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## Fire Retardants for Civil Structures

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# Fire Retardants for Civil Structures

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## I. INTRODUCTION

A fire retardant coating or paint is intended to delay ignition and reduce the surface burning rate of a combustible wood, cellulosic fiber or cellular plastic building material for a short period of time. It may be applied as a thick protective covering by trowel or as a fire-retardant paint by brush, spray, or roller. The reduction of burning rate usually depends on the applied thickness<sup>1</sup>. In the case of a fire-retardant paint exposed to fire, the paint may intumesce, forming an insulating blanket which retards surface ignition and reduces the burning rate of the combustible material on the coated side. Fire-retardant coatings will effectively reduce the burning rate of a combustible surface for a period of about 10-15 minutes. Their use is particularly applicable in very low hazard occupancies not requiring sprinkler protection, where occupancy is not likely to change and the only hazard is that of exposed, interior finish materials<sup>2</sup>. Fire retardants commonly divided into four major groups: Inorganic FRs, Organ phosphorus FRs, Nitrogen-containing FRs and Halogenated organic FRs<sup>3</sup>. Inorganic flame retardants make up a large part of the market encompassing various aluminum, nitrogen, phosphorous, and boron compounds<sup>4</sup>. These widely used low cost materials have been around for centuries, proven to be effective flame retardants in fibers in clothing and fillers for textiles. The majority of these inorganic flame retardants work by diluting both the condensed and vapor phase of the polymer with non-flammable salts, acids and by-products such as water and alumina ( $Al_2O_3$ )<sup>5</sup>. Figure-1 shows the mode of action for inorganic FRs.

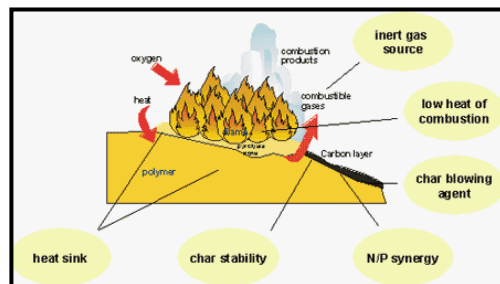


Figure 1 : Mode of action for inorganic FRs

Polymeric plastic combustion occurs in the vapor phase. When a plastic is exposed to increased temperatures, the plastic undergoes pyrolysis. Potentially combustible vapors are slowly released at first. Since many polymers are substituted, the increase in surrounding temperatures can cause variations in connectivity among the monomer units<sup>6</sup>. Often, these variations in connectivity result in an overall weakening of the polymer structure and can encourage the release of more vapors and liquids, both flammable and non-flammable. As the heat source persists, the temperature of the polymer increases steadily<sup>7</sup>.

## II. MATERIALS AND METHOD

### a) Materials Used

Aluminum hydroxide with particle size ( $1\mu$ ). Matrix material: polyvinyl chloride (PVC), this resin was supplied by Huntsman Advanced Materials (Switzerland) GmbH. Reinforcing material: Woven roving ( $0^\circ - 45^\circ$ ) carbon fibers was used as a reinforcing material, the company supplied these fibers is Hyfil It, UK.

### b) Preparation of Test Specimens

Specimen of thermal erosion test have a square shape, with dimensions ( $100 \times 100 \times 10$ mm). These Specimens consist of two layers: Fire retardant material layer with (4mm) thickness, and composite material layer with (6mm) thickness.

### c) Thermal Erosion Test

Gas torch flame with temperature ( $2000^\circ C$ ) was used in this test. The system (contains fire retardant material and composite material) was exposed to this flame under different exposure intervals (10, 15, 20mm). Surface temperature method used here to calculate the amount of heat transmitted through fire retardant material and composite material. A transformation card (AD) which called Thermal monitoring and recording

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system (Figure-2) was used to observed and saved temperatures with time (in seconds) .

