Insulating Cathedral ceilings

Before the introduction of insulation, moisture was not a problem in ceilings. Roofs were exposed to warm, humid interior air. This heat raised the interior temperature of the roof. The roof itself, made of vapor-permeable, natural materials, allowed water vapor to pass through it to the outside without condensing on the interior surfaces.

But, with the introduction of insulated ceilings, the temperature in attics was reduced and water vapor passing through the ceiling to the attic encountered the cold inner-roof surface. Condensation resulted, causing moisture problems, and, in winter, a build-up of ice.

The solution was to install an air-vapor barrier on the warm side of the insulation, and to ventilate the attic to remove any water vapor which succeeded in passing through the vapor barrier and the insulation.

When insulating a cathedral ceiling, builders faced similar moisture problems. Their solution was to leave an air space between the inner roof and the insulation material. This air space would take air in from the eaves and exhaust it through ridge vents in the roof. The function of the air space in a cathedral ceiling is exactly the same as the function performed by a cold, ventilated attic.

Modern cathedral-ceiling technology

The introduction of ICYNENE in the 1980s provided architects and builders with a new tool. While this modern material may be used with an air vent in the same configuration as fibreglass, it also allows us to roll back the clock and build as our forefathers did, without an air space. The trick is the spray-in-place, breathing, foam plastic insulation called polyicynene – the basic element of ICYNENE.

Moisture problems are due to air leakage and vapor defusion, which cause moisture to pass through insulation and to condense on the nearest cold surface. It is well documented that, in most situations, diffusion accounts for only 1% of moisture transfer, while movement of air accounts for 99% of the moisture that passes through insulation – and causes moisture problems.

Airborne moisture movement

ICYNENE has a low air permeance – low enough to be classed as an air barrier. Therefore moisture movement through polyicynene foam by air transfer is virtually nil.

Moisture movement by diffusion

The 1% of moisture that is conveyed by diffusion is usually not a problem, because the amount is so small that it s measured in nanograms (one-billionth of a gram). Its effect is usually overcome by normal drying cycles (see Quirette's paper for the National Research Council.)

Five inches of polyicynene foam has a vapor permeance of 10 perms. This property allows extremely low rates of moisture diffusion to occur, just enough to allow breathing and to prevent moisture entrapment. This perm rating was conservatively extrapolated from tests on 2-inch core material of the foam without contribution from either of the two skins.

The minimal diffusion that does occur through polyicynene foam will pass through the insulation without condensing, provided that the substrate to which it is attached is equally (or more) vapor-permeable.

Purpose of present cathedral-ceiling building practices

It is variously argued that the purpose of the air space in cathedral ceilings is (1) to remove moisture; (2) to lower the temperature of the roof to impede the buckling of shingles; and (3) to prevent a temperature rise in the roof, which could result in ice damming.

Why ICYNENE requires no air space

Scientific research (University of Illinois Small Homes Council, with the Florida Solar Energy Centre) has determined that the maximum exterior roof temperature for a cathedral ceiling roof without an air space is virtually the same as one with an air space.