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Treatment of Abandoned Coal Mine Discharged Waters Using Lime Wastes

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ABSTRACT

In Korea, hundreds of abandoned and closed coal and metallic mines are present in the steep mountain valleys due to the depression of the mining industry since the late 1980s. From these mines, enormous amounts of coal waste were dumped on the slopes, which causes sedimentation and acid mine drainage (AMD) to be discharged directly into streams causing detrimental effects on soil and water environments. A limestone slurry by-product (lime cake) is produced from the Solvay process in manufacturing soda ash. It has very fine particles, low hydraulic conductivities (10^{-8} ~ 10^{-9} cm/sec), high pH, high EC due to the presence of CaO, MgO and $CaCl_2$ as major components, and traces of heavy metals. Due to these properties, it has potential to be used as a neutralizer for acid-producing materials. A field plot experiment was used to test the application of lime cake for reclaiming coal wastes. Each plot was 20 x 5 m (L x W) in size on a 56% slope. Treatments included a control (waste only), calcite ($CaCO_3$), and lime cake. The lime requirement (LR) for the coal waste to pH 7.0 was determined and treatments consisted of adding 100%, 50%, and 25% of the LR. The lime cake and calcite were also applied in either a layer between the coal waste and topsoil or mixed into the topsoil and coal waste. Each plot was hydroseeded with grasses and planted with trees. In each plot, surface runoff and subsurface water were collected. The lime cake treatments increased the pH of coal waste from 3.5 to 6, and neutralized the pH of the runoff and leachate of the coal waste from 4.3 to 6.7.

Additional Key Words: abandoned mine land, acid mine drainage, runoff, revegetation, water quality

Introduction

In Korea, over 300 coal mines have been closed or abandoned due to the depression of the mining industry since the late 1980s (Coal Industry Promotion Board, 2000). Many of them are located in steep mountain valleys and the enormous amounts of coal mine waste

have been abandoned on slopes and acid mine drainage (AMD) from either portals or waste piles have been discharging directly to streams, causing detrimental effects on soil and water qualities. The environmental disruptions caused by the closed mines are very serious in Korea.

Materials and Methods

Ten treatments were installed on a large, abandoned coal waste pile to test the application of the lime cake for reclamation of these piles. The slope of the coal waste site was 29.2° (56%). Each plot was 20 x 5 m (L x W) in size (Figure 1) and was separated by plastic boundaries. Treatments include the control (coal waste alone), calcite ($CaCO_3$) as a reference, and lime cake (Table 1). The lime requirement (LR) for the coal waste to pH 7.0 was determined by titration to determine the amount of lime cake application. Lime cake treatments consisted of 25%, 50% and 100% of the LR (as $CaCO_3$).

Results and Discussion

Chemical Properties of the Coal Waste, Lime Cake and Topsoil

The pH of coal waste was 3.5 and about 17 Mg of $CaCO_3$ per ha were needed to adjust the pH to 7.0. The lime cake was high in bases such as Ca, Mg and Na with a high pH (11.2) and high electrical conductivity (EC: 19.6 dS m^{-1}). The topsoil was obtained from the road cut and was low in fertility.

Summary

Field plots were used to test the effects of the lime cake on the reclamation of coal wastes by examining the chemical qualities soil and water (runoff and leachate) and surface cover of grasses. Lime cake treatments increased the pH of the coal waste from 3.5 to 6, and raised the pH of runoff and leachate from coal waste from 4.3 to 6.7. Concentrations

of sulfate, Al and Fe in the runoff and leachate were significantly decreased with lime cake. Surface cover by orchard grass, Kentucky bluegrass, and Eulalia on coal waste was significantly increased with the lime cake. The amount of lime cake at 25% of the lime requirement was sufficient to neutralize the acidic coal waste and allowing germination of grasses. Either layering the lime cake between the coal waste and topsoil or mixing with coal waste could be adopted as reclamation methods. The combined treatment of lime cake and topsoil is recommended for revegetation in the coal waste piles. Results demonstrated that the lime cake from soda ash production has good potential for reclaiming abandoned coal waste piles and to alleviate the environmental problems associated poor soil and water quality from coal wastes.