

## AERATION EFFICIENCY OF THE IN-LINE AERATION AND NEUTRALIZATION SYSTEM

Ackman, T. E. (1) and Hustwit, C. C. (2). ((1) Mining Engineer, U.S. Department of the Interior, Bureau of Mines, Pittsburgh Research Center and (2) Project Engineer, Boeing Services International). Acid mine drainage treatment typically involves the removal of soluble metals by neutralization, oxidation, and precipitation. The chemical reactions are frequently limited by the availability of dissolved oxygen. For this reason a study was conducted in the laboratory to establish the aeration efficiency of the In-Line Aeration and Neutralization System (ILS). This patented treatment system, developed by the Bureau of Mines, treats mine discharge in a pipeline and involves no moving parts. It consists of two components: a jet pump and a static mixer. Testing procedures were performed in accordance with the American Society of Civil Engineers (A Standard for the Measurement of Oxygen Transfer in Clean Water). The standard requires deoxygenation of a tank of clean water before aeration. The dissolved oxygen concentration in the water is measured over time as it is continuously pumped through the ILS until saturation is achieved. Corrections are made for ambient water temperature and barometric pressure. A total of twenty-eight tests were conducted using two different jet pumps and seven types of static mixers. Each combination of jet pump and static mixer was tested at two operating pressures: 20 psig and 50 psig. The results indicated that there were significant differences in aeration efficiency based principally on the water pressure. All systems transferred more oxygen when operated at 50 psig. Differences between the two jet pumps and four of the mixers do not appear to be significant. The Standard Oxygen Transfer Rates (SOTR) for the best jet pump/static mixer combinations are comparable to those cited by manufacturers of mechanical type aerators.

Additional Key Words: oxidation, aeration, sulfite, water treatment, acid mine drainage.

## TREATMENT OF ACIDIC COAL REFUSE BY ADDITION OF CRUSHED-STONE POND SCREENINGS

Stokowski, S. J., Jr. (1) and Gilbert, R. R. (2). ((1) Consulting Geologist, Ashland, MA and (2) Civil Engineer, Adger, AL). Acidic refuse from Warrior Basin (AL) coal was treated with carbonate-rock, crushed-stone pond screenings, resulting in an improvement in the pH from 2.9 to 6.6.  $\text{Fe}(\text{OH})_3$  (yellowboy) formed on the treated waste and in ditches. Consequently, the pH of the runoff water improved from a range of 2.2-2.6 to a range of 4.4-6.2. Aqueous Ca and Mg concentrations and specific conductivity also increased. The water color changed from red to blue-green, possibly due to the iron oxidation state. The improvements have persisted for over 2 years from a single application of 54 tons/acre. The treatment process consisted of: 1) grading and ditching the refuse, 2) dumping the pond screenings and spreading with a bulldozer, 3) discing the material into the upper 6 inches of refuse, and 4) monitoring pH and other chemical variables in the refuse and surface-water runoff. After a few months of stable, near neutral pH conditions, grass was planted and is still vigorous. The refuse is waste material from the processing of coal, and is 6 inches and finer in size. It consists of shale that often contains marcasite, shale interbedded with coal and nodules or iron-pyrites with attached coal. The surface of the pile readily weathers into an impermeable, fine-grained layer. The pond screenings used are a byproduct of limestone/dolomite aggregate (Knox Group, AL) washed for concrete and other uses. They are especially finely graded (98% passing #50 sieve, 87% passing #200 sieve, 80% passing #325 sieve) because coarser fractions are removed by hydrocyclone for use in other products. The finest fractions are discharged to a sedimentation pond and recovered by dragline. Stockpiling and free drainage reduces the moisture content to acceptable levels. The fine gradation and chemical composition (79%  $\text{CaCO}_3$ , 14%  $\text{MgCO}_3$ ) make the product an efficient neutralizer of coal mine acids.

Additional Key Words: reclamation, limestone, dolomite.

## X-RAY DIFFRACTION EVALUATION OF COAL OVERBURDEN NEUTRALIZATION POTENTIAL

Despard, T. L. (Geologist, Office of Surface Mining Reclamation and Enforcement, Knoxville, TN). The Federal Regulations established to implement the Surface Mining Control and Reclamation Act of 1977 (SMCRA) require the identification of acid/toxic overburden strata and coal and the determination of the potential for such materials to adversely impact ground- and surface-water resources. The net acid-base account method is widely used to determine the acid/toxic potential of coal-bearing strata. This method is unreliable when applied to noncalcareous rocks because in these, the analytically determined neutralization potential is primarily due to silicate minerals, which react slowly with acid generated from pyrite oxidation. Leach testing has been used as an alternative to the net acid-base account method as a predictor of acid-mine drainage production; however, these tests are expensive and time-consuming. Determining the carbonate mineralogy of overburden strata, in conjunction with the net acid-base account, can greatly assist in predicting the effectiveness of the measured neutralization potential. X-ray diffraction (XRD) analysis can determine carbonate mineralogy both on a qualitative and semiquantitative basis, and the analyses can be accomplished rapidly. For the carbonates, calcite, dolomite, magnesite, and siderite, the required scan range is only from approximately  $20^\circ 2\theta$  to  $33^\circ 2\theta$ , and can be accomplished in minutes. Computer routines are available that can compute the percentage of calcite, dolomite, magnesite, and siderite in rock samples and can be expanded to include other mineral species if desired. These routines are derived from the generalized basic equation of X-ray quantitative analysis:

$$I_i = \sum_j c_{ij} x_j \quad i = 1, 2, \dots, m, \quad \text{where } c_{ij} = K_{ij} / \rho_j \mu T^*$$

Additional Key Words: overburden mineralogy, AMD prediction, acid-base accounting, carbonates.

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