Success I - 8 Case Study an Improving the Quality of Gob Pile Leachate

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The Bituminous Coal industry is losing profit dollars due to the excessive financial liabilities associated with the treatment of Acid Mine Drainage (AMD). Traditional AMD treatment methods focus on the neutralization and precipitation of the highly acidic, heavy metal laden conditions found in raw leachate. The operational cost savings capability of applying surfactant ameliorants to the source of the problem of AMD has been demonstrated by Andesco Technologies.

INTRODUCTION

Acid mine drainage is produced as a result of the oxidation and hydrolysis of iron-disulfide minerals, forming sulfuric acid and releasing soluble metals such as iron, manganese, and aluminum. Refuse materials, separated from saleable coal in the cleaning process, contain high levels of this iron and sulfur complex generally referred to as pyrite. The disposal of refuse into permitted fill areas, or gob piles, is common practice throughout the mining industry. Gob piles are designed and constructed to promote positive drainage in a single direction allowing for the collection of surface runoff and area leachate. These waters must undergo neutralization ' aeration, and settling to remove inorganic pollution prior to being released into natural waterways. Costs of complying with State and Federal regulations using traditional treatment methods impose a substantial financial liability on the mining industry.

Research[l,2] has shown that the action of the iron oxidizing bacterium *Thiobacillus ferrooxidans* significantly increases the acidity and heavy metal content of AMD. In AMD reaction chemistry, pyrite undergoes both atmospheric and biotic oxidation (Table 1, reaction A & reaction 6). As acidity increases, lowering the pH, abiotic oxidation slows and T *ferrooxidans* begins oxidizing the available ferrous iron to ferric iron (Table 1, reaction C). Eliminating the bacterium at this point will reduce the formation of ferric iron, which once formed, assumes a role as the primary oxidizer of pyrite with a net result being dramatic increases in acidity and iron (Table 1, reaction D).

Table 1. - AMD Chemical Reactions.

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A. $FeS_2 + 7/2\ O_2 + H_2O = Fe^{2+} + 2SO_4^{2-} + 2H^+$

B. $Fe^{2+} + 5/2\ H_2O + 1/4\ O_2 = Fe(OH)_3 + 2H^+$

C. $Fe^{2+} + 1/4\ O_2 + H^+ = Fe^{3+} + 1/2\ H_2O$

D. $FeS_2 + 14\ Fe^{3+} + 8H_2O = 15\ Fe^{2+} + 2SO_4^{2-} + 16H^+$

R.P. Kleinmann[3] has demonstrated the inhibiting effect anionic surfactants have on the activity of T *ferrooxidans* Anionic surfactants disrupt the cell wall of the organism, allowing acidity seepage into the cell which causes lysis of the bacterium. Andesco Technologies, Inc. developed the ANTEC AMD Abatement Program in response to the mining industry need for reduced water treatment costs. The ANTEC program utilizes nontoxic, biodegradable surfactants to reduce the biotic oxidation of pyrite by T *ferrooxidans* and reduce water treatment costs. This report discusses the results obtained from a treatment program on a 10 acre inactive gob pile.

SITE CONDITIONS

The site selected for study is located in Somerset County, Pennsylvania. It is an inactive gob pile measuring 437,500 ft^2 (1250 feet long by 350 feet wide) with a depth or approximately 40 feet. The area Is built from cleanings from the Brookville and Upper Freeport coal seams. The refuse area has exhibited a history of very poor quality drainage, Total acidity concentrations nave averaged 12,000 mg/L CaC03 and total Iron levels have assayed an average 4,500 ppm. Flow readings have averaged 9.56 gpm. A $135,500 annual requirement for sodium hydroxide (20% solution) had been used to treat the leachate from this site. A serious sludge handling problem existed due to the under sizing of settling ponds, which required vacuum cleanout every six weeks. The cost of these measures totaled $90,000 annually. These pretreatment data are important since they serve as a baseline for comparison of the effects of the application of ANTEC 128 to this site,

PRELIMINARY ANALYSIS

A physical survey and study was required to establish the suitability of the site for treatment with ANTEC 128. Site activities began with the installation of a raw water monitoring point. The refuse area underdrain outlet served ideally for this purpose. Monthly samplings from this station were analyzed by independent certified laboratories. These data are presented in Table 2. A total of fourty kgs. of refuse were collected from scattered locations on the surface of the gob pile. These materials were required for the following three determinations.

