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Vapour Barriers in Home Construction

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Please note

The term "vapour barrier" is one which has come to be accepted in building technology as describing a special class of materials which offer a high resistance to the flow of water vapour. In general, vapour barriers are special building papers, membranes, or coatings designed for this specific purpose. There are other building materials, however, which are used as cladding, insulation, or as protective coatings, and which may act as vapour barriers. In some cases their vapour barrier properties may be used to advantage, while in other situations they may create problems.

Only a few building materials, such as glass and metal, can be regarded as impervious to the flow of water vapour, but a considerable number of materials will provide sufficient resistance to be used for vapour control purposes. To classify these as vapour barriers, an arbitrary standard has been established by which materials can be rated in terms of their water vapour permeability or water vapour permeance. These coefficients indicate the rate at which water vapour will diffuse through the material under a given set of conditions. Permeance coefficients are expressed in units called "perms", one perm representing a transfer rate of one grain per square foot per hour under a vapour pressure difference of one inch of mercury. The lower the perm rating, the greater is the resistance of the material to vapour movement. The resistance to vapour flow required depends on the service conditions. For house construction, materials having a permeance of 0.75 or less when tested under prescribed conditions are generally classified as vapour barriers. For some applications, however, permeance values of 0.25 or less may be necessary.

There is a wide variety of materials that are used as vapour barriers. Some of the general classes and types of building products that fall into this category are as follows:

Asphalt coated felts and papers
Asphalt laminated papers
Heavy roofing papers
Metal foils of copper or aluminum
Polyethylene film
Aluminum paint

Asphalt paints and coatings
Varnish vehicle paints
Latex emulsion paints of some types
Exterior grade plywood
Cellular glass insulation
Cellular plastic insulation.

While the materials listed above exhibit a high resistance to the passage of water vapour, this property is not the only factor that should be considered in the selection of a vapour barrier for a specific purpose. The properties of the material in regard to tensile strength, pliability, tear resistance, durability under bacterial action, freezing and thawing or wetting and drying, may also be of importance. In the final analysis, however, the effectiveness of the barrier is determined by the design and care involved in its application. The most impermeable, most durable vapour barrier may be rendered virtually ineffective by the presence of accidental or intentional openings. The extent to which such openings will occur, the methods used to counteract their effect, as well as the conditions under which the barrier must function are largely determined by the details of the specific application. An appreciation of the factors involved in each case is therefore necessary for satisfactory performance to be realized. Not every application can be considered in this note, but some of the more common situations encountered will illustrate a few of the problems and general principles.

Vapour Barriers in Exterior Walls

The most common use of vapour barriers is in providing vapour protection for insulated frame walls in winter. Without such protection, the possibility of excessive condensation occurring within the wall is likely, giving rise to subsequent paint blistering and peeling, or even rotting of the exterior sheathing and structural members. Paint failures cannot always be prevented by proper vapour barrier installation alone, since they may result from moisture entering the wall from outside. The vapour barrier only reduces the amount of moisture entering the wall from *within* the building.

The moisture content of air within most houses in winter will be higher than that of outside air. This condition results in a vapour pressure difference between inside and outside, with water vapour tending to diffuse through the building enclosure to the outdoors. If this vapour is allowed to penetrate the interior cladding and insulation it will come in contact with surfaces within the wall that are at a much lower temperature and will condense on these surfaces as water or frost. During subsequent milder weather or through the warming effect of the sun, this moisture will be absorbed by the wall materials and may give rise to deterioration, or may drain through unintentional openings in the cladding materials to produce unsightly staining or create a nuisance.

Condensation within exterior walls can be reduced to an acceptable level by increasing the resistance of interior cladding assemblies to water vapour transfer. The simplest and most common approach in new construction is to install a sheet-type vapour barrier over the insulation immediately beneath the interior cladding. Many batt- or blanket-type insulations are sold with an integral vapour barrier as the paper backing. Such a membrane will provide satisfactory protection provided every effort is made to lap the paper over all framing members. Often it is difficult to cover the wall completely using this barrier alone, if the batt is to be indented between furring or if it is supplied in lengths shorter than the full height of the wall. Under such circumstances, and in regions of severe winter climate, a separate barrier is recommended. In the selection of separate barriers, those which possess resistance to tearing and can be applied with a minimum of joints are to be preferred.

Paint films may be used to provide reasonably effective protection, but difficulties are experienced with such coatings in obtaining adequate scaling at windows and baseboards or other trim. Cracks which may subsequently develop in the film will also reduce its effectiveness. Similar problems arise with the use of vapour-resistant interior cladding materials because of the difficulty of providing continuity at joints and window openings. Separate vapour barriers should be used with such materials except under special circumstances.

The importance of avoiding all unnecessary openings through the vapour barrier cannot lie overemphasized. These openings may not only provide a means for water vapour to pass into the wall by diffusion, but if associated with a crack or opening in the interior cladding they may also allow moist air to flow into the wall under the action of air pressure differences. Tests have shown that a vapour barrier which barely meets the permeance requirements, but has no openings, will perform satisfactorily under severe conditions. Openings in the most impermeable barrier, however, will result in excessive condensation within the wall. Slight differences in permeance ratings are therefore of secondary importance in the selection of a suitable material.

It is almost impossible to avoid some openings or breaks in vapour barriers in building construction, particularly where electrical outlet boxes or warm air supply registers occur on outside walls. Every effort should be made to fit the separate vapour barrier tightly around these openings. In walls with batt or blanket insulation the integral barrier should be forced behind the outlet and securely fastened to the adjacent framing. This will provide a secondary line of resistance to the movement of moist air into the cold regions of the wall.

