How do you insulate cathedral ceilings – properly? Through the years, this is one of the most frequently asked questions. Answers cover a wide spectrum and often are contradictory; the diversity of answers sometimes serves only to further confuse the issue.

At the epicenter of this question is, of course, ventilation -- more precisely yet, the means of dealing with vapor and/or moisture (hereafter referred to simply as "moisture). Within the framework of the ventilation question is the effect of roofing temperature on the shingle's life. Both issues will be addressed.

Controlling Moisture Movement

There are, in practical terms, two commonly found ways to attack the problem of moisture in cathedral ceilings. First, there is the traditional moisture control method in which insulation is installed on the bottom of the cavity and a ventilation area is left on top of the insulation so that moisture moving through the insulation enters the ventilation area and is transported out of the cavity.

Secondly, a new (though many knowledgeable insulation experts have been doing it for over 30 years) and much more effective technique of building and insulating the cathedral ceiling, eliminates the need for ventilation. This method stops most harmful moisture from ever penetrating the ceiling cavity, as opposed to simply trying to control it once it is already there.

Old-Fashioned Insulation Permits Easy Air Movement

The traditional control method was developed in an attempt to deal with moisture because vast amounts of air move easily through what has been the most commonly used insulation material – fiberglass. Fiberglass batts, with a density of about 1.0 pounds per cubic foot (or about .5 pounds for blown fiberglass) do not stop air movement effectively, and it is air movement more than any other factor, that transports moisture from one point to another. In other words, as air movement occurs, moisture is transported along with the air and this bulk air movement is now considered to be the main transport mechanism that allows moisture into the building envelope. Since fiberglass is very poor at stopping airflow, and the resultant moisture movement, a better method of dealing with the problem was needed.

Several different options presented themselves. One way was to build the interior so tight, through caulking, air sealing, special paint, etc…, that very little air was allowed to reach the fiberglass. This is possible, but very expensive. The most common method, however, was to forego trying to inhibit air/ moisture penetration and incorporate ventilation into the cathedral ceiling. This was the cheapest and easiest method to implement and is reflected in most building codes today. Most building codes were written on the assumption that low density fiberglass would be used and would require extensive ventilation to alleviate moisture problems. Unfortunately, this method has inherent weaknesses that limit its effectiveness.

Problems With Ventilation

There are two main problems with this strategy. First, excess heat loss is incurred because by ventilating above the insulation, a suction effect is created which encourages air movement through the low-density fiberglass, increasing the convective heat loss and air movement. This warm moisture-laden air is drawn through the fiberglass and is cooled until it must "dump" the moisture it can no longer hold. This is usually on the strands of fiberglass as beads of water form on the insulation, similar to the effect seen on a glass of iced tea on a pleasant summer day. This propensity of fiberglass to "bead up" moisture that has condensed was pointed out in a study prepared by Steven Winter Associates, Inc., Building Systems Consultants to the manufactured homes industry. In Ventilation and Condensation they state, "the most common insulation used in manufactured homes is fiberglass batt insulation. Unfortunately, this insulation type is particularly susceptible to the formation of water beads on its fibers." Of course, most experts have known this all along. That's why the ventilation method was developed.

Insulation That Restricts Air Movement

The second method of controlling moisture is dense packing - insulating so tightly that bulk air movement through the cathedral ceiling is eliminated - is gaining popularity. Numerous Building science studies have proven what many knowledgeable insulation contractors have known for years: stop moisture entering the cavity and you eliminate potential problems. This technique, not possible with traditional fiberglass because of its inherent shortcomings, is not only viable but also practical and highly effective with cellulose insulation.

Utilizing cellulose insulation, contractors blow the cathedral ceiling cavity completely full and do away with the need for outside ventilation. Although many view this as a new method, as stated previously, many contractors have been doing this for years. In fact, as far back as 1975 NCIMA standard #N-301-75 stated:

This corresponds with the feedback received at the NAHB Energy Technology Report Quoting from Building Thermal Envelope Systems and Materials Volume 1, No. 1 (March 1991):

