INSULATION FACTS #24

NAIMA
North American Insulation Manufacturers Association

The Facts About Insulation And Air Infiltration

Information from NAIMA

In recent years, there has been some debate over which insulation products are better at reducing air infiltration. In this issue, we discuss the results of several studies which support the conclusion that insulation plays a very insignificant role in controlling air infiltration.

Introduction

With energy conservation becoming an important priority, today's builders are focusing more closely on controlling the heat loss in a home and looking for reliable information concerning the control of air infiltration to achieve energy efficiency.

Causes of Heat Loss

The major causes of heat loss in buildings are:

1. Heat moving through the pieces of the building envelope (i.e. walls, ceilings, floors, doors and windows) by conduction. Conduction is the same physical principal that causes the handle of a spoon to gradually heat up when placed in a cup of hot water. Insulating the walls, ceilings and floors slows down this heat flow and keeps the heating energy inside the building longer, which reduces heating costs.
2. Warm air leaking through holes and gaps in the building envelope is called air infiltration and, depending on the size of the holes, can cause significant energy losses. Sealing the building envelope with caulk, foam, tape and an air barrier and installing tightly built doors and windows keeps warm air from leaking out of the building and also reduces heating costs.

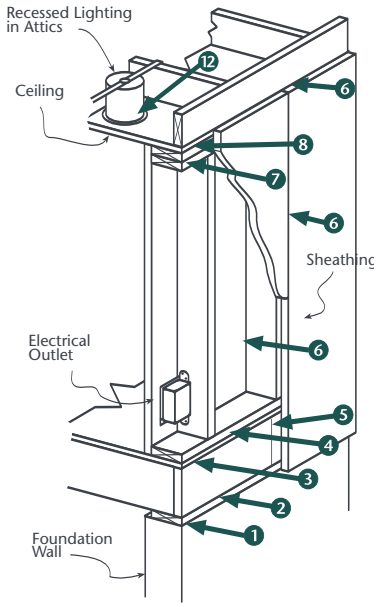
Air Infiltration

Air infiltration is driven by wind, temperature differences, or HVAC appliance-induced pressures. Research has shown that up to 35% of the heat loss in a home can be attributed to air infiltration. Most of the air that passes through the exterior wall assembly of a home does so

by way of seams and interfaces between rigid framing and sheathing components, where the infiltrating air never encounters insulation.

Figure 1 shows the typical leakage paths through an exterior wall of a residential building.

Figure 1
Air Infiltration Paths



1. Sill plate/foundation wall interface
2. Sill plate/band joist interface
3. Band joist/sub-floor interface
4. Bottom plate/sub-floor interface
5. Band joist
6. Sheathing joists/stud/cavity
7. Double top plate interface
8. Top plate/ceiling interface
9. Windows and doors (not shown)
10. Window and door frames/rough opening surface (not shown)
11. Electrical/telephone/plumbing /cable intrusions (not shown)
12. Recessed lighting in attics

Air Leakage and Cellulose

Numerous claims have been made by cellulose manufacturers about the superiority of their products in limiting air leakage in a home.

The fact is that cavity insulation, whether it is cellulose or fiber glass, plays virtually no role in blocking air infiltration through the walls of a home. The only way to stop air infiltration is to properly seal the building envelope.

Tests conducted over a number of years (see below) have concluded that fiber glass and cellulose are equal in their impact on air infiltration. The difference between the two is insignificant when compared to the overall leakage through the other components of a home.

NAHB/EPA Study (1997)

The results of a study[1] conducted by the National Association of Home Builders (NAHB) Research Center for the U.S. Environmental Protection Agency's Energy Star Homes Program concluded that alternative residential insulation products do not significantly reduce air leakage.

The study determined that the individual air sealing practices of the insulators had a larger impact on air leakage than the insulation products themselves.

The study compared the performance of fiber glass batt insulation to three alternative products — wet-spray cellulose, blown-in fiber glass (referenced as "Blow-In-Blanket Systems" or BIBS) and low density polyurethane foam insulation (also referred to as spray-applied foam or polyicynene).

Fiber glass batts, wet-spray cellulose, blown-in fiber glass and polyicynene were installed in 26 similar homes in Maryland and Virginia.

The study measured such factors as house tightness by insulation type, labor time required to install the various insulations and total installed cost to reach the specified values of R-30 in the attic and R-13 in the walls of the homes.

When compared to fiber glass batts, the study found that the alternative insulation products did not significantly reduce air leakage in the homes studied. Based on the data, the study could find no significant relationship between the type of insulation used and the amount of air infiltration.

The NAHB/EPA study confirms[2] what a lot of builders suspect: it pays to be less concerned about the type of insulation being used, and more concerned about how the home is detailed.

