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FORMALDEHYDE EMISSIONS FROM BONDED FIBERGLASS INSULATION PRODUCTS

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ABSTRACT

In recent years there has been much concern about the quality of air we breathe inside our homes, schools, and workplaces. The presence of formaldehyde in indoor air has been suspected as the cause of many irritant reactions associated with "sick building syndrome." Although fiberglass duct liner, duct board, and other building insulation products are bonded with phenol-formaldehyde-urea adhesives, literature references show that bonded fiberglass products are low emitters of formaldehyde.

The purpose of this study was the investigation of the formaldehyde emissions from bonded fiberglass products using the large-scale test chamber methodology. The test evaluation is similar to what is specified in HUD ruling 3280.308, "LSTC Method of Determining Formaldehyde Emissions from Wood Products FTM-2-1983," which went into effect February 11, 1985.

Employing standard test conditions of 50% RH, 77°F, and 0.5 air changes per hour (ach), fiberglass air-handling and insulation products emitted 100 parts per billion (ppb) or less of formaldehyde when test chamber loadings approximated the installed ratio of product area to indoor air space volume.

INTRODUCTION

Formaldehyde-based resins are used extensively as the bonding agent in many construction materials. Bonded fiberglass insulation products are typically manufactured with phenol-formaldehyde-urea adhesives at levels up to 20% of product weight.

Although research has shown phenol-formaldehyde-urea adhesives to be low emitters of formaldehyde (CPSC 1983) it is incumbent on manufacturers to achieve the lowest possible formaldehyde off-gassing from products in view of the varied human responses to formaldehyde vapor at levels of 0.5 ppm or less (NRC 1981).

Data on the formaldehyde off-gassing of bonded fiberglass insulation products are limited compared to pressed wood products.

Since a dynamic (ventilated) test chamber more closely duplicates actual product use than does a test apparatus with no ventilation, the products tested in this study were evaluated in a large-scale test chamber (LSTC). The LSTC (NPA/HPMA 1983) method determines the dynamic state formaldehyde emission potential of products under conditions that simulate ambient indoor air. The emission potential is determined by measuring formaldehyde chamber concentrations under defined test conditions. The Hardwood-Plywood Manufacturers Association provides test apparatus and method protocol in its test method, FTM-2-1983, "Large Scale Test Method for Determining Formaldehyde Emissions from Wood Products." The U.S. Department of Housing and Urban Development (HUD) adopted FTM-2-1983 in 1985 when it established the world's first government formaldehyde standards for pressed wood products used in mobile homes (HUD 1984). The HUD ruling states that certain pressed wood products cannot exceed formaldehyde chamber concentrations at specific product loadings. Thus the use of an LSTC, which utilizes standard conditions of temperature, humidity, ventilation, and product loading, has emerged as one of the important test methods for evaluating the formaldehyde emission potential of various building materials.

In this study commercial and residential fiberglass insulation products were selected for testing as well as some fiberglass products used in HVAC systems.

A test chamber loading of 0.52 m^2/m^3 (0.16 ft^2/ft^3) was used for batt and roll fiberglass insulation products based on an outside wall insulation area of a one-story structure. Chamber loading values for fiberglass duct board (0.07 m^2/m^3) and duct liner (0.12 m^2/m^3) were based on the installed area of the air-handling product in a residential structure. Conditioning time, or time to equilibration of formaldehyde release, was determined to be 24 hours or less for the fiberglass samples. The fiberglass batt and roll insulation products were all tested at 77°F and 50% RH. The two air-handling products were tested at higher temperatures (lower relative humidity), in addition to ambient temperature, to approximate service conditions. All samples used in the study were manufactured at least one month prior to securement.

