Prevention of Acid Drainage from Stored Coal[a]

Discussion by Robert L. P. Kleinmann[4] and Patricia M. Erickson[5]

The paper by Olem, Bell and Longaker describes laboratory column studies in which the surfactants sodium lauryl sulfate (SLS) and linear alkylbenzene sulfonate (LAS) were tested for their effectiveness in reducing acid production from coal. This column study was an extension of previous work which had shown that the surfactants inhibit the iron-oxidizing activity of *Thiobacillus ferrooxidans*, and thus limit ferric oxidation of pyrite (11–13). The author's paper, although published in June, 1983, was actually prepared in early Spring, 1982. In the interim, the Bureau of Mines conducted full-scale field tests using SLS on active and inactive coal refuse areas.

Olem et al. questioned whether it would be possible to correct an existing acid problem by application of surfactants. Our first full-scale test was at an 11-acre inactive coal refuse pile in Raleigh County, W.Va. which has been producing acid water since the 1890's. The adsorptive capacity of the material was determined to be 45 mg SLS/kg of coal refuse. Using a procedure described elsewhere (14), we calculated that about 150 lb SLS/acre would be an appropriate dosage rate. A hydroseeder was used to treat the site with 10 drums of 30% SLS, diluted 175:1. Water quality improved after a three month lag period, with 60% decrease in acidity, sulfate and manganese and a 90% decrease in iron (14,15). Reduced water treatment costs paid for the SLS application in about 3 weeks. Acid production remained low for about 5 months.

Our second full-scale field test was conducted at an active coal refuse area in Preston County, W.Va. SLS was applied to fresh coal refuse at approximately the same rate as at the previous site, with a dilution factor of 50:1. Water quality improved dramatically within a month of the SLS application. Acidity, sulfate and iron were reduced by more than 95%, and remained low for about 4 months after treatment (14,15).

Effluent concentrations of surfactant have been extremely low at both sites. Except for one measurement of 0.6 mg/L shortly after application of the SLS to the inactive pile, SLS concentrations have been consistently less than 0.1 mg/L; no SLS has been detected in the stream at the discharge point of either mine water treatment plant.

Olem et al. expressed concern that the hydrolysis of SLS may make it inappropriate for coals which generate a lot of acidity, and therefore also tested LAS in their columns. This concern is reasonable, but their determination that LAS is much less effective than SLS may reflect their experimental conditions. Dugan (11) has previously shown that in culture media, approximately 5 mg/L of LAS is required to effectively inhibit iron oxidation by *T. ferrooxidans* compared to SLS, which is equally effective at 2 mg/L. More recently, Kleinmann (13) has shown that approximately 10 times more surfactant is required for complete inhibition on pyritic coal substrate. Specifically, Kleinmann observed that about 25 mg/L of SLS stopped bacterial activity; LAS and alpha olefin sulfonate required about twice that concentration to be equally effective. Olem et al. used equal concentrations (50 mg/L) of SLS and LAS in their columns. Thus, LAS was used at about the threshold concentration for complete inhibition; their results may simply reflect that higher concentrations of LAS are required to equal the effectiveness of SLS. Since LAS is significantly cheaper than SLS, this requirement may not be an obstacle to its use. We have recently started full-scale field tests using LAS at sites where acid hydrolysis of SLS could be a problem.

As a result of previously published articles (14,15) there are over 50 mining companies using anionic surfactant solutions to control acid drainage, with varied success. A procedural guide on the use of the anionic surfactant technique is now in press, and should be available by December, 1983.

[a]June, 1983, by Harvey Olem, Tracey L. Bell, and Jeffrey J. Longaker (Paper 18036).

[4]Supervisory Geologist, Environ. Engrg. Sect., Pittsburgh Research Center, Bureau of Mines, Pittsburgh, Pa. 15236.

[5]Chemist, Environ. Engrg. Sect., Pittsburgh Research Center, Bureau of Mines, Pittsburgh, Pa. 15236.

Appendix.—References

11. Dugan, P. R., "Bacterial Ecology of Strip Mine Areas and Its Relationship to the Production of Acidic Mine Drainage," *Ohio Journal of Science*, Vol. 75, 1975, pp. 266–278.
12. Kleinmann, R. L. P., "Bactericidal Control of Acid Problems in Surface Mines and Coal Refuse," *Proceedings*, Symposium on Surface Mining Hydrology, Sedimentology and Reclamation, D. H. Graves, ed., Report No. UKY BU123, University of Kentucky, Lexington, Ky., 1980, pp. 333–337.
13. Kleinmann, R. L. P., "The Biogeochemistry of Acid Mine Drainage and a Method to Control Acid Formation, thesis presented to Princeton University, at Princeton, N.J., in 1979, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.
14. Kleinmann, R. L. P., "Control of Acid Mine Drainage Using Surfactants, Bureau of Mines Technology News No. 167, 1983, 2 pp.
15. Kleinmann, R. L. P., Erickson, P. M., "Full-Scale Field Trials of a Bactericidal Treatment to Control Acid Mine Drainage," *Proceedings*, Symposium on Surface Mining Hydrology, Sedimentology and Reclamation, D. H. Graves, ed., Report No. UKY BU129, University of Kentucky, Lexington, Ky., 1982, pp. 617–622.

Closure by Harvey Olem[6]

The writers would like to thank the discussers for providing an update on Bureau of Mines field tests conducted since preparation of the paper. It should be noted, however, that all our work concerned coal in storage, while the discussers' field tests were with refuse material, a waste product of coal. The properties of coal refuse and coal are different, and the results of field tests with coal refuse may not be directly applicable. Also, coal refuse is a waste material to be disposed of, while coal must eventually be used in industrial applications. A new set of questions must be answered in future field trials, such as the burning characteristics of

[6]Projects Mgr., Div. of Air and Water Resources, Tennessee Valley Authority, Chattanooga, Tenn. 37401.

treated coal, the effects on boilers and ancillary equipment, and the characteristics of stack gases. We are now seeking to conduct such a test at the coal pile of a southeastern U.S. power plant.

The discussers' remarks regarding the relative effectiveness of sodium lauryl sulfate and linear alkylbenzene sulfonate are well taken. In fact, further studies are in progress in our laboratory on their relative effectiveness in correcting an existing acid drainage problem at coal storage piles, and we plan to apply higher dosages of the latter detergent.

VOL. 110 NO. 2. JUNE 1984

ISSN 0733-9402
CODEN: JLEED9

Journal of Energy Engineering

Edgar T. Moore, Jr.
Harza Engineering