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Moisture & Corrosion Performance of Cotton Duct Liner Materials in HVAC Ducts

In this issue, NAIMA reveals the results of moisture and corrosion tests conducted on cotton duct liner

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.[1] 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.[1] 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[2]

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[3]

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.

Table 1: ASTM C 1104 Water Vapor Sorption Test

Sample	Initial Weight (g)	Final Weight (g)	% Weight Gain
1	27.10	42.90	58.30
2	27.93	39.92	42.93
3	27.60	40.83	47.93
Average		**FAIL**	**49.72**

The maximum percentage of water vapor sorption allowed by ASTM C 1071 is 3%
Source: Johns Manville Technical Center Report

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.

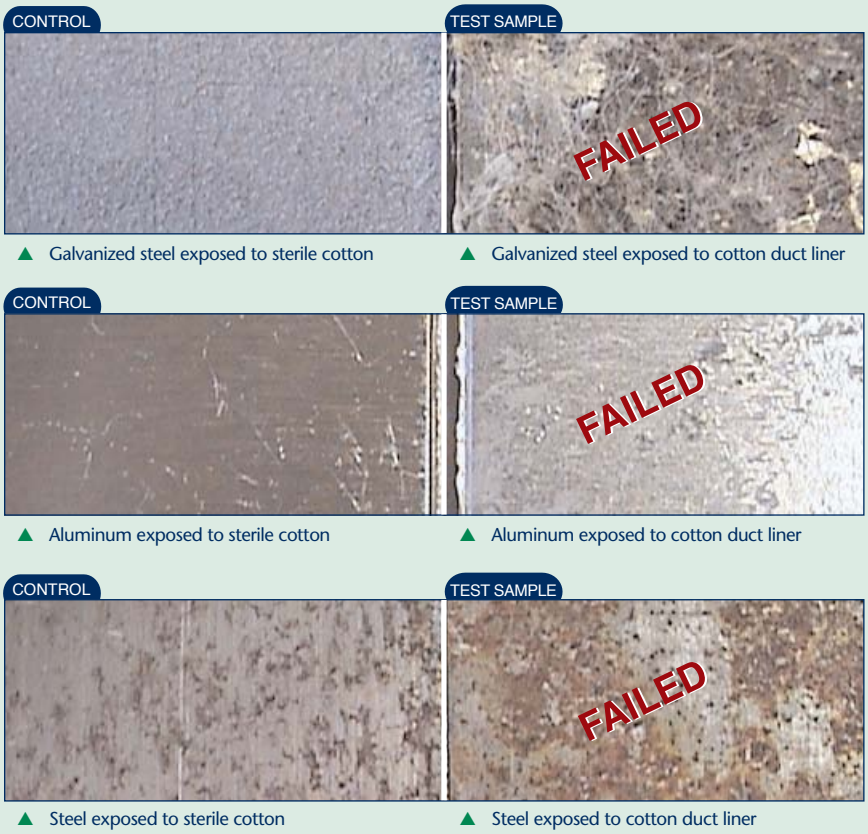
The maximum percentage of water vapor sorption allowed by ASTM C 1071 is 3% and the cotton duct liner samples tested by the NAVLAP-certified lab had an average of 49%. These materials had more than 16 times the water vapor sorption allowed by the ASTM standard.

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 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.[4] 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.

Figure 1: Difference Between Corrosion Caused by Cotton Duct Liner and Sterile Cotton Controls Based on ASTM C 665 Test



▲ Galvanized steel exposed to sterile cotton
▲ Galvanized steel exposed to cotton duct liner
▲ Aluminum exposed to sterile cotton
▲ Aluminum exposed to cotton duct liner
▲ Steel exposed to sterile cotton
▲ Steel exposed to cotton duct liner

NOTE: Copper was also tested, but showed no corrosion. Copper is rarely in contact with duct liner materials.

Source: Owens Corning ASTM C 665 Test Report

References:

1. Reflectix Submittal Sheet November 2004.
2. Johns Manville Technical Center Report, February 5, 2003.
3. Owens Corning ASTM C 665 Test Report April 30, 2003.
4. "Mold: Cause, Effect and Response," FWCI, March 2002, p. 31. http://www.awci.org/mold-series-1.pdf

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.

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