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Technical Report

Slurry erosion behaviors of basalt filled low density polyethylene composites

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ABSTRACT

In this study, slurry erosion behaviors of basalt filled low density polyethylene composites were investigated. Pure low density polyethylene and four different compositions of the composites 10 wt.%, 30 wt.%, 50 wt.% and 70 wt.% basalt were used in the study. Slurry wear, tensile strain, hardness and fracture toughness tests were performed on the samples. Samples turns in the abraded slurry media including 50 wt.% Al_2O_3 with nominal particle size of 500 μm and the erosion tests of pure low density polyethylene and basalt filled composites were performed at the contact angles of 15°, 30°, 45°, 60°, 75° and 90° for 30 min. in 3 periods at 500 rpm turning speed (1 m/s speed). It was observed that erosion rate have no effect up to 30 wt.% basalt content. Wear resistance of the composites including over 30 wt.% basalt were micro structural examination of the worn samples showed that the basalt particles on the worn surface can be sustained by matrix. Basalt particles were worn more slowly than that of the matrix. The more the basalt content in the basalt filled low density polyethylene resulted to the lower the tensile strength, tensile strain and fracture toughness, and the higher the hardness. The slurry erosion rate of the basalt filled low density polyethylene composites was getting sharply increase above 30 wt.% basalt content above 60° contact angle.

1. Introduction

The loss of materials due to erosive wear is a serious problem in gas turbines, pumps, heat exchangers and piping systems in aircrafts and other applications [1]. Erosion is a process of material damage caused by hard particles striking the surface, either carried by a gas stream or entrained in a flowing liquid. Mechanisms of material removal differ for ductile and brittle materials. For ductile materials, the main mechanism is severe localized plastic strain at the contact site exceeding the material strain to failure. For brittle materials, the contacting particles typically cause localized cracking on the surface. For particle reinforced composites, mass loss due to solid particle erosion quite depends on intrinsic micro structural features [2,3].

Slurry erosion is caused by the interaction of solid particles suspended in a liquid and surface of the material. In the slurry erosion, there is a mass loss on the material surface by the repeated contacts of particles. It is one of the main sources of failure of several slurry equipment and hydraulic components used in many industrial applications [4]. The slurry erosion is a complex phenomenon and it is not yet fully understood because it is influenced by many factors. These factors include flow field parameters, target material properties and erodent particle characteristics. Among these parameters, the impingement angle and microstructure of the target material play an important role on the material removal process [5–7]. The effect of impingement angle on slurry erosion behavior for ductile and brittle materials has been studied widely [8–10].

Lopez et al. [11] studied the erosion mechanisms of the samples submitted to liquid impingement and erosion condition effects of contact velocity, mean contact angle and particle addition to the flow. The wear characteristics of materials in slurry environments have been studied by Prasad [12]. Erosive wear of materials encountered in flowing slurry is a very complex process that can be affected by many factors including the properties of slurry, target material, wear mode (e.g. sliding and contact), the velocity and contact angle of solid particles/slurry. Slurry erosion by the contact of liquid-carrying solid particles reduces the life of mechanical components used in many industrial applications and is one of the main sources of failure of impellers, valves, turbine blades, slurry pumps and pipes conveying solid particles and used in power plants and oilfield mechanical equipment [13–15].

Previous study realized by Yabuki et al. [16] revealed that, erosive wear behavior of pipes and fittings of systems such as household sewerage, storm drains in cities produced with low density polyethylene, linear low density polyethylene, middle density polyethylene, high density polyethylene, polyethylene 100, cross-linked high density polyethylene, ultra high density molecular weight polyethylene, polyvinylchloride, phenol formaldehyde, glass fiber reinforced polymer. To cope with these problems, it would be desirable to replace the more traditional iron and steel

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