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INCREASING FLAME RETARDANCY FOR POLYETHYLENE RESIN REINFORCED BY HYBRID FIBERS BY USING SURFACE COATING LAYER FROM ZINC BORATE - ANTIMONY TRIOXIDE

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ABSTRACT

zinc borate and antimony trioxide was used as a surface coating layer of (5mm) thickness with weight percentage (50%:50%) for each other to increase the flame retardancy for polyethylene resin (GT 8010) reinforced by Boron fibers ,this system was exposed to gas flame (2000ºC) with (10 mm and 20 mm) exposure distances. Method of measuring the surface temperature opposite to the flame was used to determine the heat transferred to composite material. The best results were obtained with large exposed distance and percentage from protective layer which is zinc borate and antimony trioxide.

Keywords: Hybrid Flame Retardant, Composite Material, , Inorganic Retardants .

INTRODUCTION

Flame retardants (FRs) are chemicals that slow the spread or intensity of a fire. They help fire Fighters on the ground and are sometimes also dropped from aircraft. Flame retardants work through a number of different mechanisms. The ultimate goal is to decrease the potential of ignition or to delay the spread of a flame over the body of material the retardant is protecting (Horrocks , 2010). This is accomplished by increasing the combusting resistance of the materials to continue burning. Flame retardants are applied in a number of different methods. They can be impregnated into plastics during processing, blended with insulation materials during application, used as treatments on shingles and decks and applied on the surface of materials as coatings or paints (Levchik, 2007).

Some flame retardants cause a treated material to char thus inhibiting the pyrolysis process. Others remove flammable gases by reacting with the hydrogen and hydroxide radicals in the air. There are four primary substances which work to retard fire in different ways. These families include halogenated, phosphorus, nitrogen and inorganic flame retardants (Giu, 2001). Inorganic FRs are added as fillers into the polymers and are considered immobile, in contrast to the organic additive FRs (Levchik, 2007).

A composite material is commonly defined as a combination of two or more distinct materials, each of which retains its own distinctive properties, to create a new material with properties that cannot be achieved by any of the components acting alone (Mallick, 2007). Generally, the composite material contains two elements:

Matrix material: it is the continuous phase; it may be metal, ceramic or polymer matrix. Polyethylene resin belong to epoxy group which has excellent thermal and physical properties, and usually used in composite materials for different applications, where it distinct by excellent adhesive capability especially to fibers, also it retain constant dimensions after dryness (Vincenzini , 2006).

Reinforcing material: The distributed phase is called reinforcement, many reinforcement materials are available in a variety of forms; continuous fibers; short fibers; whiskers, particles...etc. (Biron, 2007). High strength, and high modulus carbon fibers are of about (7-8μm) in diameter and consist of small crystallites of turbostratic graphite, one of the allotropic forms of carbon (Tong *et al.,* 2002). Kevlar is an organic aramid fiber with (3100 MPa) tensile strength, and (131,000 MPa) elastic modulus. A density approximately one-half of aluminum, good toughness, in addition it is flame retardant (DeGarmo *et al.,* 2008).

MATERIALS AND METHODS

Materials: Zinc Borate was used as a flame retardant, which supply from C-Tech corporation. Antimony Trioxide (Sb_2O_3) : supplied from (BDH Chemical Ltd Pool England) with particle size (2µ). Polyethylene resin (GT 8010). Boron fibers with (0 º - 45 º) fibers direction.

Preparation of Test Specimens: Specimens of thermal erosion test are a disc shape with diameter (100mm), and (10mm) thickness, which it consists of two layers: Flame retardant material layer with (5mm) thickness represented by zinc borate. And composite material layer with (5mm) thickness, it contains Boron fibers which used as consecutive layers in polyethylene resin .

Thermal Erosion Test: Gas tourch with temperature (2000ºC) was used in this test. The system was exposed to this flame under different exposure distances (10 mm and 20mm). Surface temperature method used here to calculate the amount of heat transmitted through flame retardant material and composite material .Temperature monitoring and recording system (Program) was used to observed and saved temperatures measured by thermocouple type-K by entering it in computers by transformation card (AD).

