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RESEARCH ARTICLE

Thermal Resistance of Epoxy Resin and Phenol Formaldehyde Compound Mixed with Mixed Inhibitors

Mustafa A. Rajab[1]*, Ziad T. Khodair[2], Hind W. Abdullah[2], Asaad A. Kamil[2]

[1.] *Middle Technical University, Technical Institute of Baqubah , Iraq.*

[2.] *Faculty of Science - University of Diyala, Iraq.*

***Corresponding Author: Mustafa A. Rajab**

Abstract

The properties of flammability and the effect of zinc oxide with antimony trioxide were examined on the thermal corrosion testing of epoxy resin and formaldehyde. Zinc borate was added to the resin and then reinforced with silica fiber and woven glass fibers (90 ° -0º) with thickness (4 mm). Then expose the system to Acetylene Oxide flame (3500 ° C) directly with different exposures of flame (10 mm, 20 mm), to study flame retardant resistance and protection of the substrate. Animein trioxide was then added to zinc porcine in different quantities (10%, 20% and 30%) to form hybrid flame retardants for hybrid exposure to the same flame temperature and exposure distances. The method of measuring the surface temperature of the flame was used to determine the temperature transferred to the composite material. The results showed that the best exposed distance and a large proportion of protective layer of zinc boron with antimony trioxide was at 30%.

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

Introduction

Long chains of similar molecules are connected by secondary forces called Van dervals forces and thermoplastics polymers soften when heated and reduce viscosity when applying additional heat [1, 2]. Examples of these polymers are polyethylene, polystyrene, polypropylene and nylon [3, 4]. However, thermoset polymers are crosslinking molecules and these crosslinking limit the movement of molecule chains and prevent the crystallization of molecules and increases the energy required to move the parts of polymer chains [5, 6]. For this reason, these polymers are often non-crystalline and have high degrees of glass transition (Tg). Therefore, thermoset polymers are ideal for high temperature applications. In heating polymer the chains are cross-linked and the polymers become insoluble, non-fusion and poorly conductive to thermal and electrical. Most of these resins are added to hardener to harden at room temperature or by Heat source for example epoxy resins, unsaturated polyester resins [7, 8]. The Structure of epoxy resin repeating unit is shown in Figure.

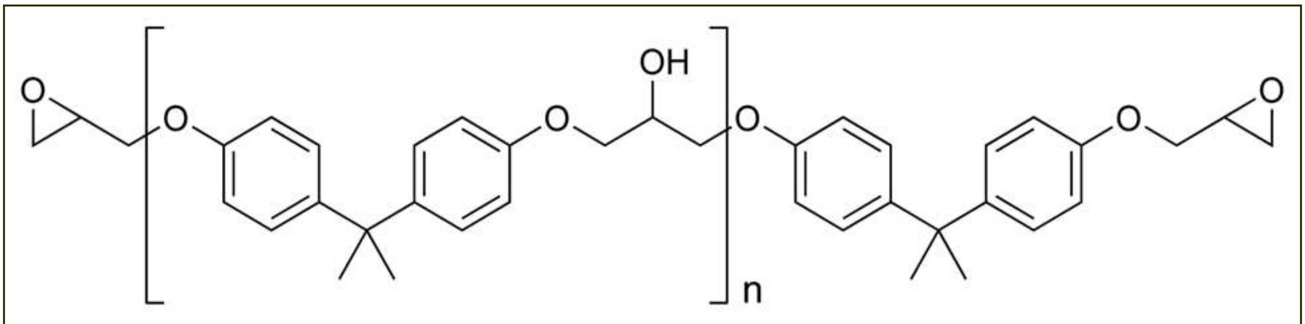

Figure 1: Schematic representation structure of epoxy resin, n denotes the number of polymerized subunits [9]

In order to understand polymer blends, one must have an understanding of polymer as concept. Any substance that flows or gets deformed under influence of heat, pressure or both and retains the new form given to it when the stress is removed is called plastic material [9]. Polymers of large molecules are found abundantly in nature such as wood, cotton, silk, wool, leather, rubber, shellac and some silicates.

