

INCREASING FLAMMABILITY RESISTANCE FOR AIRCRAFTS TIRES BY USING MAGNESIUM HYDROXIDE

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ABSTRACT

Aircraft tire must withstand a wide range of operational conditions. When on the ground, it must support the weight of the aircraft. During taxi, it must provide a stable cushioned ride while resisting heat generation, abrasion and wear. When aircraft down, the tire may be fired because of high friction with the ground. So to protect aircraft tires from fires, magnesium hydroxide was used in various quantities (10%, 20%, 30%) as a flame retardant to enhance flame retardancy for tire material. Magnesium hydroxide was added to a master batch of tire and then exposed the resulting material to a direct flame generated from a gas flame (2000°C) with a flame exposure distance of 10 mm, and the range of tire resistance to the flame and the range protected by hydroxide addition was studied. The method of measuring the surface temperature opposite to the flame was used to determine the heat transferred through the tire material. The results obtained from the thermal erosion test show improved flammability resistance for tires by adding magnesium hydroxide, and this resistance increased with increasing hydroxide percentage.

Keywords: Flammability Resistance, Magnesium Hydroxide, Aircrafts Tires.

INTRODUCTION

An ideal flame retardant polymer system should have high resistance to ignition and flame propagation, a low rate of combustion, a low rate and amount of smoke generation, low combustibility and toxicity of combustion gases, no change in flammability during use, performance of the base material should be fairly close to the original and that there not be a difference in appearance, and that the economic penalty be acceptable.

Since plastics and rubber are synthetic organic materials with carbon and often high hydrogen contents, they are combustible. The objective in flame retarding polymers is to increase ignition resistance and reduce rate of flame spread (Horrocks, Price, 2008). One way to better protect combustible materials against initiating fires is the use of flame retardants, which are substances that can be chemically inserted into the polymer molecule or be physically blended in polymers after polymerization to suppress, reduce, delay or modify the propagation of a flame through plastic materials (Levchik, 2007).

Inorganic flame retardants don't evaporate under the influence of heat; rather they decompose, giving off non-flammable gases like water, carbon dioxide, sulphur dioxide, hydrogen chloride, etc. mostly endothermic reaction. In the gas phase, these act by diluting the mixture of flammable gases and by shielding the surface of the polymer against oxygen attack (Lomakin, Zaikov, 2003).

The inorganic flame retardants act simultaneously on the surface of the solid phase by cooling the polymer via endothermic breakdown process and reducing the formation of pyrolysis products. In addition, as in the case of inorganic boron compounds, a glassy protective layer can form on the substrate, fending off the effect of oxygen and heat. As an example of inorganic flame retardants is

magnesium hydroxide, zinc borate, aluminum hydroxide, and antimony oxides (Al-Mosawi *et al.*, 2012).

Magnesium hydroxide ($Mg(OH)_2$), is a white powder, very slightly soluble in water. It is used as a flame retardant and smoke suppressant for plastics, synthetic rubber, reinforced polyesters, phenolics, and urethane foam. Magnesium hydroxide releases its 31% water when heated to above $(325^\circ C)$, which cools the product below flash point to reduce fire occurrence (Matthew, Mark, 2000). The gaseous water phase is believed to envelop the flame, thereby excluding oxygen and diluting flammable gases. Similar to the function of char formed by phosphorous-containing flame retardants, a heat insulating material may form on the surface of the plastic in contact with the flame, reducing the flow of potentially flammable decomposition products to the gas phase where combustion occurs (Stark *et al.*, 2010).

EXPERIMENTAL WORK

Master Batch

There are eight types of materials employed in this study:

1. Natural Rubber (NR): basic of batch.
2. Zinc Oxide (ZnO): activator material.
3. Stearic Acid (St.A): activator material.
4. Carbon Black (N-330): Reinforcing material.
5. Sulfur (S): Vulcanization material.
6. MBS: Accelerating material.
7. DPPD: Anti oxidation and ozone material and thermal stabilizer.
8. Resorcinol Formaldehyde Resin (RFR): Increasing adhesive, creep and fatigue and Intumescent resistance, and thermal stabilizer.

The weight percentages of materials in master batch are shown in Table .1.

Table 1. Weight percentages of materials in master batch (Al-Maamori, Auda, 2009)

Material	NR	ZnO	St.A	(N-330)	S	MBS	DPPD	RFR
pphr	100	5	2	35	2.25	1.2	1	1

Magnesium Hydroxide

It was used as a particle (3μ) in size. This material was supplied from (C-Tech Corporation). Magnesium hydroxide was added to master batch with (10%, 20%, 30%) weight percentages.

Preparation of Test Specimens

Specimens of thermal erosion test are a square shape with dimensions $(100 \times 100mm)$, and $(10mm)$ thickness. All compounds of master batch and magnesium hydroxide were mixed in open mill working at $(70^\circ C)$. This mixture result was press in square die with the same dimensions of thermal erosion specimens by a hot press working at $(40 atm)$ pressure and $(170^\circ C)$ which found in company of tires industry –Babel.