RESULTS AND DISCUSSION

Fig.1 represents the thermal erosion test for composite material with retardant surface layer at exposed distance (10mm), the temperature of the opposite surface to the torch begins to increase with increasing exposition time to the flame. During this stage, zinc borate has a water of hydration in its chemical structure, therefore, it released this water to extinguish the fire through cooling, in addition, zinc borate will formed glassy coating layer which protecting the substrate (composite material) and the fire spread will decrease. In another hand, antimony trioxide because its phase transformations happened in internal structure of this oxide which cause with zinc borate enhanced flame retardancy of composite materials (Formicola *et al.,* 2009).

Fig.2 the thermal erosion test for composite material with retardant surface layer with exposed distance(20mm) . As a result, when the exposed distance to flame increased to (20mm), the time necessary to break down of flame 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 zinc borate, and antimony trioxide because the mode action of this oxide with glassy coating layer increasing flame retardancy. All that will rise the time of break down for zinc borate-antimony trioxide layer and substrate composite material (Cem *et al.,* 2009).

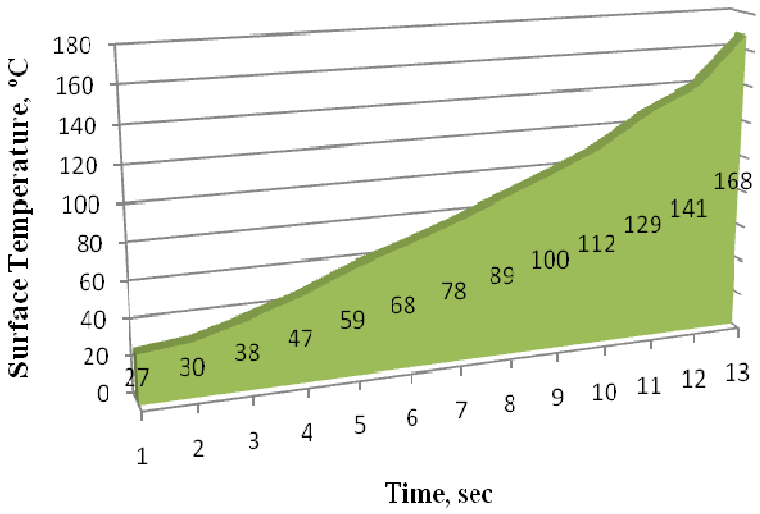

Fig 1. Exposed Distance (20 mm)

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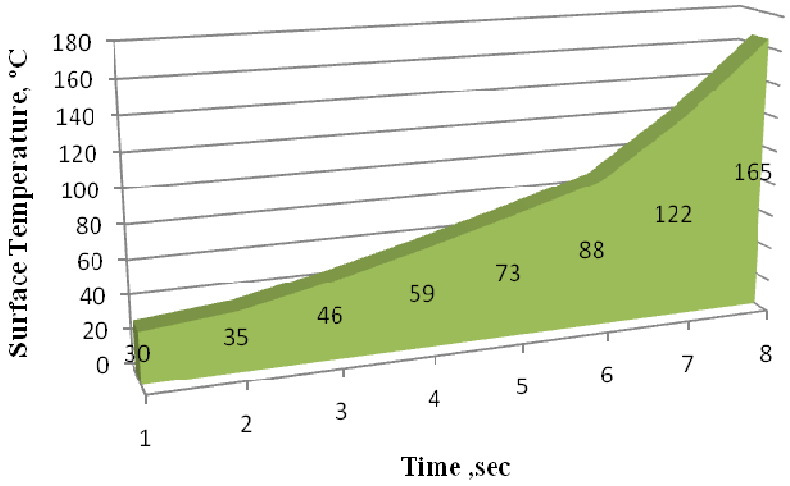

Fig 2. Exposed Distance (10 mm)

CONCLUSIONS

We observed from thermal erosion test that ,when Added zinc borate and antimony trioxide as retardant layer will enhance flame retardancy for composite material. The resistance of composite material to flame spread on surface will increased with increasing of exposed distance ,and the flame retardancy is increased as the flame temperature is decreased.

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