Their variety has been enormously increased by the chemists using synthetic means. Polymer blends are formulated to represent a very effective technique for modification of polymer properties. This is why there has been an increased awareness of polymer blends, particularly in the last decade [10, 11]. Polymers can be blended with other polymers. The physical properties of the resulting blends would depend directly on several factors, namely the properties and the percentages of the original components, degree of compatibility and dispersion, the nature of the interaction that are utilized to produce those polymers [8].

Experimental Produce

The materials used are flame retardants and include : Zinc borate (2 ZnO.3B2O3.3.5H2O) as flame retardant, in addition to antimony trioxide (Sb2O3) with particle size (1µ), with epoxy resins and formaldehyde resin, as well as homogeneous carbon fibers of homogeneous fibers (0 ° -90 °) (1.90 g / cm3) and homogeneous woven glass fiber (0º - 90 º) with density (1.60 g / cm 3). The test samples were then prepared. The thermal erosion test samples shown in Fig. 1 have a diameter of 100 mm and a thickness of 10 mm. These samples consist of two layers: first, a flame retardant layer with thickness (12 mm) represented by zinc porates. Second, the composite material layer thickness (6 mm), containing glass fibers.

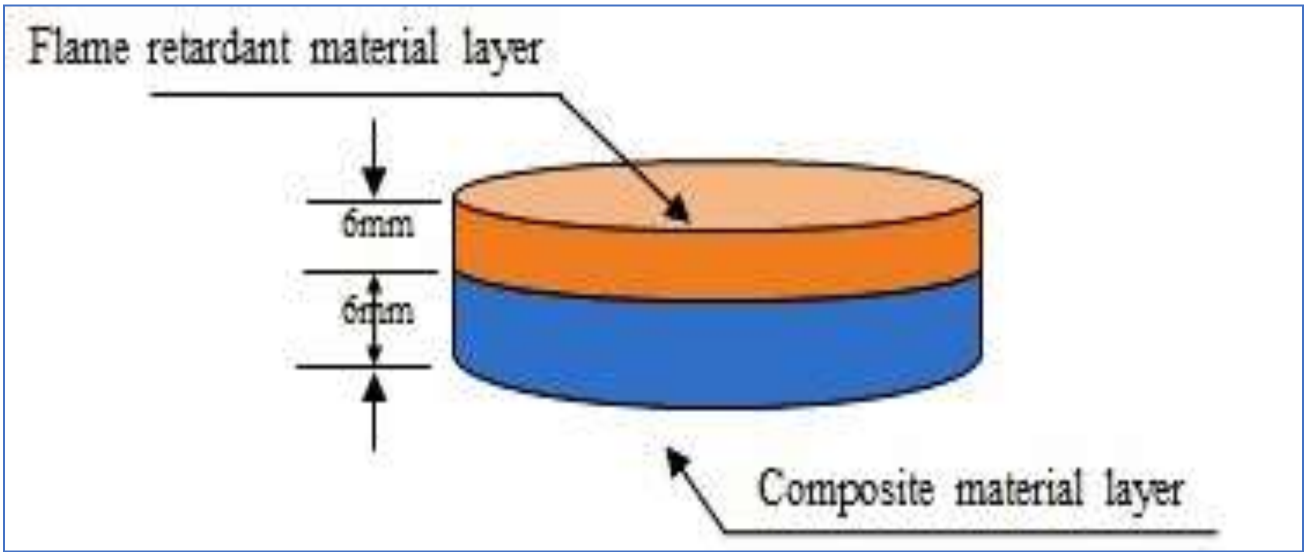

Fig. 2: Specimen of thermal erosion test

Thermal Erosion Test

Flame generated from Oxyacetylene torch with temperature (3500ºC) was used in this test. The system (contains flame retardant material and composite material) was exposed to this flame under different exposure distances (10,30mm). Surface temperature method used here to calculate the amount of heat transmitted through flame retardant material and composite material. A transformation card (AD) which called Thermal monitoring and recording system (Fig. (3) Was used to observed and saved temperatures with time (in seconds). Temperatures measured by thermocouple type-K in opposite surface. Any changed in temperatures and time will appears in computer. In thermal erosion testing the Oxyacetylene torch was used with temperature (3500 ° C). This system (which contains flame retardant and composite materials) has been exposed to this flame under different exposure distances (10, 30 mm). The surface temperature method was used to calculate the amount of heat sent through flame retardants and composite materials. Where the conversion card (AD), called the monitoring and thermal recording system, is used as shown in Figure (3) to monitor the temperatures saved with time (sec). Temperatures of the K-thermal type in the opposite surface. Any change in temperature and time will appear directly on the screen.

