INSULATION FACTS #14

NAIMA
North American Insulation Manufacturers Association

Wet-Spray Cellulose Insulation Systems

Information from NAIMA

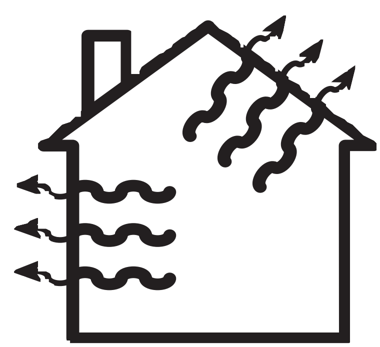
In this issue we discuss concerns that have been raised about wet-spray cellulose insulation and its effectiveness.

Over the last few years there has been an increased focus on the use of wet-spray cellulose insulation systems in the sidewalls of new construction. Wet-spray cellulose insulation is shredded newspaper, mixed (or treated) with various chemicals (up to 25% by weight) to reduce its flammability, that is installed in conjunction with water spray and adhesive so that it adheres to open wall cavities before being covered with drywall. Unlike fiber glass batt insulations which have been widely used for over 50 years and whose performance is well-documented, there is little information on the long-term thermal effectiveness and overall performance of wet-spray cellulose insulations.

In addition, there has been little research on the effect of the high moisture content (up to 50% water by weight) of wet-spray cellulose on the building structure itself. Also, new research shows that the claimed advantage of better air sealing is not true.

This paper will discuss several areas of concern regarding the use and effectiveness of wet-spray cellulose insulation.

Thermal Performance



"R-Value per Inch"

A common promotional claim for cellulose products is that their "higher R-value per inch" makes them a better value than fiber glass. These claims

Factory-made fiber glass, rock or slag wool batt insulation is the product of choice used to insulate most wall cavities. Mineral fiber batt performance is well documented. Literally thousands of thermal and acoustical tests have been performed on batt products by the North American Insulation Manufacturers Association (NAIMA) member companies and independent testing laboratories including the National Association of Home Builders (NAHB) Research Center, Inc., in their ongoing product certification program. In more recent years, tests have also been run to study the impact that various insulation systems have on air infiltration. Results have shown that cavity insulation does not affect air infiltration. (See reports cited in footnotes 15, 16 & 17 in bibliography.) These tests unequivocally demonstrate that batt insulation achieves labeled thermal performance objectives. Tests on wall systems have shown that assemblies perform well with properly installed batt insulation. Batts have become the accepted insulation material against which alternative products are measured. They are the standard insulation responsible for most of the 12 quadrillion Btus of energy savings attributed annually to insulation in residential and commercial buildings throughout the U.S.[2]

originated with comparisons of some attic products. However, "higher R-value per inch" is a consideration only in areas with little space for insulation. Even for enclosed wall cavities, this claim is clearly not true when cellulose is compared to the popular high-performance fiber glass wall batts of R-13, R-15 or R-21.

Performance is Based on Good Workmanship

A direct comparison of whole-wall performance with fiber glass batts versus wet-spray cellulose was made by Johns Manville (formerly Schuller Corporation).[1] The average R-values for insulated 8′x10′ frames that included utility boxes, wiring, and piping were measured. The tests showed that R-13 fiber glass batts provided whole-wall R-values equal to or better than the equivalent wet-spray cellulose or dry-blown systems.

No matter what R-value is claimed for a wet-spray cellulose application, the "true" R-value of the installed insulation is significantly dependent upon:

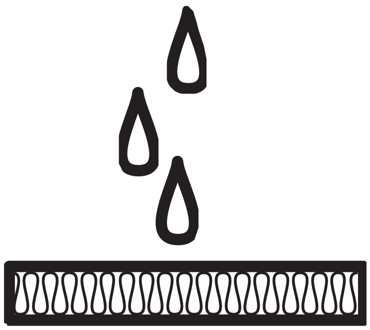
- The quality of workmanship
- The amount of insulation material that is actually installed
- The moisture content

It is very difficult to maintain consistent density due to variations in the amount of water added as well as variations in installation techniques.

