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Moisture Control in Residences

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Excess moisture within a home can result in condensation problems, mildew growth and eventual deterioration of construction materials and furnishings. Too little moisture often increases static electricity and wood shrinkage, which causes damage to glued joints.

Comfort within the home depends on the air temperature, surrounding surface temperature and the moisture content or relative humidity of the air. As temperature rises, relative humidity should decrease for maximum comfort. In winter, a temperature of 68 to 70 degrees F in the home generally is comfortable if the relative humidity is in the range of 40 to 50 percent.

Sources of Moisture

The amount of moisture in the air depends on air temperature and the availability of water which can be vaporized. Air within a closed space will continue to pick up available moisture in that space until it is saturated, that is, until the relative humidity is 100 percent. The higher the air temperature the more moisture the air will hold.

Water vapor is supplied to the air when people breathe. A family of four will give off about ¼ pint of moisture per hour. Mopping floors, washing dishes, bathing and any activity which exposes water to the air increases the moisture in the air. Washing the dishes once may release as much as ½ pint of water vapor into the air. Cooking is also a major source of water vapor.

There are several ways to indicate the amount of moisture in the air. Relative humidity indicates the proportion of water vapor in relation to the amount the air can hold at a given temperature. Another measure of air moisture content is the vapor pressure, which is measured in pounds of water vapor per pound of dry air. If the vapor pressure inside a home is higher than the vapor pressure outside the home, moisture vapor will try to move through walls and cracks to the outside until the vapor pressures are equal. In winter, the inside vapor pressure usually will be higher than that outside and moisture will try to move out through the walls. In hot, humid climates, air conditioned homes may have a lower vapor pressure than the air outside. For example, air at 85 degrees F and 60 percent relative humidity has a higher vapor pressure than air at 75 degrees and 60 percent relative humidity.

Moisture may move from an unventilated damp crawl space into the home. Poor drainage and high water tables under slab-on-grade floor systems may be a source of moisture if there is no vapor barrier under the slab. Finally, moisture may come from roof leaks, plumbing leaks or similar sources as a home becomes older and maintenance requirements increase.

Condensation Problems

A major cause of home deterioration is excess moisture which results largely from condensation. Where moisture levels in wood are above 12 to 15 percent, fungus, wood rot, mildew and plywood delamination may occur. Condensation results from air coming in contact with objects or surfaces whose temperature is below the dew point of the air. As air with less than 100 percent relative humidity is cooled it will retain its moisture vapor until it reaches a temperature where the amount of moisture it contains is enough to bring the relative humidity to 100 percent. If the air is cooled below this temperature, some of the moisture vapor must condense or change from a vapor to a liquid. The temperature at which this occurs is called the dew point. For example, air at 70 degrees F and 50 percent relative humidity has a dew point of about 50 degrees F. If you place a glass of water whose temperature

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is 50 degrees F or less in a room with the above conditions, you will notice beads of moisture forming on the outside of the glass. Condensation often occurs on cold window panes in the winter, and may occur on cold wall surfaces or within the wall when moisture is allowed to move into the wall space.

When moisture condenses on wood it is absorbed. This increases the moisture level of the wood and its susceptibility to rot. Moisture condensing on insulation will reduce the insulating value of the material and thus accelerate condensation.

Moisture Control

Moisture problems can be controlled in several ways. First, the production of moisture vapor within the home can be reduced by: (1) decreasing bathing time; (2) not boiling water or liquids excessively when cooking; (3) washing only full loads of clothes; and (4) using floor coverings that do not require wet mopping. Second, moisture vapor movement through walls, floors and ceilings can be controlled by proper installation of vapor barriers. Third, excess moisture vapor can be removed from the home by proper ventilation. Exhaust fans in bathrooms and over the range, and vents for automatic dryers will move excess moisture out rapidly. These fans should exhaust the moisture laden air to the outside, never into the attic or crawl space. Fourth, condensation on wall and window surfaces can be prevented by raising the temperature of these surfaces above the dew point. In most cases this is accomplished by proper use of wall and ceiling insulation and by the use of storm or insulating windows.

Use of Ventilation

When summer temperatures of 85 to 90 degrees F occur in conjunction with relative humidities of 75 percent or higher, there is some danger of condensation within the wall cavity if interior temperatures are maintained at 75 degrees F or below. High humidity conditions usually occur only at night, and if condensation occurs, the moisture is likely to be vaporized again during the day provided the wall space is vented to the outside.