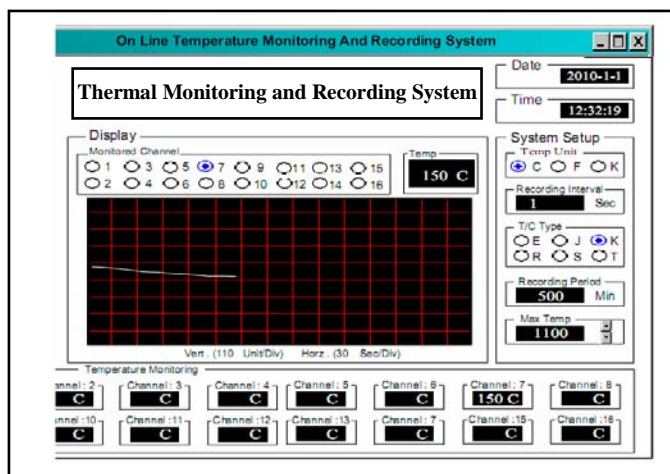


Figure 2 : Thermal monitoring and recording system

### III. RESULTS AND DISCUSSION

Figure-3 Curve.1 represents the thermal erosion test for composite material with retardant surface layer at exposed interval (10mm), the temperature of the opposite surface to the torch begins to increase with increasing the time of exposition to the flame <sup>8</sup>. Aluminum hydroxide will form a glassy char at high

temperatures that prevents flame propagation ,It also releases water of hydration from its chemical structure . Therefore, the substrate (composite material) will protect and the fire spread will decrease <sup>9</sup>.

The improvement in flame retardancy will increased with increased exposed interval to (15mm) as shown in Figure-3 Curve.2. As a result, when the exposed interval to flame increased to (15mm), the time necessary to break down of fire retardant layer will increase and the combustion gaseous will reduced and there will be a less plastic to burn due to water of hydration and protected glassy coating layer comes from Aluminum hydroxide <sup>10</sup> .

Figure-3 Curve.3 represents the thermal erosion test for composite material with retardant surface layer at exposed interval (20 mm),where this increment in exposed interval will rise the time of break down for Aluminum hydroxide layer and substrate composite material <sup>11</sup> . From figures , the better results obtained with large exposed interval (20 mm).

### IV. CONCLUSIONS

Flame resistance of composite material will enhanced with addition retardant layer from Aluminum hydroxide. The resistance to flame spread will increased with increasing of exposed interval. The flame retardancy is increased as the flame temperature is decreased.

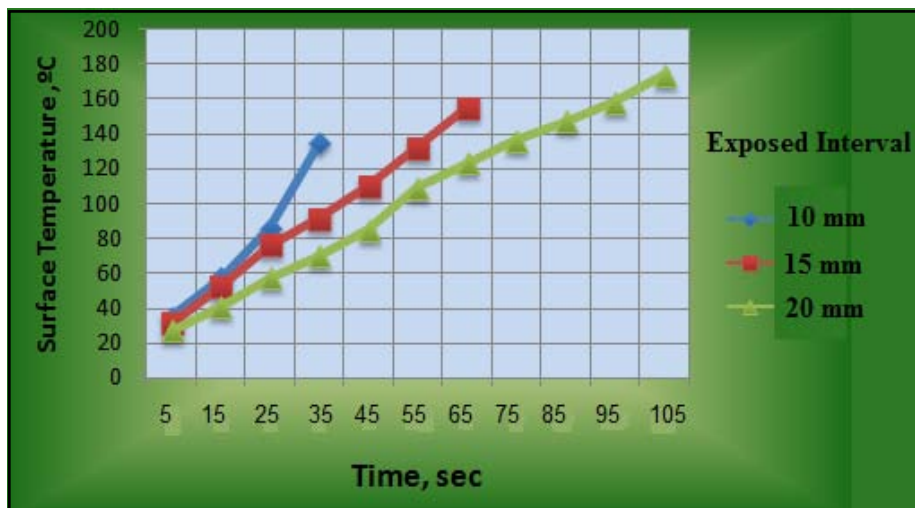


Figure 3 : Thermal Erosion Test

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