ABRASION FAILURE OF LINING RUBBER ON AGITATOR BLADES IN THE LEACHING CIRCUIT OF MINERAL PROCESSING INDUSTRIES

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Dedicated To My Parents
I hereby declare that this submission is, to the best of my knowledge and belief, original, except as acknowledged in the text. I also state that the material contained herein has not been previously submitted, either in whole or in part, for a degree at Central Queensland University, or any other institution.

A.K.M/ Shamsul Huda Akan
Abstract

The failure of agitator blades was an issue of major concern in the leaching circuit of the Australian Magnesium Corporation (AMC) pilot plant in Gladstone. The aim of this project was to investigate the causes of the failure of the agitator blades and to make some recommendations to help avoid the problem in the future. At the start of this thesis, a comprehensive failure analysis was carried out in order to understand the potential failure mechanisms operating in the slurry tanks. A number of potential failure mechanisms were identified and these included erosive slurry wear of the rubber and chemical and/or thermal degradation of the rubber. These failure mechanisms may also act synergistically. An experimental programme of research was planned to investigate the separate influences of slurry wear and chemical and/or thermal degradation of the rubber. The results of these tests were then used to extend our understanding of the failure of the agitator blades.

A slurry erosion test has been developed in order to quantify the erosion of bromobutyl rubber. The study investigated the effects of particle size, erosion time, slurry weight concentration and specimen velocity. Wear was measured using surface roughness measurements and scanning electron microscopy (SEM) of the worn surfaces. The degree of wear was found to increase with increased particle size, slurry weight concentration and erosion time and the wear appear to be at a maximum at a nominal angle of impact of the particles of approximately 40°. Wear appeared to decrease with increasing slurry velocities, but this may have been due to changes in particle shape. One of the key factors in the development of damage on the surface of the rubber was found to be wear of the abrading particles and the condition of the abrading particles needs to be taken into account when interpreting the results of slurry wear tests. In general the experimental results were found to be in good agreement with the predictions from the literature and a model has been developed in order to obtain a better understanding of slurry erosion.

In addition to the slurry wear tests, the chemical degradation behaviour of bromobutyl rubber was investigated by measuring hardness (shore A) and surface morphology of the rubber after exposure of the rubber to acid and water at 70°C. In acid,
the rubber hardness increased with time and whereas in water alone, the rubber hardness decreased. This indicated that the acid immersion had a hardening effect on the rubber and this may have played some part in the failure.

From this work, it is apparent that both slurry wear and exposure to acid and/or temperature have an effect on the degradation of the rubber. Particle size and shape had a major effect on damage accumulation rates, with most damage occurring with large, sharp particles. For tests where the particle size was below 3.35 mm the damage accumulation rate was insignificant. Morphological studies of the worn surfaces suggest that a major mechanism of damage was the formation of cracks which penetrated the rubber and exposed the underlying steel agitator blades to the acidic environment. Hardening of the rubber by exposure to the acid solution would have decreased the resilience of the rubber and may have increased the effect of the slurry wear on crack formation, but at this stage the coupled effects of slurry wear and chemical/thermal degradation have not been explored.
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