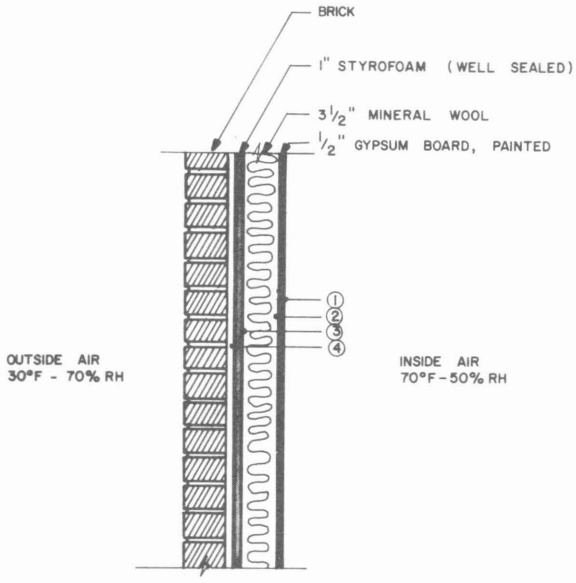
Moisture condensation in walls and ceilings can be controlled by cold side venting. When moisture vapor moves through an interior wall or ceiling surface and vapor barrier, the vapor pressure will tend to become equal to that of the outside air, if the wall or ceiling space is well ventilated. This can be done by providing screened openings at the top and bottom of exterior siding and sheathing. These openings should extend into the stud space. For pier and beam construction, holes in sole and top plates can provide this venting. Ceilings will be properly vented if adequate attic ventilation is provided. Winter attic ventilation levels will not need to be as high as those for summer temperature control. Peak summer attic temperatures can be reduced to about 105 to 110 degrees F by venting to provide about one-half air change per minute. This air flow rate can be determined by multiplying the attic floor area (in square feet) by one-fourth the ridge height (in feet) above the ceiling. If power ventilation is used, the fan should move this number of cubic feet per minute against a static pressure of 1/8-inch water column. Ventilation openings for air intake should be uniformly distributed around the eaves and should have a total area in square feet equal to the rate of the fan volume divided by 300.

Gravity ventilation can be effective if a balanced system of ridge and eave venting is provided. The total net ventilation area should be 2 square inches per square foot of attic area. This should be equally divided between ridge and eave vents — 1 square inch of ridge vent and 1 square inch of eave vent. The eave vents should be uniformly distributed or continuous. If continuous ridge vents are not used, fixed roof vents or turbine vents may be used. More uniform ventilation is achieved if there are several well distributed roof vents as near the ridge as possible.

Use of Vapor Barriers

A vapor barrier is a film, membrane or surface material which is highly impervious to moisture vapor flow. Of course all construction materials have some resistance to moisture flow, but only those materials highly resistant to vapor flow should be used as vapor barriers. Membranes which best serve this purpose include polyethylene film (4 or 6 mil.), aluminum or other metal foil, "Duplex" (laminated) papers containing a continuous asphalt-saturated building paper (not ordinary roofing felt or building papers). The lower the vapor permeability the more effective the barrier will be over a period of years. However, a film must present a solid surface with no holes in it, and where joints or laps are made they must be formed over a framing member for backing.

Vapor barriers should be applied as near the warm side of a wall as possible. In home construction this usually will be between the framing and the interior sheathing or wall and ceiling finish. Openings for electrical outlet boxes should be sealed to prevent moisture flow. Under-floor vapor barriers should overlap wall vapor barriers. Ceiling and wall vapor barriers should overlap also.



TEMPERATURE – MOISTURE CONDITIONS

LOCATION	TEMP (db)	TEMP. OF CONDENSATION
1	68.6° F	50.5° F
2	67.5° F	55.0° F
3	41.7° F	53.5° F
4	31.5° F	22.5° F

Fig. 1. Effect of using tightly sealed foam board on exterior frame surface without vapor barrier adjacent to gypsum board. Under conditions shown, condensation will occur on the foam board surface and adjacent insulation.

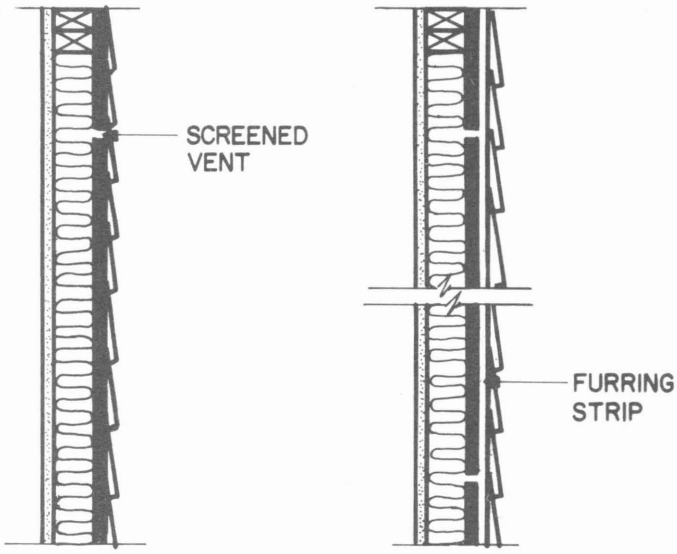


Fig. 2. Methods of providing wall cavity ventilation for homes with wood siding. All openings should be screened to prevent insect entry.