Cellulose promoters claim that installations using batt insulations have voids which cause reduced thermal performance. They cite the ASHRAE Handbook of Fundamentals which references a test showing that a 4% void area in wall insulation increases heat loss by 15%.[3] However, the 4% void test is not representative of typical installation, or even very sloppy workmanship.

In sidewalls, a 4% void is equivalent to approximately a 4 inch space the entire width of every stud cavity. This would not be tolerated on a job and is an unrealistic example to cite. Reasonably good workmanship is important for any insulation product, and batts can be installed with minimal void areas. Many cellulose applications use fiber glass in areas that are difficult or impossible to spray with cellulose when they take the time to do the job properly.

Moisture Control



In general, insulations will lose R-value when wet. Cellulose fibers are “hygroscopic” – very effective at absorbing and retaining moisture. Problems can occur when installers apply too much moisture to the insulation. Many manufacturers have been allowing installers of their material to use up to 5 gallons of water per 30 lb. bag of insulation (instead of the recommended 1.5 to 2 gals per 30 lb. bag.)[4] In any wet-spray situation, the builder should wait until the material is totally dry before putting up drywall.

The first study, conducted in the humid Newfoundland climate, revealed that when wet cellulose was sprayed into a wall cavity, the cellulose did not dry out and the moisture content of the wood framing members remained extremely high: 60% after two years. The normal moisture content of wood is about 12%, while 30% is the fiber saturation point.

Field Studies Measure Drying Times

Actual field studies have shown that wet-spray applications of cellulose insulation do not achieve their advertised R-value until dry. Moisture investigations in New England and Ohio[5], Canada[6] and elsewhere[7] showed significant moisture problems. Two Canadian field studies were sponsored by the Canada Mortgage and Housing Corporation (CMHC). The first study, conducted in the humid Newfoundland climate, revealed that when wet cellulose was sprayed into a wall cavity, the cellulose did not dry out and the moisture content of the wood framing members remained extremely high: 60% after two years.[5] Moisture problems such as rot and mold growth can occur when moisture remains above 20-25% for extended periods of time. The normal moisture content of wood is about 12%, while 30% is the fiber saturation point.[8]

Another field study was conducted in the dry Alberta climate.[9] This study showed that sheathing and framing dried to “near original moisture levels” in approximately five months (160 days).

These studies confirm that moisture escape from a wall cavity is often a slow process. Even in the dry Alberta climate, five months is a long drying time. Consequently, concerns about potential moisture-induced problems such as condensation, poor thermal performance, mold growth, and corrosion are justified in most climates.

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Reliable Drying Guidelines Needed

All of these tests indicate a need for more reliable drying guidelines. Many contractors[10] acknowledge that they have no clear guidelines on the subject. They are acutely aware of the potential problems that can develop if walls are closed-in too soon. Little information, however, is available from cellulose manufacturers regarding recommended drying times. For example, one cellulose manufacturer's research report states a drying time of 72 hours when the ambient temperature is less than 70°F and 48 hours when higher than 70°F. Two other cellulose research reports state that insulation may be enclosed only after adequate curing and mention minimum time periods of three hours and 24 hours. But what is "adequate curing?" Is 72 hours (three days) curing sufficient in all cases when testing shows that after six days of curing the insulation may still require more than five months to dry to near original moisture levels?

Lab Test Shows Similar Drying Rates

A study of wet insulation drying rates by Johns Manville produced results similar to the Canadian studies. When vapor retarders were used in these tests, they were installed within two days of the sprayed cellulose application. This is considered consistent with field practice. As expected, there were significant differences in drying times with and without vapor retarders.

Several test frames insulated with sprayed cellulose were placed in environmental chambers simulating moderate (75°F — 50% Rh) and humid (90°F — 90% Rh) climates.

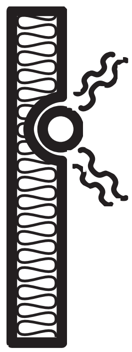
Other test frames were stored in the Denver laboratory, which represented a dry climate with temperatures ranging from 70°F to 81°F and relative humidities from 11% to 46%. In the dry environment, the insulated frame with no vapor retarders reached a stable weight, indicating complete drying, in about one month. With a vapor retarder on one side, the sample completed much of the drying in three months but did not dry completely for 10 months. With a vapor retarder on both sides, the sample was still not dry after one year.