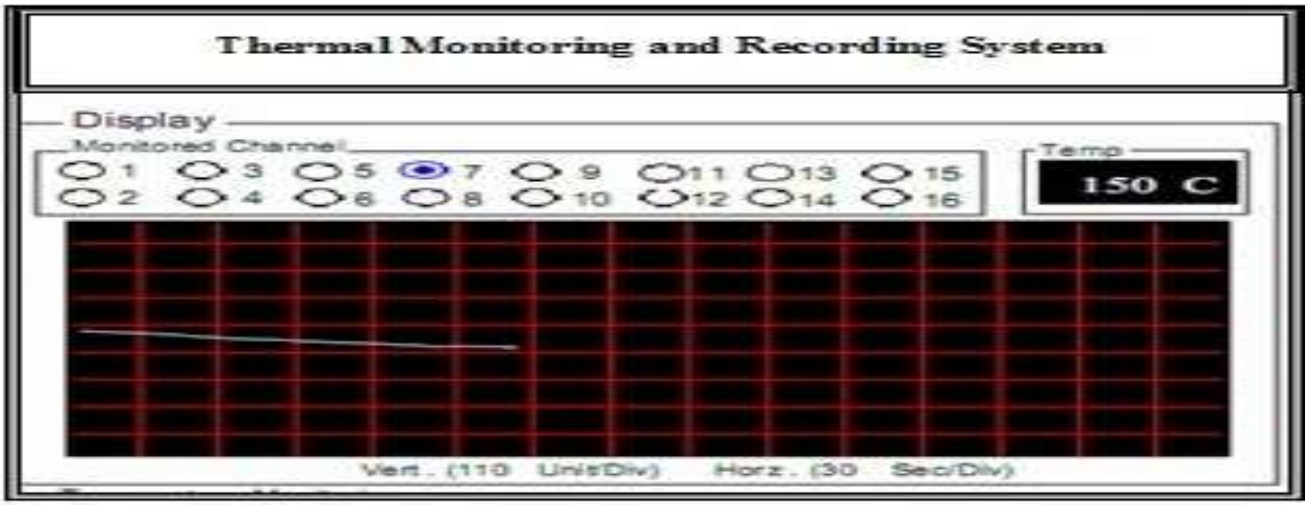

Fig. 3: Thermal monitoring and recording system

Results and Discussion

The thermocouples of polymers are weak, which are less than ceramic materials and metals, because of their polymer-like structure. Thermal capacity is generated by two mechanisms: the vibrational vibrations and characteristic vibrations that arise from the internal movements of the repeating unit. The results of the thermal corrosion test of composite materials with the inhibitory surface layer at exposed distance (10 mm) indicate that the corresponding surface temperature starts with the flame while increasing the exposure time of the flame. Thermal resistance is increased by flame retardants by adding antimony trioxide to zinc porates, where zinc surfaces with oxide increase flame resistance from separate materials.

When 15% of the antimony trioxide was added to the zinc borate, changes occurred in the internal structure of the oxide with the zinc borates, where the thermal resistance of the composite material against the flame improved. The thermal resistance is increased and the inhibitor improves with the content of the antimony trioxide with an increase to 30% (45%). The results of the thermal corrosion test of the composite materials with the surface layer indicate an open distance (20 mm), increase in flame retardation with an increase of exposed distance to 20 mm, thus increasing the time required to break the flame retardant layer, reducing gas and water reduction, (15%, 30% and 45%) of the three antimony oxide because the way this oxide works with the coating layer increases flame retardation, and the best ratio obtained from the oxide Antimony is (45%). Figure 4 shows the thermal conductivity of compound mixtures, when silica nanoparticles are added together, the thermal conductivity (k) of the samples is calculated based on the temperature obtained from the disk. A decrease in the thermal conductivity values is observed by increasing the fiber size fraction due to the nature of the thermally insulated fibers.

