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FORMATION HYBRID FLAME RETARDANT AND ITS EFFECT ON THERMAL RESISTANCE OF ARALDITE RESIN COMPOSITE

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ABSTRACT

Investigations on zinc borate-Sb_2O_5 *have been performed up to (3000ºC) to increase the flame retardancy of araldite composite .A surface layer from zinc borate-* Sb_2O_5 *with (4mm) thickness was used and exposed to a direct flame generated from Oxyacetylene torch with exposure intervals [10,15, 20mm] and study the range of resistance of retardant material layer to the flames and protected the substrate . The results show that the mixing ratio of 3:1 (zinc borate:* Sb_2O_5*) is the optimum mixing ratio which is obtaining the best result.*

Keywords: Hybrid flame retardant, Araldite resin composite.

INTRODUCTION

Polymers are commonly made from highly flammable hydrocarbons that burn quite readily upon ignition. Hence, making polymers resistant to burning is of great importance to their safe use in today's society. One way to make polymers flame retardant is by blending in additives. Flame retardants(FRS) are materials that inhibit or resist the spread of fire ,for example, many plastics are highly flammable and therefore their fire resistance is increased by adding flame retardants in order to reduce the risk of fire (Sravanthi,2011) . Room combustion tests comparing FR plastics with non-FR plastics conducted by the National Bureau of Standards (The National Institute of Standards and Technology) have shown that FR materials allow longer escape time, less heat release, less smoke and release of a lower concentration of toxic gases (Obidiegwu, Ogbobe, 2012).

These effects are due to a decrease in the amount of burning materials (Kashiwagi *et al.,* 2009). Flame retardants commonly divided into four major groups: Inorganic FRS, Organo phosphorus FRS, Nitrogen-containing FRS and Halogenated organic FRS. Flame retardancy can be achieved using any of three different approaches: (1) causing "char" formation in the pyrolysis zone, (2) adding material that decomposes to produce nonflammable gases or endothermic ally cools the pyrolysis zone, and (3) prohibiting the combustion process in the vapor phase (Formicola *et al.,* 2009). Figure 1 shows the mode action for inorganic FRS.

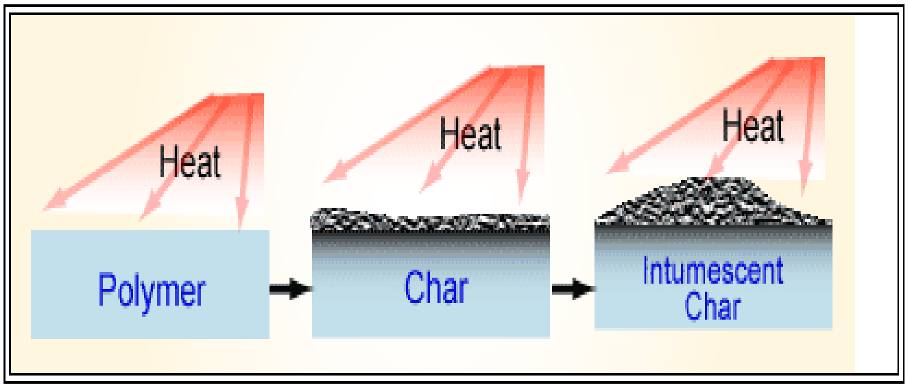


Figure 1. Mode of action for inorganic FR$_S$

EXPERIMENTAL PROCEDURE

Materials Used

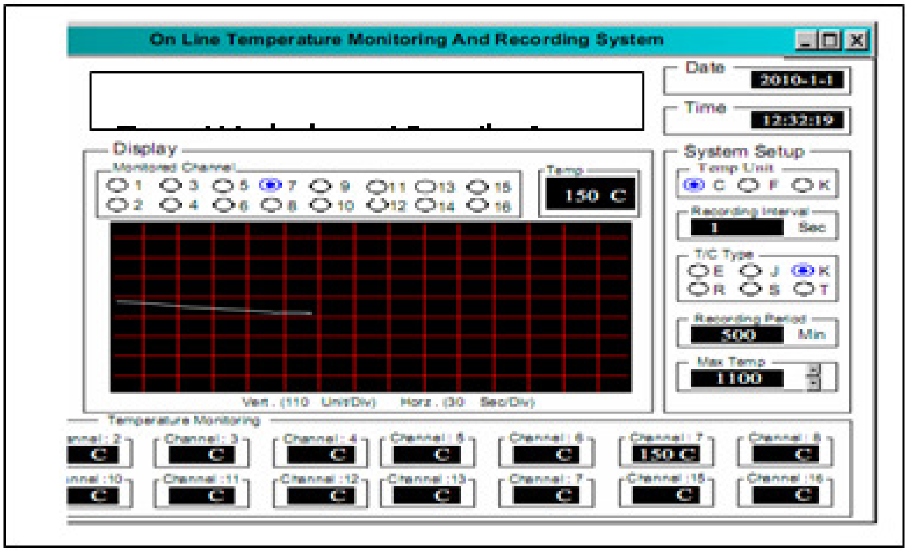
Zinc borate ($2ZnO.3B_2O_3.3.5H_2O$), which supply by Akrochem Corporation. Antimony pent oxide (Sb_2O_5): produced by NL Industries with particle size (1µ). Araldite GY 250 resin: Supplied by Huntsman Advanced Materials (Hong Kong) Ltd. Carbon fibers (0° - 45°).