Several builders in the audience responded to several controversial details showing unvented cathedral ceiling assemblies by mentioning that they have been building with these techniques for several years with satisfactory results despite the standing recommendations in many building codes stating that ventilation is required.
Installations of this type must be made by pneumatic means, and the cavity should be completely filled. This is done by inserting a fill tube into each cavity and withdrawing it as the cavity is filled. (From Application Procedure, Ceiling Area 8.1.2 Enclosed Ceiling Cavities)
The March – April 1989 edition of the Drexel Insulation Report confirmed the performance of dense pack cathedral ceilings, when it reported on 18 out of 20 classrooms with identical cathedral ceilings that had developed moisture problems. What prevented the two other rooms from suffering the same fate? The ceiling cavity was completely filled in the two that escaped moisture problems, while the other 18 ceiling cavities produced:

severe condensation problems occurring where the cavities contained a mixture of insulation and air. It appears that the air current travels upward along the warm side of the cavity, picking up any moisture that has leaked through the ceiling. At the top of the cavity, the air current is reversed, and it travels down the cold side of the cavity. Here, the temperature drops and, when it reaches the dewpoint, moisture condenses.
The article goes on to say that other similar occurrences have taken place.

Advantages to Dense Packing

There are several major advantages to dense packing (completely filling) a cathedral ceiling cavity with cellulose.

First, cellulose has a natural density about two times that of fiberglass batts, and four to five times that of loose blown fiberglass. This makes it much more difficult for air to move through the insulation.

Second, cellulose has a stated R-value of 3.8 per inch as compared to 3.2 for commonly used batts and 2.2 for blown fiberglass. Cellulose insulation’s higher R-value is very important in limited space areas such as a cathedral ceiling cavity. Plus, with fiberglass batts, you must leave ventilated space, further diminishing the insulating potential of the cavity. Cellulose offers much greater insulating power per inch, and, compared to fiberglass, provides more insulating room because ventilation space is not required. This means that in a limited space such as a cathedral ceiling, cellulose offers a much higher stated R-value. Keep in mind that cellulose not only holds a big advantage in stated R-value, but the advantage skyrockets when considering the “effective” or “installed” R-value of cellulose compare to fiberglass.

Third, you eliminate the need for an air or moisture (vapor) retarder, because as researcher J. K. Latta says in his report, Vapor Barriers: What are they? Are they effective?: Air leakage is now considered to be the prime cause of most condensation problems in walls and roof spaces. If, therefore, a building can be made tight against air leakage, it may not need a vapor barrier, as defined.

In a correctly insulated cathedral ceiling (using the tight fill, moisture elimination method), the high density of cellulose reduces moisture penetration to the point that no vapor retarder barrier is needed. As mentioned earlier, cellulose has a natural density that is usually two to four times that of fiberglass. However, in a cathedral ceiling application cellulose is installed at a much higher density. The density is important because it answers two questions at once. The first is moisture penetration, which we have discussed at length, and the second is settling.

"Will cellulose settle?" is the question that inevitably comes up when discussing cathedral ceiling applications. If it's done properly, settling is no problem. In a closed roof/ceiling or wall cavity make sure the cavity is filled to the proper density. Some HUD standards call for a density of 3.5 pounds per cubic foot (pcf) for dry loose fill cellulose insulation in closed cavities, but experience indicates that an installation density of 3.0 pcf, or greater is adequate to prevent voids in the cavity with current low density products. At that density the cavity is pressurized as the cellulose is actually compressed to 200% of its natural density. Instead of settling, the packed cellulose wants to expand back to its natural condition. This tension keeps the cathedral ceiling cavity filled for the life of the home.

Blowing the Roof Off the Shingle Myth

Lastly, myth has it that the ventilation serves to keep shingles cool in summer. This was debunked by studies conducted by William Rose at the University of Illinois at Champaign-Urbana and reported in Proceedings of the Thermal Performance of the Exterior Envelopes of Buildings Conferences in the early and mid-1990s. Rose found that contrary to common belief, attic or roof ventilation in cathedral ceilings appears to have little or no effect on shingle or sheathing temperature. The Illinois results were confirmed by tests at the Florida Solar Energy Center, which showed no more than three to five- degree difference in sheathing temperature between vented and unvented roofs.

In Conclusion

Dense pack non-ventilated cathedral ceilings are, as a building science study entitled "Report On Roof And Wall Details: Upper Canada Post And Beam" points out, "nothing more than well insulated exterior walls with insulating sheathing which is sloped."

Cellulose has been used for years to dense pack cathedral ceilings with excellent results, outperforming the ventilated method. It is now being accepted as the preferred method of installation by building experts across the country.