Thermal Erosion Test

Flame generated from butane-propane gas ($C_3H_8-C_4H_{10}$) with temperature $(2000^\circ C)$ was used in this test. The system (contains flame retardant material and composite material) was exposed to this flame under exposure distance $(10 mm)$. surface temperature method used here to calculate the amount of heat transmitted through flame retardant material and composite material. Temperature monitoring and recording system (see Fig.1) was used to observed and saved temperatures measured by thermocouple type -K by entering it in computers by transformation card (AD).

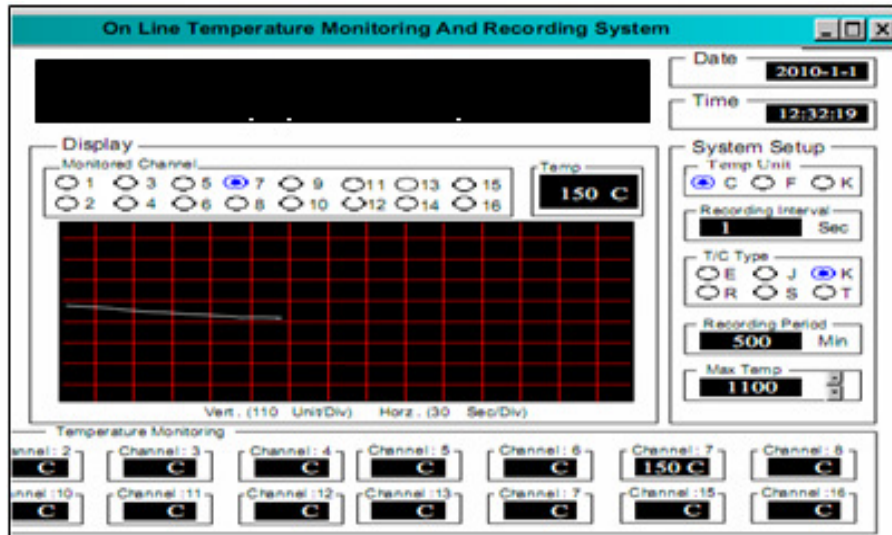


Figure 1. Thermal monitoring and recording system

RESULTS AND DISCUSSION

Figure 2 represents Parentages of magnesium hydroxide addition to aircraft tires .Curve.1 represents the thermal erosion test tire material with (10%) magnesium hydroxide, the temperature of the opposite surface to the torch begins to increase with increasing exposition time to the flame . During this stage, magnesium hydroxide has a water of hydration in its chemical structure, therefore, it released this water to extinguish the fire through cooling, in addition, magnesium hydroxide will formed char layer which protecting the substrate and the fire spread will decrease.

Curve.2 represents the thermal erosion test for tire material with (20%) magnesium hydroxide. As a result, when the magnesium hydroxide increased to (20%), the time necessary to break down of tire material increase and the combustion gaseous will reduced and there will be a less rubber to burn due to water of hydration and protected char layer comes from this hydroxide, and this protection will improves with addition (30%) from magnesium hydroxide as shown in Curve.3, because the mode action of this hydroxide with char layer increasing flame retardancy. All that will rise the time of break down for zinc borate- antimony trioxide layer and substrate composite material. From figurers, the better results obtained with large percentage from magnesium hydroxide (30%).

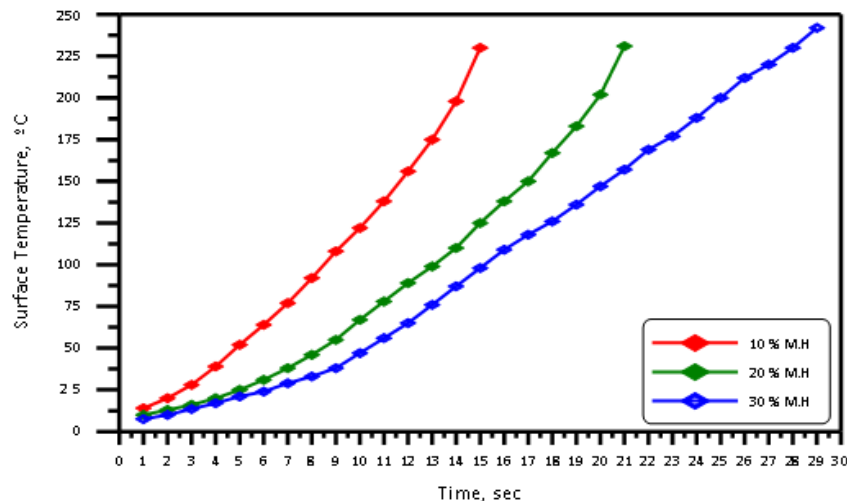


Figure 2. Parentages of magnesium hydroxide addition to aircraft tires

CONCLUSIONS

From this study, we concluded that improvement flame retardancy for aircraft tires with added magnesium hydroxide as a retardant material. The resistance to flame spread will increase with increasing of magnesium hydroxide addition and the optimum magnesium hydroxide percentage was (30%).

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