TEST METHOD

The bonded fiberglass samples were evaluated in Georgia-Pacific's 1077 ft^3 (30.5 m^3) large-scale chamber located in Sacramento, CA (Newton et al. 1986). The test chamber is constructed of embossed aluminum panels that are filled with an insulating styrofoam and interfaced with each other using an epoxy adhesive. The chamber dimensions are 16.72 ft long, 9 ft high, and 7.15 ft wide. A variable-speed blower pumps air to the test chamber from a conditioning room where temperature and relative humidity are controlled to 77°F ± 2°F and 50% ± 4% RH, respectively. The air in the conditioning room is scrubbed with a bed of chemisorbent to reduce formaldehyde levels to less than 5 ppb. The air passes through a positive displacement gas meter for volume measurement prior to entering the chamber through a rigid, non-metallic conduit. The air is diffused into the chamber through numerous holes while a three-speed fan with a plastic baffle aids in chamber air circulation. The air exchange rate was controlled to 0.50 ± .05 ach.

The fiberglass samples, which represented faced and unfaced material, were placed on metal support racks within the chamber so that the facing and fiber side of the fiberglass samples were equally exposed to the chamber environmental conditions. Temperature, humidity, and air exchange rate within the chamber were allowed to equilibrate for 24 hours prior to each test. A background chamber value was determined before placing test samples in the chamber. Once in

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TABLE 1

Large Scale Test Chamber Results

Product	Temp. °F	RH %	Chamber Loading m^2/m^3	ACH	Chamber Background Formaldehyde ppm	Chamber Formaldehyde ppm
R-30, 11.5 "(a)	77	50	0.52	0.50	0.024	0.065
R-19, 6.5"(a)	77	50	0.52	0.50	0.026	0.072
R-11, 3.5"(a)	77	50	0.52	0.50	0.025	0.072
R-11, 3.5" UNF	77	50	0.52	0.50	0.028	0.085
R-13, 4", UNF	77	50	0.52	0.50	0.028	0.085
Duct Liner, 1"(b)	77	50	0.12	0.50	0.028	0.015
Duct Liner, 1"(b)	110	10	0.12	0.50	0.026	0.020
Duct Board, 1"(c)	77	50	0.07	0.50	0.026	0.028
Duct Board, 1"(c)	110	10	0.07	0.50	0.027	0.051
Duct Board, 1"(c)	110	10	0.07	0.50	0.026	0.070

(a) Kraft faced building insulation
(b) Nonwoven fabric facing
(c) Foil scrim kraft facing

the chamber, test samples were equilibrated for 24 hours before sampling the chamber air for formaldehyde. The modified NIOSH test procedure was the analytical method used to determine the formaldehyde. The modified NIOSH method uses 1% sodium bisulfite as the absorbing solution in two series-connected impingers each containing 20 ml of absorbing solution. The air sample was taken over a one-hour period at a sample flow rate of 1 L/min. The measured formaldehyde was reported as parts per million (ppm) in the sampled chamber air.

RESULTS

The results of the large-scale chamber testing at 77°F, 50% RH, and 110°F, 10% RH with 0.50 ach are summarized in Table 1. The steady-state formaldehyde concentrations (C_s), or chamber formaldehyde values, varied from 0.015 ppm to 0.085 ppm for the tested samples. Since little variation was observed in the chamber values (C_s) for the residential insulation product, it would appear that the formaldehyde emission levels are dependent on·product surface area and not product thickness or weight. Chamber values for the duct liner samples were below the chamber background levels, indicating that these samples acted as a sink adsorbing formaldehyde. The duct board results at 77°F and 50% RH show formaldehyde values the same as chamber background. With increasing test temperatures (110°F and 120°F) and lower relative humidity, the chamber formaldehyde values increased to levels above background readings.

Although humidity has been shown to affect the formaldehyde off-gassing of bonded wood products, it is not known what effect HVAC cooling conditions (55°F, 95% RH) would have on formaldehyde off-gassing of fiberglass products.

CONCLUSIONS

A large-scale test chamber with a modified FTM-2-1983 wood products protocol was used to measure formaldehyde emissions from bonded fiberglass products. At chamber conditions of 77°F, 50% RH, and 0.50 ach, the measured formaldehyde values were 15 to 85 ppb. The measured formaldehyde emission values, employing approximate product end-use chamber loadings, are below the ASHRAE (1986) recommended guideline of 100 ppb.

Since many of the large chamber test values are very close to the chamber background formaldehyde values, the formaldehyde contribution of the fiberglass products is not being accurately determined. Therefore, it is not feasible to use the test results to calculate an accurate emission rate (mg/m²/h).

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