of the facing sheet to water vapor transmission decreases as the ambient temperature increases and increases as the ambient temperature decreases.

17. The variable perm faced building insulation assembly, according to claim 1, wherein:

- the first and second major surfaces and at least lateral surfaces of the insulation layer are overlaid by the facing and the backing sheet.

18. A variable perm facing for a variable perm faced building insulation assembly, comprising:

- a sheet having a length and a width; the sheet having a central field portion for overlaying and being bonded to a major surface of an insulation layer; the central field portion of the sheet having a first outer major surface and a second inner major surface for bonding to a major surface of an insulation layer overlaid by the sheet; the central field portion of the sheet having a resistance to water vapor transmission that changes when ambient relative humidity changes with the resistance of the central field portion of the sheet to water vapor transmission decreasing as the ambient humidity increases and increasing as the ambient humidity decreases; and the central field portion of the sheet being fungi growth resistant.

19. The variable perm facing for a variable perm faced building insulation assembly according to claim 18, wherein:

- the central field portion of the sheet is embossed to stretch and thin the central field portion of the facing sheet at numerous locations and thereby affect the water vapor transmission characteristics of the central field portion of the facing sheet.

20. The variable perm facing for a variable perm faced building insulation assembly according to claim 18, wherein:

- the sheet exhibits no sporulating or non-sporulating growth.

21. The variable perm facing for a variable perm faced building insulation assembly according to claim 18, wherein:

- the sheet has first and second lateral tabs extending for the length of the sheet that are separated from each other by the central field portion of the sheet.

22. The variable perm facing for a variable perm faced building insulation assembly according to claim 18, wherein:

- the central field portion of the sheet has at least one longitudinally extending line of weakness to facilitate separation of the sheet longitudinally by hand along the line of weakness.

23. The variable perm facing for a variable perm faced building insulation assembly according to claim 18, wherein:

- the second major surface of the central field portion of the sheet has a discontinuous bonding layer thereon that leaves the water vapor transmission properties of the central field portion of the sheet substantially unaffected.

24. The variable perm facing for a variable perm faced building insulation assembly according to claim 18, wherein:

- the second major surface of the central field portion of the sheet has a discontinuous bonding layer thereon that affects the water vapor transmission properties of the central field portion of the sheet but leaves the water vapor transmission properties of the central field portion of the sheet within a selected permeance rating range.

25. The variable perm facing for a variable perm faced building insulation assembly according to claim 18, wherein:

- the second major surface of the central field portion of the sheet has a bonding layer thereon that has a resistance to water vapor transmission that leaves the water vapor transmission properties of the central field portion of the sheet substantially unaffected.

26. The variable perm facing for a variable perm faced building insulation assembly according to claim 18, wherein:

- the second major surface of the central field portion of the sheet has a bonding layer thereon that has a resistance to water vapor transmission that affects the water vapor transmission properties of the central field portion of the sheet within a selected permeance rating range.

27. The variable perm facing for a variable perm faced building insulation assembly according to claim 18, wherein:

- the second major surface of the central field portion of the sheet has a heat activated bonding layer thereon.

28. The variable perm facing for a variable perm faced building insulation assembly according to claim 18, wherein:

- the central field portion of the sheet has a permeance rating of 1 perm or less as measured by the ASTM E 96-00 dry cup method and a permeance rating of 10 perms or more as measured by the ASTM E 96-00 wet cup method.

29. The variable perm facing for a variable perm faced building insulation assembly according to claim 18, wherein:

- the central field portion of the sheet has a heating rating of 1 perm or less as measured by the ASTM E 96-00 dry cup method and a heating rating of 10 perms or more as measured by the ASTM E 96-00 wet cup method.

30. A variable perm faced building insulation assembly, comprising:

- a facing sheet; the facing sheet having lateral edge portions and a central field portion extending between the lateral edge portions of the facing sheet; the central field portion of the sheet having a resistance to water vapor transmission that changes when ambient relative humidity changes with the resistance of the central field portion of the sheet to water vapor transmission decreasing as the ambient humidity increases and increasing as the ambient humidity decreases.
a reflective water vapor transmitting sheet material; the reflective sheet material having lateral edge portions and a central field portion extending between the lateral edge portions of the reflective sheet material; and

the lateral edge portions of the facing sheet being spaced from the central field portion of the facing sheet to form an insulating space between the central field portion of the facing sheet and the reflective sheet material to form an insulating assembly.

31. The variable perm faced building insulation assembly according to claim 30, wherein:

the facing sheet is embossed to stretch and thin the central field portion of the facing sheet at numerous locations and thereby affect the water vapor transmission characteristics of the central field portion of the facing sheet.

32. The variable perm faced building insulation assembly according to claim 30, wherein:

the facing sheet exhibits no more than traces of sporulating growth, non-sporulating growth, or both sporulating and non-sporulating growth.