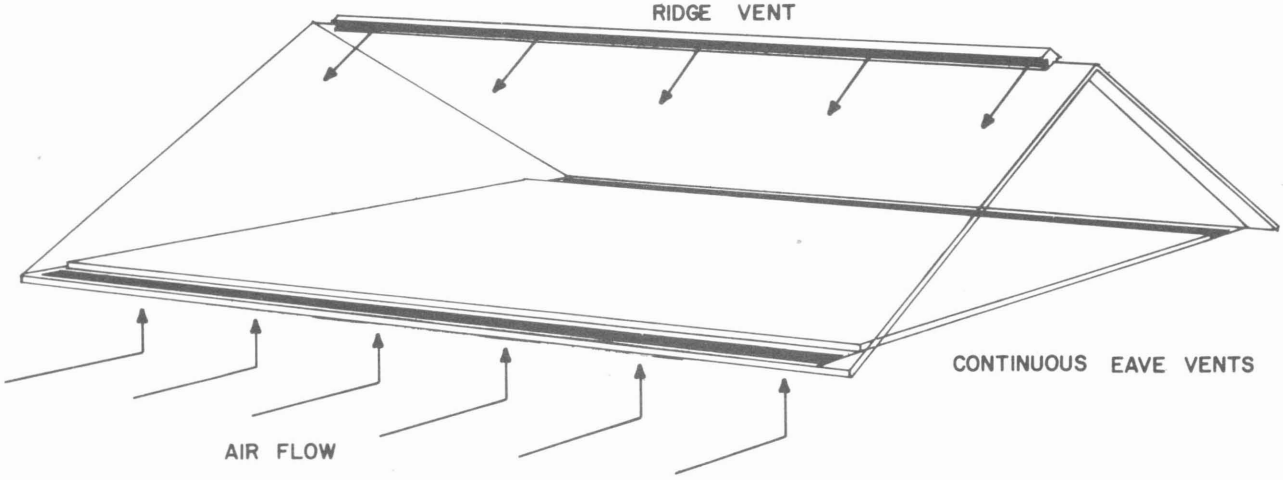


Fig. 5. Attic ventilation for removal of excess heat will serve adequately for attic moisture control.

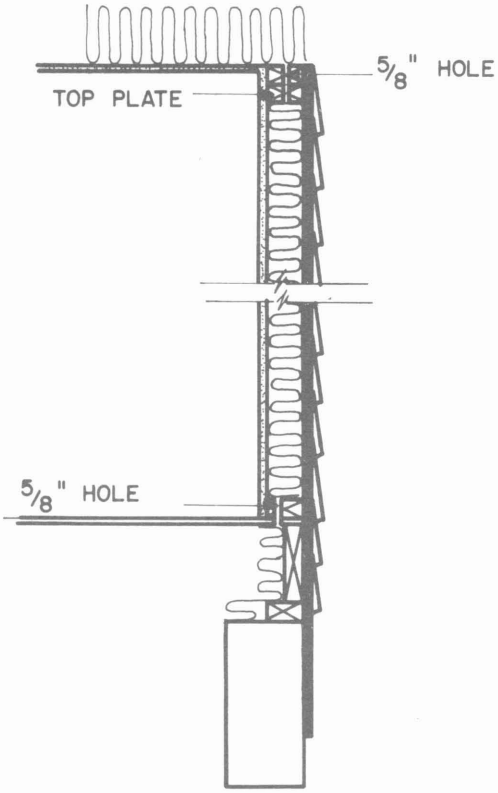


Fig. 3. Wall cavities in pier and beam constructed homes can be ventilated by drilling holes in top and bottom plates to allow moisture dissipation.