Because a completely impermeable interior cladding is seldom, if ever, achieved it is important to recognize that some condensation may occur within exterior walls in winter. Every effort should therefore be made to permit this moisture to escape, either by using materials for exterior sheathing and cladding that are permeable to water vapour, or by providing some other means for moisture removal. Under normal conditions, and where reasonable care has been exercised in the application of vapour barriers, the small amount of moisture that may accumulate will escape during the annual weather cycle without causing serious difficulty. When using sheathing or cladding materials that possess vapour barrier properties, special steps must be taken to control condensation. If these materials are relatively resistant to water vapour flow but not impermeable, such as exterior grade plywood, use of separate vapour barriers of lower permeance on the inside, carefully applied, may give adequate protection. Where impermeable materials, such as metal or glass, are used as cladding, provision must be made for venting the interior of the wall to outside to permit the escape of water vapour. Vents are most effective when located at different levels and connected by air spaces within the construction since air interchange with outside is promoted by chimney action. Precautions must be taken, however, to ensure that excessive ventilation and air movement within the construction do not occur as a result of wind pressures.

Vapour Barriers in Ceilings and Roofs

The same basic principles of vapour control in frame walls apply to insulated ceilings and roofs. There is a greater possibility for more openings to exist in vapour barriers in ceilings of frame construction than in walls. Not only are electrical ceiling fixtures common, but openings occur around plumbing vents, ductwork, and chimneys. Of even greater significance is the tendency for moist interior air to flow upward through these openings due to the chimney action of the building itself. The danger of excessive amounts of moisture accumulating in the attic space is therefore more acute than in exterior walls.

Pitched roofs offer means for the removal of this moisture by natural ventilation. The small amount of heat transferred to the attic through the insulation and the heat gain through the roof from the sun warm the air in the attic space and increase its moisture-carrying capacity. At the same time, this slight elevation in attic air temperature creates a chimney effect which induces ventilation, provided adequately sized and properly located vent openings are incorporated. As a general rule, these vents should be of such size as to provide a total screened area of one square inch for each square foot of ceiling area, and should be so located that the total vent area is distributed equally between caves and ridge.

Flat or low pitched frame roofs present a somewhat more difficult problem for they do not provide sufficient height to create adequate chimney action. In addition, the smaller passageways above the insulation offer a greater resistance to air flow and inhibit natural ventilation due to wind. The problem of vapour control with this type of flat roof becomes more difficult as the span of the roof increases. In most cases roof joists will be blocked at bearing partitions and some means must be provided for the through-flow of air. Furthermore the potential for flow of moist air from the building into the roof space increases as the height of the building increases and it becomes more and more difficult to provide a sufficiently tight vapour barrier.

An alternative approach to the problem of flat roof design in frame construction is the use of rigid insulation applied over a vapour barrier on the roof deck. There is less likelihood of breaks and openings occurring in the barrier under such conditions and little opportunity for flow of moist air from the building. Its location, however, from the thermal standpoint may not be the best. Care should be taken to provide sufficient insulation above the barrier to ensure that at no time will the temperature of the decking fall below the dew point temperature of the air within the building. With exposed beam ceilings this danger is not acute unless the decking contributes a substantial portion of the over-all thermal resistance or unless the humidity within the building is excessively high. With finished ceilings, the thermal resistance of the interior cladding and air space must be kept to a minimum.

In flat roof designs with rigid insulation on the deck, the fact that the roofing and vapour barrier restrict both the entry and escape of water vapour should be recognized. Moisture may accumulate in the insulation by means other than condensation: from rain during construction, for example, or through subsequent roof leaks. Following application of the roofing, or repair of leaks, heating of the roof by the sun may result in very large pressures being developed by the moisture within the insulation. This effect is regarded by some authorities as contributing to blistering and early roof failure. To prevent this from occurring, a suitable venting arrangement is sometimes used to relieve the pressure developed within the insulation. Still another approach to the problem is to use insulations which have low water and water-vapour absorption properties.

Vapour Barriers for Special Applications

Certain applications for vapour barriers require special properties of the material. One notable example is the use of membranes to prevent moisture transfer from the ground into concrete slab floors or into crawl spaces. In both of these instances, resistance to damage by tearing or puncturing, and resistance to bacteria and fungi attack, are prime requisites. Roll roofing, of 45-lb weight or heavier, or polyethylene film of 4 ml or greater thickness, perform satisfactorily in these respects. When used under concrete slabs placed on gravel or crushed rock fill, a layer of ordinary building paper should be placed between the polyethylene and gravel. Unless this is done, excessive puncturing of the film may occur.

Summary

In building terminology, a vapour barrier refers to any material used to restrict the movement of water vapour. It may take the form of a coating, membrane, or board, but is normally a sheet material designed to fulfil this one particular function.

The correct selection of a vapour barrier is influenced largely by the peculiarities of the application for which it is intended, and involves consideration of other properties of the material in addition to its water vapour permeance. These properties vary widely with different vapour barriers, and no one material is necessarily suited to all applications. The conditions to which the vapour barrier is exposed after installation are a factor, but the circumstances during application are usually of most importance. The most important general principle to be followed in both design and installation is to reduce to a minimum the number of openings in the barrier. Where such openings are necessary, special care should be taken to seal the barrier so as to approach complete continuity.