Preparation of Test Samples

The samples of thermal erosion test are squared shape with dimensions of 100 × 100 mm^2 and 10mm thick consisting two layers: flame retardant layer with 4 mm thick and composite material with 6mm thick.

Thermal Erosion Test

Flame generated from Oxyacetylene torch with temperature (3000ºC) was used in this test. The system was exposed to this flame under different exposure intervals (10, 15, 20mm). A transformation card (AD) which called Thermal monitoring and recording system (see Figure 2) was used to observed and saved temperatures with time (in seconds).



On Line Temperature Monitoring And Recording System

Date 2010-1-1

Time 12:32:19

Display

Monitored Channel: ○1 ○3 ○5 ●7 ○9 ○11 ○13 ○15 ○2 ○4 ○6 ○8 ○10 ○12 ○14 ○16

Temp 150 C

Vert . (110 Unit/Div) Horz . (30 Sec/Div)

System Setup

Temp Unit: ● C ○ F ○ K

Recording Interval: 1 Sec

T/C Type: ○ E ○ J ● K ○ R ○ S ○ T

Recording Period: 500 Min

Max Temp: 1100

Temperature Monitoring

Channel : 7 150 C

Figure 2. Thermal monitoring and recording system

RESULTS AND DISCUSSION

Figure 3 represents the thermal erosion test for composite material with retardant surface layer at exposure interval (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(Cem *et al.,* 2009).

This process of flame retardancy will be increased by addition 10 % from antimony pent oxide because its phase transformations happened in internal structure of this oxide which cause with zinc borate enhanced flame retardancy of composite materials, and this retardant action increased with increased antimony pent oxide content to 20 % and 30 %. The flame retardancy is reduced when the mixing ratio is increased to 4:1 and 5:1. This retardant action decreased with the increasing of antimony pent oxide percentage of 40% and 50% and expecting to decrease rapidly with the increasing of antimony pent oxide percentage. The 40% and 50% test shows that the surface layer was starting to decomposed and fractured after exposed to 3000˚C flam temperature (Al-Maamori *et al.,* 2011).

Figure 4 the thermal erosion tests for composite material with retardant surface layer with exposure interval (15mm). As a result, when the exposure 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 zinc borate, and this protection will improves with addition 10% 20 %, and 30 % from antimony pent oxide because the mode action of this oxide with glassy coating layer increasing flame retardancy (Al-Mosawi *et al.,* 2012) .

The improvement in flame retardancy will increased with increased exposure interval to (20mm) as shown in Fig .5 ,and this will rise the time of break down for zinc borate- antimony pent oxide layer and substrate composite material (Al-Maamori *et al.,* 2011) . From figures, the better results obtained with large exposure interval and large percentage from protective layer which is antimony pent oxide 30%. All that will rise the time of break down for zinc borate- antimony pent oxide layer and substrate composite material (Rahatekar *et al.,* 2010). From figures, the better results obtained with large exposure interval and large percentage from protective layer which is antimony pent oxide (30%).

