Moisture and corrosion performance characteristics are a major consideration when selecting materials for use in HVAC systems. Properly designed and maintained HVAC systems are subject to high humidity during normal operation. Ducts can be exposed to transient moisture from condensation on cold surfaces such as air conditioning coils and other cold metal surfaces. Cotton is an organic fiber that can absorb and hold moisture for an extended period of time - for this reason duct insulation products made from cotton must be carefully evaluated.

Description
Cotton duct liner insulation is made mostly of recycled denim and cotton fibers that are bonded together using a thermal process. The air stream surface is overlaid with a fire-resistant black facing, which provides additional strength to the product. The materials are chemically treated for fire and microbial resistance.

ASTM Standard C 1071
ASTM is an organization that sets standards for duct liner materials used in commercial and residential construction. The ASTM Standard C 1071 Specification for Fibrous Glass Duct Lining Insulation contains criteria for water vapor sorption (ASTM C 1104) and corrosion (ASTM C 665).

Material Testing
The moisture and corrosion tests required by the ASTM C 1071 standard were conducted to determine if cotton duct liner materials comply with the standard as claimed in product literature. These tests were performed in accordance with the applicable ASTM test standards at testing labs operated by Johns Manville and Owens Corning. These labs are certified by the National Voluntary Laboratory Accreditation Program (NAVLAP). This publication summarizes the results from these tests conducted at the aforementioned labs.

Test #1 — Water Vapor Sorption
Three samples of 1/2” thick cotton duct liner were tested by NAVLAP-certified labs for water vapor sorption in accordance with ASTM C 1104. This test determines how much water vapor is retained in a sample of the material after being exposed to high humidity.

The cotton duct liner material was exposed to a relative humidity of 95% for 96 hours. The water vapor sorption is equal to wet weight minus dry weight divided by dry weight. In these tests by the NAVLAP-certified labs the cotton materials had an average weight gain of 49%, which is 16 times higher than the 3% allowed by ASTM C 1071. (See Table 1).

Test #2 — Corrosion
Materials used in HVAC systems are in direct contact with metal in nearly every application. Samples of cotton duct liner were tested on steel, copper and aluminum in accordance with the corrosion test requirements in ASTM C 665. This test demonstrates a material’s likelihood to cause corrosion on steel, copper and aluminum.

In addition to the materials listed in the ASTM C 665, galvanized steel was also tested as it is the material that is typically used to fabricate sheet metal duct work.

Specially cleaned plates of steel, galvanized steel, and aluminum were sandwiched between samples of the cotton duct liner material and placed in a chamber maintained at 95 ± 3 % relative humidity and a temperature of 120 ± 3 °F. The steel samples were tested for 96 ± 2 hours while the aluminum and galvanized steel samples were tested for 720 ± 2 hours.

The test samples were then assessed by NAVLAP-certified labs against a set of comparative plates. The comparative plates consisted of identical metal test plates that were sandwiched between pieces of washed sterile cotton and exposed to the same temperature and humidity conditions for the same period of time.
The photographs in Figure 1 show the difference between the corrosion caused by the cotton duct liner and the sterile cotton controls which were the results of the ASTM C 665 tests performed by the NAVLAP-certified lab. The cotton duct liner materials failed the ASTM test due to corrosion of the steel, aluminum and galvanized steel test coupons.

Conclusion

The ability of materials to absorb water combined with their corrosion performance must be considered when specifying duct liner materials. The maximum percentage of water vapor sorption allowed by ASTM C 1071 is 3% and the cotton duct liner samples tested by the NAVLAP-certified lab had an average of 49%. These materials had more than 16 times the water vapor sorption allowed by the ASTM standard.

The ASTM C 665 corrosion criteria state that “the insulation shall show no corrosion greater than the comparative plates in contact with sterile cotton which has been tested in the same manner.” All of the metal coupons shown in Figure 1 below from the ASTM tests performed at a NAVLAP-certified lab had more corrosion than their comparative plate and therefore the product did not meet the requirements of ASTM C 665.

The maximum percentage of water vapor sorption allowed by ASTM C 1071 is 3% and the cotton duct liner material shown in these tests by a NAVLAP-certified lab absorbed water and caused corrosion on two types of metal commonly used in HVAC systems, steel and galvanized steel.

In addition to corrosion, the possibility of long term mold growth should be considered due to the water sorption characteristics of the materials. Mold can occur when duct liner materials become wet and do not dry quickly. While cotton duct liner does not grow mold when new, the long-term performance after exposure to a variety of climatic conditions has not been demonstrated.

References:

Table 1: ASTM C 1104 Water Vapor Sorption Test

<table>
<thead>
<tr>
<th>Sample</th>
<th>Initial Weight (g)</th>
<th>Final Weight (g)</th>
<th>% Weight Gain</th>
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<tbody>
<tr>
<td>1</td>
<td>27.10</td>
<td>42.90</td>
<td>58.30</td>
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<tr>
<td>2</td>
<td>27.93</td>
<td>39.92</td>
<td>42.93</td>
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<tr>
<td>3</td>
<td>27.60</td>
<td>40.83</td>
<td>47.93</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td><strong>FAIL 49.72</strong></td>
</tr>
</tbody>
</table>

The maximum percentage of water vapor sorption allowed by ASTM C 1071 is 3%.

Source: Johns Manville Technical Center Report

About NAIMA

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

For additional information or copies of the test results contact:

NAIMA
44 Canal Center Plaza, Suite 310
Alexandria, VA 22314
Phone: 703-684-0084
Fax: 703-684-0427
www.naima.org

NAIMA AIR HANDLING COMMITTEE MEMBERS:

CertainTeed Corp.
P.O. Box 860
Valley Forge, PA 19482
800-233-8990

Johns Manville
P.O. Box 5108
Denver, CO 80217
800-654-3103

Knauf Insulation
One Knauf Drive
Shelbyville, IN 46176
800-825-4434

Owens Corning
One Owens Corning Parkway
Toledo, OH 43659
800-GET-PINK