G.K. Yuill Study (1996)

A 1996 study conducted by Penn State University professor G.K.Yuill, Ph.D.,[3] tested fiber glass batts and wet-spray cellulose insulations for resistance to air flow through the wall cavities of two houses. Based on the test data, the researchers found it impossible to determine which insulation material provided a more air-

tight structure and concluded that the difference between the two types of insulation had little influence on the air tightness of a house.

The data showed that most of the resistance to air flow through a house's walls is provided by drywall and not insulation. Drywall contributes about 77% of the total resistance of the wall, the sheathing and siding about 12% and the insulation about 11%. The study made it clear that any difference between the two insulations was insignificant when compared to the overall leakage through the other components of a house.

Small differences in workmanship elsewhere in a house are likely to be more significant than differences in the air permeability of wall insulation.

Union Electric Study (1995)

A study initiated in 1995 by a St. Louis, MO utility company, Union Electric,[4] tested seven homes for air infiltration. It concluded that a properly installed sealant package can significantly reduce air infiltration and save energy in a home regardless of the insulation installed (fiber glass or cellulose).

The purpose of the study was to determine the effects of different types of insulation on the air changes, operating costs and comfort level of a home.

The study found that a sealant package can decrease air infiltration by more than 50 percent compared to a home that does not have one. In field tests, fiber glass and cellulose insulation were considered equal in their impact on air infiltration, leading to the conclusion that air infiltration is dependent upon the sealant package, not the insulation material type.[4]

Holometrix Study (1994)

Another study that examined the role stud cavity insulation plays in house air infiltration was conducted by Holometrix, an independent accredited laboratory in Bedford, Massachusetts.[5]

For the study, test wall sections were insulated with fiber glass batts, loose-fill, and spray-on cellulose. Slight air leakage through the pressurized test walls occurred with each of the insulation systems at a rate of about 0.02 cu.ft. per minute per sq. ft. for each sample.

The addition of an air infiltration barrier to each test wall resulted in a measurable reduction in air leakage in every case, indicating the cavity insulation was not effective in controlling the air leakage.

Alberta Study (1990)

A field study conducted in Alberta, Canada[6] included air leakage tests which indicate that spray cellulose provides some resistance to air flow but is not an effective air barrier. The air blocking characteristics of cavity insulation (density claims) were of little consequence because, as the tests verified, sheathing and drywall are substantially better air barriers than any cavity insulation. Air infiltration barriers and polyethylene are installed for this specific purpose.

Colorado Study (1990)

For this study,[7] two test buildings were constructed on the University's campus. Walls in building "A" were insulated with 5-1/2 inches of wet-spray cellulose; and walls in Building "B" were insulated with R-19 fiber glass batts.

An independent review of the study by David Yarbrough Ph.D., PE of R&D Services, Inc., Lenoir City, TN, a longtime insulation researcher with Tennessee Technological University and Oak Ridge National Laboratory, states that the facts do not support the conclusion that cellulose insulation limited the air leakage in a building.

Yarbrough states that he sees major deficiencies in the study. He says that "Comparative studies…must characterize the structures used and the materials used in order to eliminate the possibility that differences observed are the result of construction or mismatch of the thermal values of installed insulation. Specification of nominal insulation R-values is not sufficient for a serious thermal study."

He adds that the Colorado study "illustrates the difficulties associated with large-scale thermal studies."

The report reveals that blower door tests were conducted with no wallboard on the walls. Wallboard is a critical element for reducing air infiltration.

In addition, the testing did not isolate the effects of floor tightness, window tightness and door seals. Therefore, it is likely that some or all of the difference in air infiltration could be attributed to these sources. There is no data to prove that these factors were even considered.

From an energy standpoint, the study concludes the building insulated with cellulose used less heating energy during the test period. However, according to Yarbrough "The reasons for the lower heating energy usage of the building insulated with cellulose cannot be identified in the study."

Yarbrough suggests that the 26.4% difference in energy usage "could be explained by the difference in the insulation R-values that were used."

According to Yarbrough, "[Since] the thermal resistances of insulation materials actually installed were not reported … there is good reason to believe that the thermal resistance of the installed cellulose was greater than the thermal resistance of the installed fiber glass in both the walls and attics of the test units."

Conclusion

While insulation plays a significant role in energy savings in a home, its role in reducing air infiltration is negligible. Minimizing air infiltration is dependent on the sealant package, not the insulation.

As these studies have shown, there is little difference between fiber glass and other insulations when it comes to blocking air infiltration through walls.

If a wall cavity has been properly closed off using drywall, sheathing, and caulking, very little air will flow through regardless of the type of insulation used.

References

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About NAIMA

NAIMA is a trade association of North American manufacturers of fiber glass, rock wool, and slag wool insulation products. NAIMA's role is to promote energy efficiency and environmental preservation through the use of fiber glass, rock wool, and slag wool insulation products and to encourage safe production and use of these insulation products.

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