Firstly, microbiological testing[4] was conducted to identify the presence of T *ferrooxidans* This was accomplished by culturing the leachate from sampled refuse in a 9-K media and observing an orange color change. Secondly, adsorption testing[5] was performed on the refuse to provide an indication of the dosage and application rate per acre required to provide the optimum

effect against biotic oxidation, and at the same time prevent off site contamination. Finally, a control/test column leach experiment[6] was conducted to determine the effectiveness of the ANTEC 128 treatment, the results of which indicated that reductions of 74% total acidity (fig. 1) and 79% total Iron (fig, 2) were achieved by ANTEC 125.

The results of these analyses established the nature and extent of this acid drainage problem, and Indicated that substantial Improvements would be achieved by the application of ANTEC 128.

ANTEC PROGRAM PLAN

Having established the suitability of the gob pile for treatment with ANTEC 128, a treatment plan was developed for the application of the product to the refuse area. A field team marked ten one acre sections over the refuse area. Optimum coverage was attained using a dilution ratio of 25 parts water to I part ANTEC 128, A 3,000 gallon truck mounted hydroseeder was selected for the application, with 1,375 gallons of water applying 55 gallons of ANTEC 128 to each acre of the refuse area. Chemical transfer pumps were used to load the ANTEC 128 into the hydroseeder. Raw water sampling and analysis were performed monthly. Samples would be analyzed for pH, total acidity, total Iron, total sulfate, and conductivity. Property discharges were monitored for ANTEC 126 content, the limit of detection being 0-1 ppm.

PROGRAM ACTIVITY

The initial application was conducted in November, 1984. Additional applications were made during March, June, September, and December 1985. Applications were completed within 5.5 hours, each tankload having a 45 minute loading/unloading cycle. Improvements in water quality were recorded In June 1985 with current assays for total acidity at 56% of the original levels, and total iron reduced by 55% (figs. 3, 4). Total sulfate, the primary indicator of pyrite oxidation, had been reduced by 61% (fig. 5). No detectable levels of ANTEC 128 were recorded in property discharges. Table 2 provides data from the monthly raw water site samplings.

Table 2. --Raw Water Sample Analysis.

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MONTH	TOTAL ACIDITY	TOTAL IRON	TOTAL SULFATE
September	11,540	4,320	13,300
October	11,546	4,540	14,200
November (T)	12,000	4,420	13,800
December	11,836	4,510	17,400
January	12,504	4,500	15,800
February	10,602	3,250	12,100
March (T)	10,794	3,898	12,700
April	11,184	4,040	9,810
May	11,222	3,680	9,789
June (T)	7,688	2,680	9,500
July	9,468	2,680	6,741
August	8,865	2,856	6,805
September (T)	9,075	2,981	5,104
October	8,500	2,981	8,400
November	8,546	2,900	8,700
December (T)	9,168	2,740	9,200
January	7,772	2,550	7,800
February	6,642	2,190	7,200
March	6,242	1,866	7,290

- Sampling program started in September 1984.
- (T) indicates ANTEC 128 treatment.

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WATER TREATMENT COST SAVINGS

The average daily requirement for 207, sodium hydroxide before applying ANTEC 128 to the refuse area was 1,092 gallons per day, or $ 135,500 per year. The current daily requirement has been reduced to 562.5 gallons per day, $ 69,800 annually, representing a savings of $ 65,700. Additionally, the reduced iron content of the leachate has provided an extension in the time between pond vacuum cleanouts. This major program benefit extended the 6 week utility of the sludge settling ponds to a utility of 11 weeks, and has saved $ 39,400. These savings total $105,100 in operational expenses, normally accrued for water treatment, which have been recovered through use of the ANTEC program and returned to the company as additional profit.