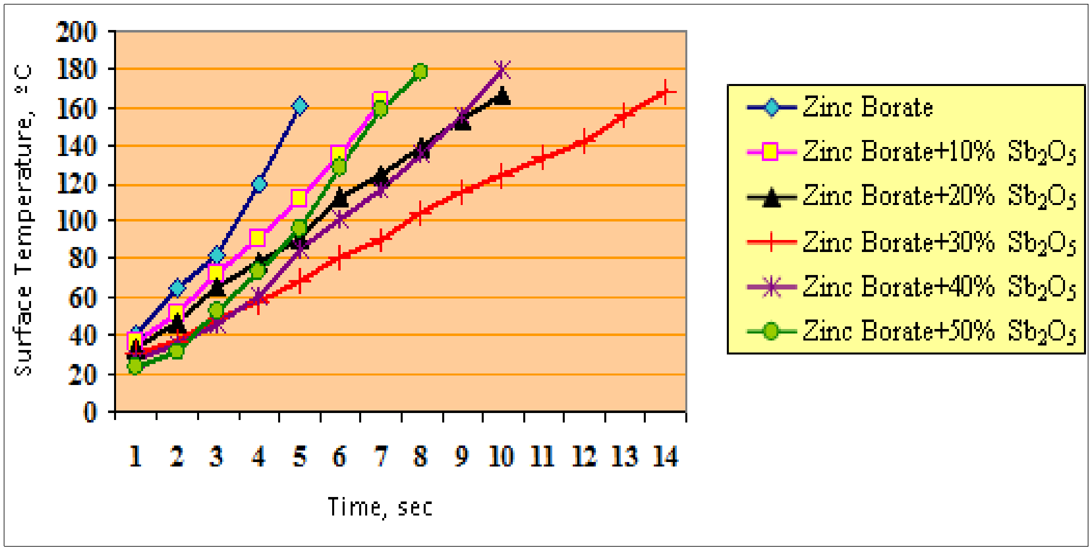


Figure 3. Exposure interval 10 mm

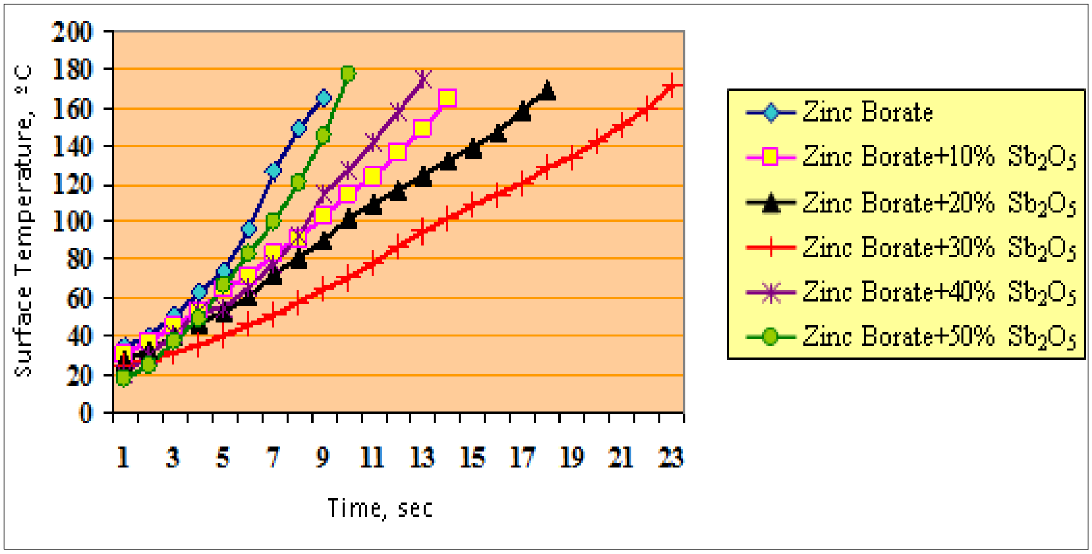


Figure 4. Exposure interval 15 mm

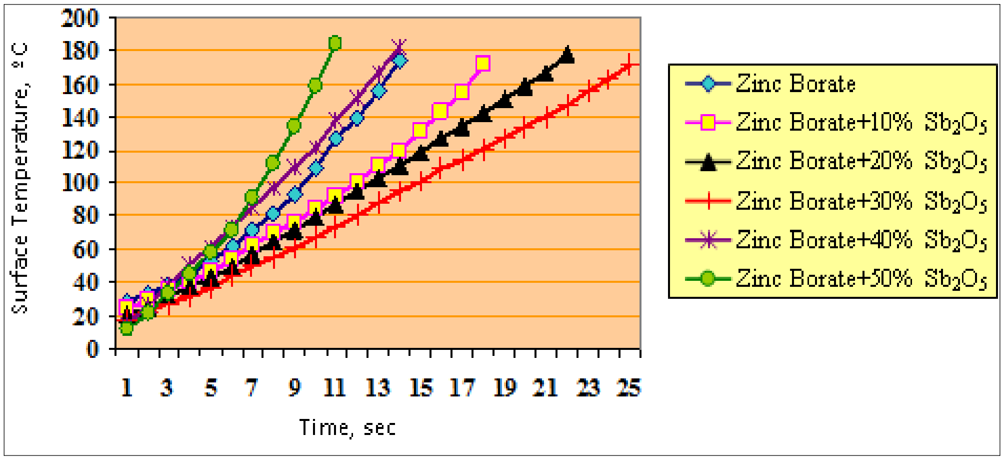


Figure 5. Exposure interval 20 mm

CONCLUSIONS

From the results obtained by thermal erosion test we concluded that: Improved flame retardancy of composite by using zinc borate. Adding Antimony pent oxide to zinc borate improved the layer Durability and structure. The retardant action decreased with the increasing of antimony pent oxide percentage of 40% and 50% and expecting to decrease rapidly with the increasing of antimony pent oxide percentage.

The 40% and 50% test shows that the surface layer was starting to decomposed and fractured after exposed to 3000°C flam temperature ,and the mixing ratio of 3:1 (zinc borate: antimony pent oxide) is the optimum mixing ratio which is obtaining the best result.

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