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Remediation of acid mine drainage using metallurgical slags

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ABSTRACT

This research focuses on the remediation of Acid Mine Drainage (AMD) using metallurgical slags. Slag leach beds are a promising low cost and low maintenance technology for the remediation of AMD compared to potentially expensive and maintain once intensive conventional active methods that entail addition of chemicals to treat AMD. Slags are highly alkaline in nature hence they neutralise acidic water; this in turn leads to reduction of iron and sulphate concentration due to formation of iron precipitates and gypsum at higher pH values. Laboratory experiments were carried out to investigate the possibility of reducing acid, iron and sulphate concentration from synthetic AMD using two types of slag namely the basic oxygen furnace and stainless steel slag. These experiments include ratio tests, contact time tests and continuous flow studies.

Experiments were performed to determine the optimum slag to AMD ratios that would result in maximum pH increase as well as maximum iron and sulphate reduction. These experiments were carried out by varying the amount of slag in use per 1L of AMD for a given period of time. The ratio tests showed that the amount of iron and sulphate removed as well reduction of acidity increased with an increase in the slag to AMD ratio with both slags used. This was an indication that chemical reaction and precipitation was taking place. It was found that 100 g/L of slag: AMD was the optimum ratio. At that ratio a resultant pH of 12.31, 99.7% iron reduction and 75.0% sulphate reduction was achieved.

The reduction of acid, iron and sulphate concentration was rapid in the first hour of mixing slag and AMD in processes carried out to investigate the effect of contact time. It was discovered that reduction gradually decreased with time for all experiments under investigation. The continuous flow studies showed that slags were also capable of reducing acid, iron and sulphate concentration from synthetic AMD in a continuously flowing process. The data collected showed that iron was removed from 1000 mg/L to undetectable concentration while sulphate was reduced from 5000 mg/L to 743 mg/L, which translated to 85.1% decrease for a residence time of 2.0 hours. For a residence of 2.53 hours, sulphate was reduced from 5000 mg/L to 693 mg/L which translated to 86.1% decrease. The pH was also increased from 2.25 to 13.21. The Department of Water Affairs and Forestry (DWAF) standards stipulate that wastewater must have iron concentration less than 0.30 mg/L and

sulphate concentration less than 400 mg/L. The results show that iron was reduced below the DWAF general limit for wastewater while sulphate was still above that limit. A graph was also created to predict the amount of slag required to treat different AMD flowrates for different residence times and target concentrations of iron and sulphate.

The results obtained, it was shown that slags are a viable option to treating AMD. The results also revealed that basic oxygen furnace slag was better than stainless steel slag for reducing acidity, iron and sulphate concentration. Slags were able to bring about high pH values necessary for formation of iron precipitates as depicted by the Pourbaix diagram for the iron-sulphate- water system. This therefore ensured that soluble iron was removed from water in the form of various insoluble compounds. The results therefore indicate that metallurgical slags are well suited for increasing pH values of AMD and reducing iron.