For example, the transfer of elastic waves (photons) through the base material and the hard part of the fiber through the movement of vibration of atoms and the effect of covalent bonds, when the photons reach a part of the sun irrigation Of fiber. Photons suffer from blockage due to the different structural structure of this medium (because it contains atoms and bonds different from the previous medium). It also contains atoms and bonds that are different from the previous medium, leading to a decrease in the value of thermal conductivity.

Studies indicate that the conductivity values are reduced By increasing the fracture in fiber size. The rate of reduction in the thermal conductivity values of the random samples in the fiber arrangement is greater than the samples with the specified scheme. Fiber is distributed in all directions. Depends exclusively on the type of fiber and the direction of the material [9, 10].The stratosphere affects the thermal conductivity values when the volumetric fraction is constant; reducing the thermal conductivity values and the rate of decrease depends on the nature of the fiber material for the outer layers. The samples whose outer layers are armed with glass fibers do not give high thermal conductivity. This is due to the nature of the fiberglass, because it contains in its internal structure an ionic bond as well as a covalent bond, which inhibits the movement of photons within the fiberglass. The thermal energy of polymers is transmitted by vibrations. Plastic materials are strongly influenced by temperature changes depending on the type and composition of plastic materials.

Plastic materials with linear chains are more effective because of weak interstitial forces that are easily overcome. They have a three-dimensional grid structure. And its behavior, it maintains its structure and resistance to temperature. Thermal conductivity increases with increased bonding, making it easy to move from side to side through plastic materials. The density of the bonding increases thermal conductivity, but sometimes it may reduce the addition of some particles from the density of that bonding and this leads to the formation of pores and gaps within the additives. Previous studies show that the thermal conductivity of the material is affected by the volumetric fracture, where the highest thermal conductivity value can be reached, with a 70% reinforcement rate due to the increase in the percentage of materials that contain percentage of the conductive material.

The results showed a significant reduction in the conductivity of the samples by 80% volume fracture because of the low ratio of the bonding material to the reinforcing material, leading to a decrease in the components of the sample, which depend on the density of the bond because the particles of the material are touching each other, The value of thermal conductivity depends heavily on the rate of fiber reinforcement, because fiber has a high thermal conductivity.

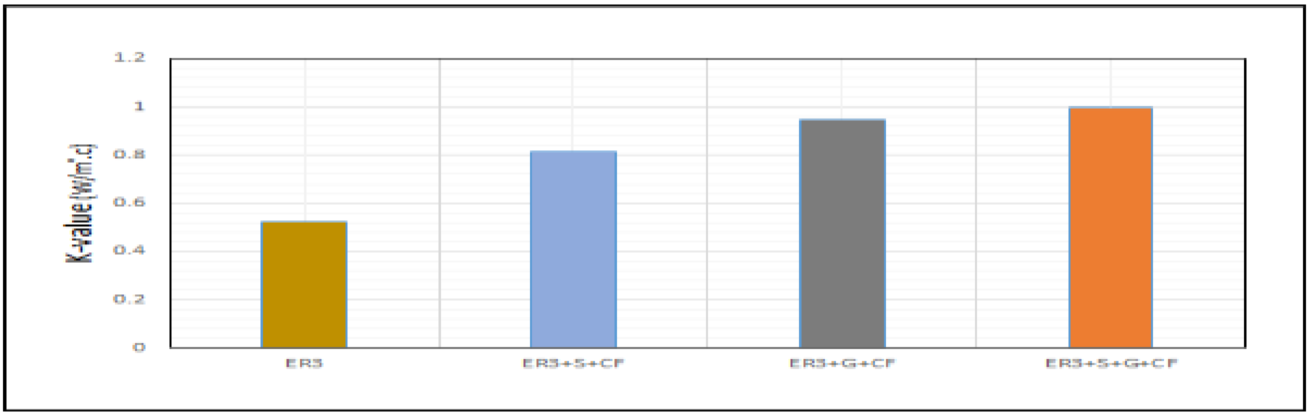

Fig. 4: Thermal conductivity of composite material

Conclusions

- Improving flame retardants for epoxy resin and phenol formaldehyde with zinc-added borates as an inhibitory layer
- Increased flame retardation when the addition of antimony trioxide to zinc porates at different rates and the formation of inhibitory material for the hybrid.
- Increase resistance to the spread of flame with increased distance exposed.
- Increase flame retardation with low flame temperature.

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