The Study of Different Type of Fibers for Using as the Ablative Materials

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***Abstract*—Ablative composite materials are required for using in solid motor rocket nozzles and follow on long range ballistic rockets which are multi-component mixture of resins, fibers and fillers. To increase the ablation resistance efficiency, the ratio of percent of materials were studied by using Oxyacetylene ablation testing which shown the result in burning time of the flame passing through the sample. The radiographic images were also captured to study the void of the laminate samples from compression molding process. The lowest ablation rate of this study shown that the 60 percent fiber glass which adhered with the 40 percent resin gave the best results.**

Keywords—Ablative material; Resin; Rocket; Fiber glass; Ablation.

I. INTRODUCTION

The thermal, chemical, and mechanical environments produced by high performance solid propellants introduce many materials problems in the development of rocket nozzles. The temperatures of the rocket flame can be over 5000 ºF to 6400º F [1-8]. The material which will choose to be insulate the surface of rockets should be also high temperature resistance. Nowaday, reinforced phenolic composites have been extensively used as ablation materials [6] which are the mixture of resins [7-8], fibers [9-15], and fillers [1]. However, there still need to improve their ablation resistance.

Fiber Glass is the most common type of insulation [6]. It has excellent heat resistance at relatively low cost such as the type E fiberglass will not burn and will withstand continuous exposure to temperatures of 1000°F or 520°C. Because of these performance, it is used to protect many equipment for providing thermal insulation and personnel protection.

Carbon fiber-reinforced phenolic resins are particularly effective in resisting high temperatures, since the resin evaporates and burns at the surface creating a thermal protective layer [16-19] but there are expensive and the result in high heat conductance are excessively used in production.

In this study, we improved the ablation resistance efficiency by using the different ratio of fibers and phenolic resin and also observed the results of ablation rate from different ratio in the combination between fiber glass and carbon fiber.

II. MATERIALS AND METHOD

A. Materials

E-type woven roving Fiber Glass and Carbon Fiber were selected from commercial available product. The Phenol formaldehyde resins (PF) or thermosetting phenolic resins with density 1.250 – 1.330 g/cm^3 were purchased from Thai GCI Resitop Co.,Ltd., Thailand.

B. Sample Preparation Processes

The laminate samples were prepared by immerging the 11 cm x 11 cm fiber sheets into the chamber of the resin. After this step, the hand lay-up technique was used to reduce the excess of resin at ratio of 70: 30 and 60:40 (Fiber:Resin). The ratio of Fiber Glass combined with Carbon fiber (FC) were studied in different ratio of 70:30 and 30:70 (Fiber Glass: Carbon fiber) as shown in Figure 1. The impregnated fiber sheets were pre-cured in drying oven for 2 hours at 90°C for removing the solvent of the resin. Then the fiber sheets were stacked and compressed in the compression molding machine with pressure at 90 bar, 175 °C for 30 minutes as shown in Figure 2. The laminate samples were then post-cured in drying oven at 175 °C for 15 hours.

C. Measurements

The ablative property testing were conducted on an oxyacetylene ablation tester in accordance with ASTM E285-80 standard. The radiographic were used to detect the void in the laminate samples.

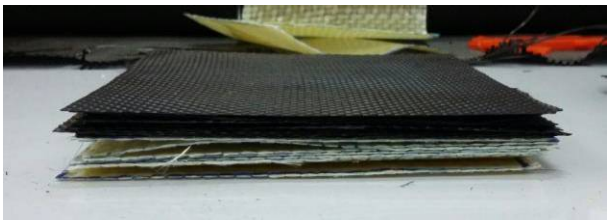

Fig.1. Prepared laminate sample from Fiber Glass and Carbon fiber (FC) at ratio 70:30.