CONCLUSIONS

The ANTEC AMD Abatement Program effectively reduces biotic oxidation of pyrite by T *ferrooxidans*. The reductions in total acidity and total iron achieved through application of ANTEC 128 provide improvement in financial and operational areas. Expressed in terms of

coal production, where shift output is 750 tons, clean coal recovery rate is 60%, and the market price is $25.00 per ton, the $105,100 savings represents an equivalent profit from 9.34 shifts is being returned to the mining company bottom line.

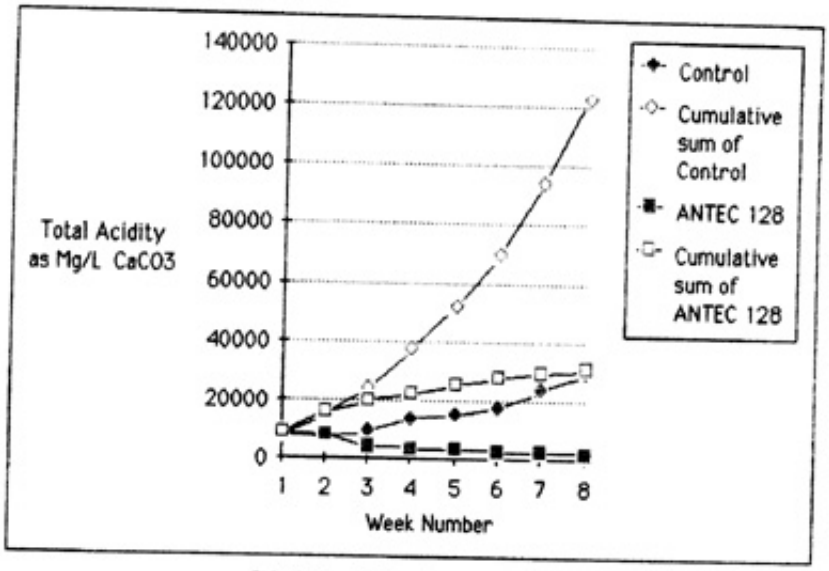

FIGURE 1. - Laboratory Acidity

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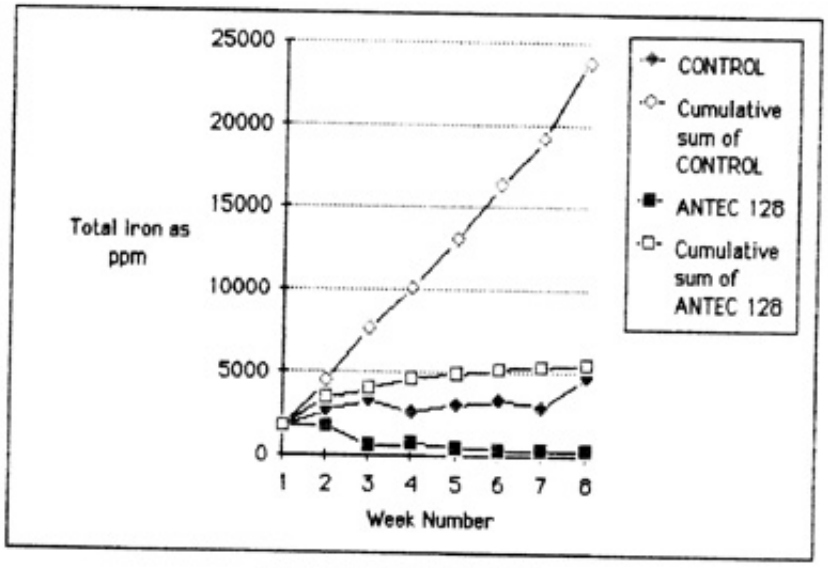