In the moderate environment, a double vapor retarder sample had not completed drying after one year. In the humid environment, none of the three samples had completed drying after one year. Clearly, wet sprayed walls will often not dry before the building is completed and occupied.

Temptation is to Close Wall Before Insulation is Dry

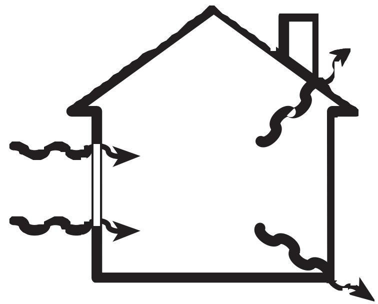
Waiting for wet insulation to dry can be a major inconvenience for a builder. It means that the scheduling of wall finishing contractors in most cases must be delayed. On the other hand, fiber glass can be covered up immediately. Delaying wall finishing also increases the likelihood of the insulation being damaged before it is covered. If scheduling is tight, there is a strong temptation to close the wall before the insulation is dry. Thus the insulation is sealed away from sight and potential repair. Because mold spores are inherent in old newspapers, and cellulose is a natural nutrient for numerous types of mold, this can create a breeding ground for mold.

Corrosiveness



Corrosiveness is a concern because insulation treated with chemicals and installed in sidewalls can come in contact with metal fasteners, electrical boxes, pipes, ducts, etc. Corrosiveness tests have been conducted by the Oak Ridge National Laboratory[11] (ORNL) on fiber glass, rock wool, and cellulose insulation. In the presence of moisture from condensation, there was no corrosion on steel or copper coupons or on cooled copper pipes embedded in fiber glass and rock wool insulations. In contrast, the tests showed that "all of the cellulosic insulation materials tested produced corrosion of steel and copper."[11] The test report concludes that moisture absorption appears to be the primary factor in causing corrosion. Moisture weight gain due to condensation was in the range of 0.16% to 6% for fiber glass and 4% to 100% for cellulose.[11]

Air Infiltration



Colorado Study

Numerous claims have been made about the superiority of cellulose in limiting air leakage in a house. Cellulose manufacturers base their claims largely on a report by the University of Colorado School of Architecture and Planning[12] which examined the installed performance of fiber glass vs. cellulose.

For the study, 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,[13] a long-time insulation researcher with Tennessee Technological University and ORNL, 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."[13] He adds that the Colorado study "illustrates the difficulties associated with large-scale thermal studies."[13]

> ...THE FACTS DO NOT SUPPORT THE CONCLUSION THAT CELLULOSE INSULATION LIMITED THE AIR LEAKAGE IN A BUILDING.

The study reveals that blower door tests were conducted with no wallboard on the walls. Wallboard is a critical element for reducing air infiltration. The testing was not done to 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."[13]

Yarbrough suggests that the 26.4% difference in energy usage "could be explained by the difference in the insulation R-values that were used."[13]

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."[13]

Alberta Study

The previously mentioned Alberta study[9] included air leakage tests which indicate that wet-spray cellulose provides some resistance to air flow but is not an effective air barrier. The air blocking characteristics of cavity insulation (density claims) are 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.

G.K. Yuill Study

A 1996 study conducted by Penn State University professor G.K. Yuill, Ph.D.,[14] 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 airtight 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.

Recent testing has confirmed that there is no air infiltration or R-value advantage in using wet-spray cellulose to insulate wall cavities.

Union Electric Study

A study initiated in 1995 by a St. Louis, MO utility company, Union Electric,[15] tested seven homes for air infiltration. It concluded that a properly installed sealant package can significantly

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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 insulations 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.

NAHB/EPA Study

The results of a recent study[16] 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 System" 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[17] 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.

Summary

Recent testing has confirmed that there is no air infiltration or R-value advantage in using wet-spray cellulose to insulate wall cavities. In fact, many important technical questions remain concerning the installation of wet-spray cellulose insulation in sidewalls. Besides the obvious concern about fire safety, doubts persist about thermal performance, moisture retention, and corrosiveness. Further research is needed in these areas, especially in the area of moisture control where the term "adequate drying" needs to be defined.

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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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