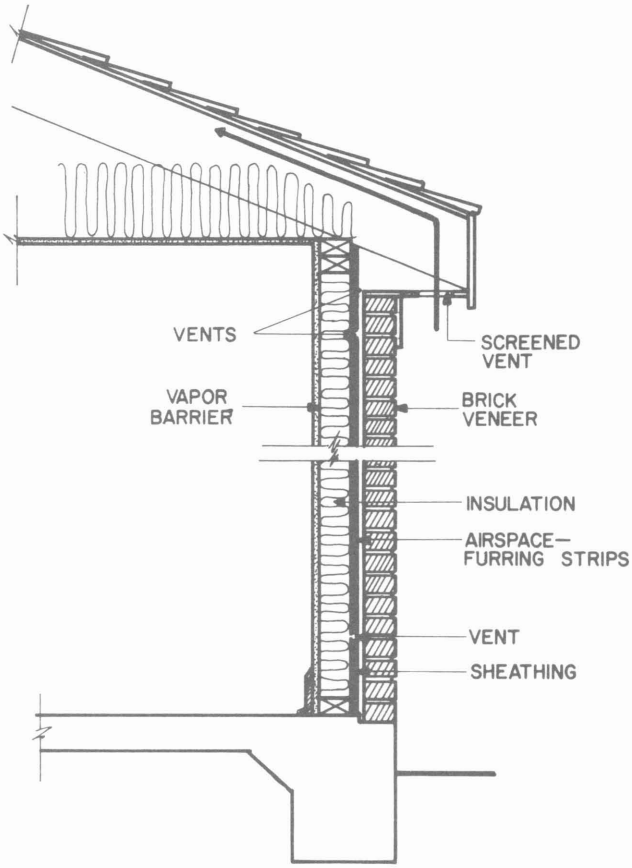


Fig. 4. Ventilation of wall cavities for brick veneer construction. Presence of an excellent vapor barrier near the inside wall surface should eliminate the need for cavity ventilation.

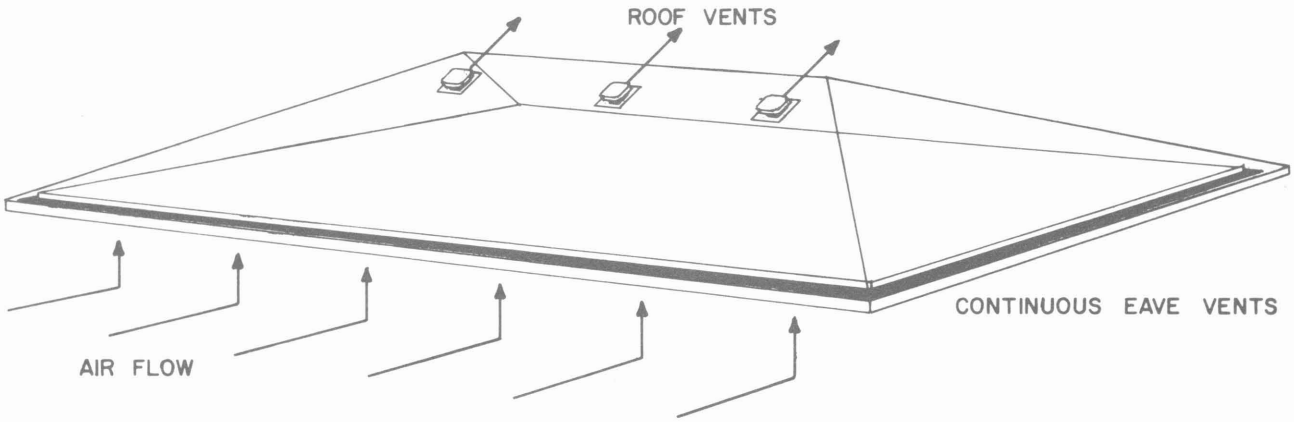


Fig. 6. Individual roof vents or continuous ridge vents in combination with continuous or well distributed eave vents are recommended.

There is some consideration being given to using vapor barriers near the exterior wall surface in coastal areas of Texas. But there are no conclusive data at this time which indicate summer condensation is a problem in residences except around air conditioning ducts. Installation of vapor barriers both inside and outside may trap moisture in a wall space if a small vapor leak should occur. A vapor barrier should never be installed on the outside only of a well insulated wall if the winter temperature gets as low as 35 degrees for a period of 2 or 3 days.

Heating/Air Conditioning

Control of the moisture level within the home is assisted by providing some ventilation. In winter, as cool outside air is brought into the home and heated, its ability to hold moisture is increased. This air picks up the moisture produced in the home and as more fresh air is brought in the moisture laden air is exhausted. This ventilation occurs in most homes because of air leakage around doors and windows. An average home will have from one to two air changes per hour in this manner. Since this air must be heated, it is desirable to reduce the ventilation as much as possible. Ventilation for adequate moisture control in the winter need not exceed one-half air change per hour. Excess ventilation can be reduced by careful caulking around windows and doors, use of weatherstripping and installation of a good vapor barrier.

Winter conditions often cause air within the home to be too dry. If respiratory problems result or static electricity is noticeable, a humidifier may be used to add moisture to the air. Use of humidifiers in homes without vapor barriers or where insulation is poor may cause moisture problems.

Residential air conditioning systems provide effective moisture control during the summer. But a cooling unit which is too large for the home usually will result in poor moisture control because the unit does not run enough. In these cases a dehumidifier may be needed.

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