FIGURE 2. - Laboratory Iron

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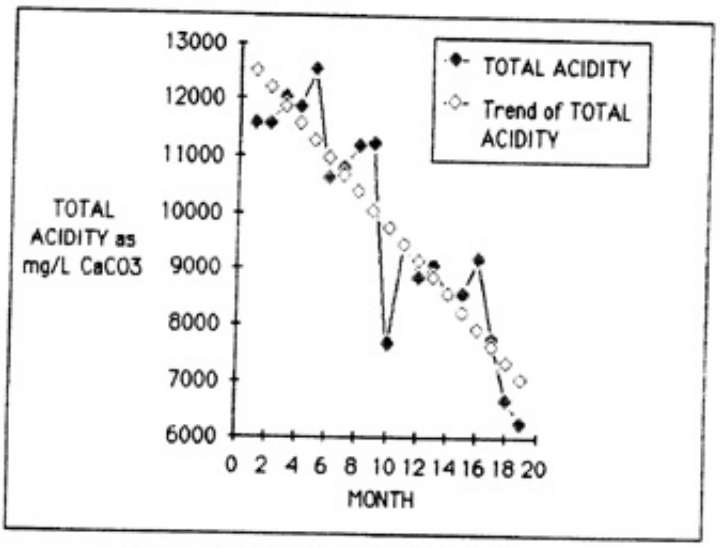

FIGURE 3. - ANTEC 128 treatment beginning month 3. Acidity concentration is 56% of the original level.

FIGURE 3. - ANTEC 120 treatment beginning month 3. Acidity concentration is 56X of the original level.

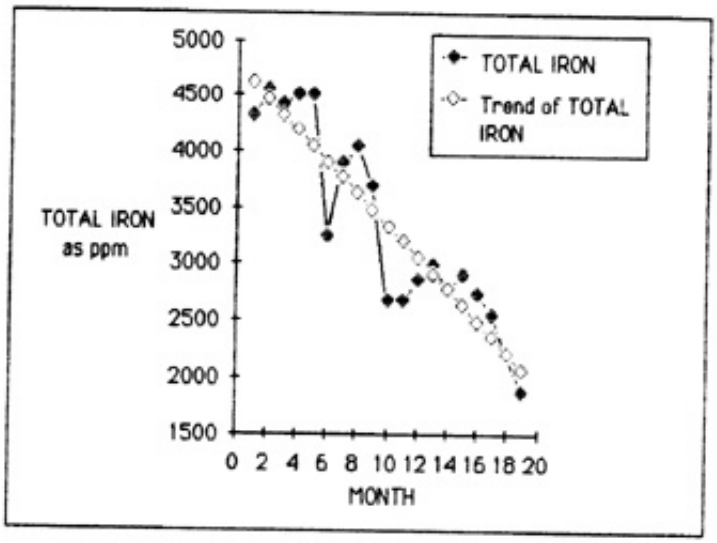

FIGURE 4. - ANTEC 128 treatment beginning month 3. Total iron concentration is reduced by 55% of the original level.

FIGURE 4. - ANTEC 128 treatment beginning month 3. Total iron concentration is reduced by 55X of the original level.

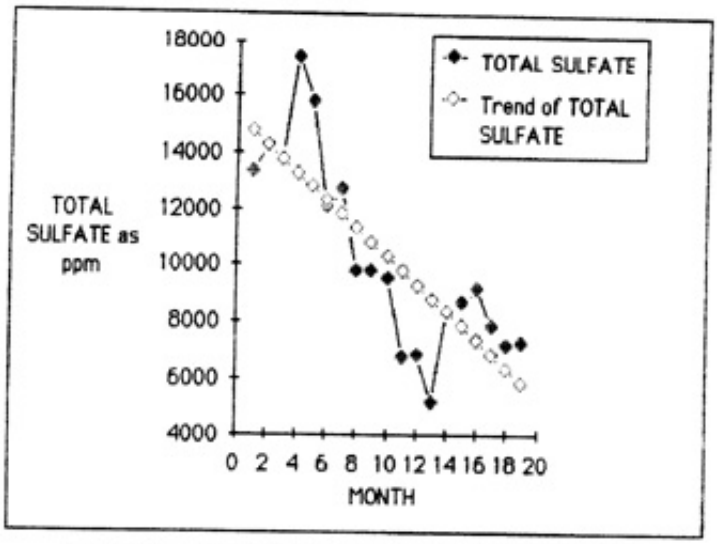

FIGURE 5. - ANTEC 128 treatment beginning month 3. Total Sulfate is reduced by 61%.

FIGURE 5. - ANTEC 128 treatment beginning month 3. Total Sulfate is reduced by 6 1 X -

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