

A Review of the Permanency of Fire-Retardant Chemicals Used in Cellulosic Insulation

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ABSTRACT

Cellulosic insulation is manufactured from various types of paper stock or wood fiber with fire retardants added to reduce its combustibility. Since this insulation is used in residential and commercial buildings, the performance period can be 40 years. The fire-retardant chemicals must be effective for the life of the building or as long as the insulation remains in place. Fire-retardant chemicals are added to the cellulosic fiber during the manufacturing process as either a dry mix or as a spray-applied aqueous solution. In some cases, a small amount of water is added in a "dry mix process" to assist the blending of the solids. Inorganic fire retardants make up 14 to 36 wt %, with an average of 22% (untreated fiber basis) of the product and are a major part of the cost of producing the cellulose insulation (Yarbrough et al. 1982).

Fire-retardant formulations generally contain two to five compounds. Boric acid, sodium tetraborate (borax), and ammonium sulfate are widely used, while aluminum sulfate, aluminum trihydrate, borates other than borax, and other phosphates, carbonates, and chlorides are also used. The requirement for the manufacturer of a cellulosic insulation is that the product pass the smoldering combustion test and have a critical radiant flux value of greater than 0.12 W/cm² at the time of manufacture. The procedures for these tests are part of the ASTM standard (ASTM 1991) for the product.

The term "permanency" refers to the need for the effectiveness of the fire retardants to extend over the life of the installation. Reduction in effectiveness is attributed, for example, to chemical decomposition, sublimation, leaching, or redistribution of chemicals within the insulation. The available data are for boric acid, borax, and ammonium sulfate, since these compounds are widely used in fire-retardant formulations.

Both laboratory (Yarbrough 1982; Chiou and Yarbrough 1990; Fisher et al. 1992) and field studies (Wampnar 1991; Katz and Siddiqui 1989; Graves and Yarbrough 1989; Yarbrough 1991) related to the chemical permanency issue have been completed. The objectives of these studies have been to assess product performance by changes in the performance test results and to identify the mechanisms causing these changes to occur. In most of the studies cited, the primary evaluations are the smoldering combustion and critical radiant flux tests.

These tests have been supplemented in some cases by an analysis of the amount and composition of fire retardant present in the insulation after a period of aging.

This review will present and discuss the results from published aging studies and some data (Wampnar 1991; Yarbrough 1991) that have not previously been published. The body of data available for the effect of time on fire retardant effectiveness is not consistent, and fire retardant loss mechanisms have not been irrefutably established. The fire-related tests, effectiveness of existing and new formulations, and permanence represent issues for the insulation industry.

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