33. The variable perm faced building insulation assembly according to claim 30, wherein:

the variable perm faced building insulation assembly comprising a series of cavities that are each defined in part by spaced apart parallel extending framing members; the insulation system comprising:

unfaced fibrous insulation batts contained within each of the series of cavities; and

a variable perm vapor water vapor transmission retard cover overlying the series of cavities, substantially coextensive with the series of cavities, and secured to the framing members defining the cavities; the variable perm water vapor retard cover comprising a variable perm sheet material having a first major surface, a second major surface, and being fungicide resistant; and the variable perm sheet material having a resistance to water vapor transmission that changes when ambient relative humidity changes with the resistance of the central field portion of the sheet to water vapor transmission decreasing as the ambient humidity increases and increasing as the ambient humidity decreases; and for a constant ambient humidity and ambient temperatures between 50°F and 100°F, the resistance of the central field portion of the facing sheet to water vapor transmission decreases as the ambient temperature increases and increases as the ambient temperature decreases.

36. The insulation system according to claim 35, wherein:

the variable perm sheet material exhibits no more than traces of sporulating growth, non-sporulating growth, or both sporulating growth and non-sporulating growth.

37. The insulation system according to claim 35, wherein:

the variable perm sheet material exhibits no sporulating growth or non-sporulating growth.

38. The insulation system according to claim 35, wherein:

the variable perm sheet material is reinforced by an integral mat layer of a spunbond nonwoven continuous polymeric filament mat weighing between about 15 and about 30 grams per square meter.

39. The insulation system according to claim 35, wherein:

the variable perm sheet material is reinforced by an integral nonwoven fiberglass mat weighing between about 20 and about 80 grams per square meter.

40. The insulation system according to claim 35, wherein:

the variable perm water vapor transmission retard cover comprises a series of sheets of the variable perm sheet material; each of the sheets has lateral longitudinally extending edge portions; and the lateral longitudinally extending edge portions of adjacent sheets are overlapped and bonded together, in situ, to form an integral variable perm water vapor transmission retard cover.

41. The insulation system according to claim 40, wherein:

the lateral longitudinally extending edge portions are adhesively bonded together by a cold seal adhesive.

42. The insulation system according to claim 35, wherein:

the cover is embossed to stretch and thin the cover at numerous locations and thereby affect the water vapor transmission characteristics of the cover.

43. An insulation system for an exterior of a building comprising:

a sheathing layer of the exterior; and

a variable perm water vapor transmission retard layer overlying, substantially coextensive with, and secured to an outer surface of the sheathing layer, the water vapor transmission retard layer comprising a variable perm sheet material that is reinforced and is fungicide resistant; and the variable perm sheet material having a resistance to water vapor transmission that changes when ambient relative humidity changes with the resistance of the central field portion of the sheet to water vapor transmission decreasing as the ambient humidity increases and increasing as the ambient humidity decreases; and for a constant ambient humidity and ambient temperatures between 50°F and 120°F, the resistance of the central field portion of the facing sheet to water vapor transmission decreases as the ambient temperature increases and increases as the ambient temperature decreases; and the variable perm water vapor transmission retard layer functioning as an air transmission barrier and liquid water transmission barrier.

44. The insulation system according to claim 43, wherein:

the variable perm sheet material exhibits no more than traces of sporulating growth, non-sporulating growth, or both sporulating growth and non-sporulating growth.

45. The insulation system according to claim 43, wherein:

the variable perm sheet material exhibits no sporulating growth or non-sporulating growth.
46. The insulation system according to claim 43, wherein:
the variable perm sheet material is reinforced by an
integral mat layer of a spunbond nonwoven continuous
polymeric filament mat weighing between about 15 and
about 30 grams per square meter.

47. The insulation system according to claim 43, wherein:
the variable perm sheet material is reinforced by an
integral nonwoven fiberglass mat weighing between
about 20 and about 80 grams per square meter.

48. The insulation system according to claim 43, wherein:
the variable perm water vapor transmission retarding
layer comprises a series of sheets of the variable perm
sheet material; each of the sheets has lateral longitudi-
nally extending edge portions; and the lateral longitudi-
nally extending edge portions of adjacent sheets are
bonded together, in situ, to form an integral variable
perm water vapor transmission retarding layer and an
air transmission barrier and liquid water transmission
barrier.

49. The insulation system according to claim 48, wherein:
the lateral longitudinally extending edge portions are
adhesively bonded together by a cold seal adhesive.

50. The insulation system according to claim 43, wherein:
the variable perm sheet material is embossed to stretch
and thin the variable perm sheet material at numerous
locations and thereby affect the water vapor transmis-
sion characteristics of the variable perm sheet material
and the variable perm water vapor transmission retard-
ing layer.

51. The insulation system according to claim 43, wherein:
the exterior of the building is an exterior wall of the
building.