FLOC LOGS IMPROVE THE EFFLUENT QUALITY ?[1]

by

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Abstract. Enforcement of the U.S. Surface Mining Control and Reclamation Act (SMCRA) of 1977 and the National Pollutant Discharge Elimination System (NPDES) led to the suggestion that flocculant (floc) logs can be utilized to improve the quality of the effluent leaving coal mine sites. The two main pollutants generated from the surface coal mining operations are acid discharge and sediment. At a mine site in Iowa, sediment not acid discharge was the main pollutant. SMCRA design standards for sedimentation ponds require that a pond have adequate capacity to contain from its watershed the sediment and runoff resulting from the design event. The east pond at the Iowa site was not big enough for the 860-acre watershed. Alternatively, as allowed by the regulations, the operator demonstrated using the computer model SEDIMOT II that peak settleable solids in the effluent would meet the NPDES criterion of 0.5 ml/l. However, the regulatory authority contended that the particle size distribution used in the model was not representative. Another computer run for the soil sample taken from the pond exceeded the NPDES limits. Both recognition of the property of the floc logs and increasing the capacity of the east pond contributed to a solution.

REGULATIONS

The Surface Mining Control and Reclamation Act (SMCRA) of 1977 mandates that (1) all surface drainage from the disturbed area shall be passed through a siltation structure before leaving the permit area, (2) discharges of water from areas disturbed by surface mining activities shall be made in compliance with the National Pollutant Discharge Elimination System (NPDES) permit, and (3) sedimentation ponds shall be designed, constructed and maintained to contain or treat the 10-year, 24-hour precipitation event ("design event") unless a lesser design event is approved by the regulatory authority based on terrain, climate and other site-specific conditions and on a demonstration by the operator that the effluent limitations of the NPDES permit will be met. One of the requirements of NPDES permits is that the peak settleable solids in the effluent shall not exceed 0.5 ml/l.

PROBLEM IDENTIFICATION

A pond, known as "east pond" (see figure 1) at American Coals Corporation surface mine number 3 in Mahaska County, Iowa, was the key structure where the runoff left the permit area since the inception of the mine in 1979. The sediment was dredged out of the pond only twice in 8 years for having excessive accumulation in the pond. There had not been any acid discharge problem at the mine site, perhaps because the overburden was not pyritic.

The pond, having a total storage capacity of 10 acre-feet, was identified in 1987 to be too small to contain

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the required runoff resulting from the 860-acre drainage area in the design event of a 4.8-inch precipitation. Further, it was suggested that the peak settleable solids in the effluent from the principal spillway for the design event would exceed the limit of 0.5 ml/l, thus violating the NPDES permit conditions. The operator was asked either to enlarge the pond to contain design storm event runoff from or to demonstrate that the effluent would have settleable solids within the allowable limits for the design event.

ANALYSIS

Of the 860-acre drainage area of the east pond the disturbed area according to the mine plan was 100 acres within the 262-acre permit area. The rest of the 860-acre drainage area was in row crop or pasture, excluding ponds, roads, buildings, and drainageways. The east pond was the last in a series of ponds, which were proposed as final pit impoundments and were integral components of the comprehensive sediment and water management plan. The enlargement of the east pond from its 10 acre-feet capacity to the required 60 acre-feet to contain the runoff from the design storm event would submerge a substantial area of land and would require relocation or raising of the county road.

The operator tried the second alternative. Using a computer model SEDIMOT II, developed by the University of Kentucky, the operator demonstrated that without enlarging the pond the effluent would have only 0.16 ml/l peak settleable solids for the design event. However, the Iowa Department of Agriculture and Land Stewardship's Division of Soil Conservation (DSC), the State agency which has primacy to enforce SMCRA, contended that the first soil sample used in the model was not representative of the soils in the drainage area as it was taken from the upstream end of the main drainage. A second run of SEDIMOT II was conducted for a 4.8-inch precipitation event, for a second soil sample from the pond itself. With the pond capacity increased to 17.5 acre-feet, this model projected 1.10 ml/l settleable solids. A third run, differing from the second only for a 3.3-inch precipitation event, projected 0.39 ml/l peak settleable solids. The particle size distribution of the two samples is compared in Table 1. It seemed apparent that soil particle size was a vital factor in this case.

Use of gel flocculants is documented in the literature (e.g., Moore, 1982). Flocculants were used in the form of 9-inch diameter, 20-inch long, 40-pound stiff gel logs. When water flows around the logs, a polymer is released by hydration and erosion to form a solution that first neutralizes the charge on the surface of suspended particles and then agglomerates fine particles into a larger mass.

Theoretically, the settling velocity of a particle increases with the square of its diameter, according to Stoke's law. However, there was no correlation available for the quantitative effect of the flocculant on the particle size. Still, the operator demonstrated the qualitative effectiveness of the flocculants in a jar to both DSC and OSMRE. Equal amount of the same soil was mixed with equal amounts of water in two different jars, turning the water murky. Gel flocculants were added in one jar and the solids started settling immediately, making the water clear at a pretty fast rate.

SOLUTION

The pond was widened and deepened, increasing its capacity to 17.5 acre-feet at the crest level of the emergency spillway; thus assuring that the pond was design-safe for a 3.3-inch precipitation event without any treatment. Additionally, floc logs were placed hoping that they would cause the soil particles to coagulate and settle to such a degree that the peak settleable solids in the effluent would remain within NPDES permit limits.

The number of floc logs was recommended by the manufacturer to expose a certain surface area of the logs for the design discharge. However, it was not known if the flocculants were ever used for such high discharges (710 cft/sec in this case). Thirty-eight logs were cut longitudinally into halves. The 76 half-logs were suspended by steel cables in 13 rows, 10-feet apart; 6 rows in the emergency spillway channel of pond #2 (see figure 2) and 7 rows near the road culvert, which is 1,000 ft. upstream of the east pond dam, in the main drainageway. The half-logs were hung at such a height above the drainage bed that they would be submerged in the runoff resulting from a 3.3-inch or greater precipitation event.

POST-SOLUTION STATUS

By the summer of 1988, a comprehensive sediment and water management plan was implemented in the field. Coal extraction was ceased and backfilling, grading, and seeding were started. The years 1988 and

1989 were drought years. Since then, vegetation was re-established in the disturbed area of the permit. However, the effectiveness of the plan could not be verified since the effluent had not been tested for settleable solids prior to placement of the floc logs.

RECOMMENDATIONS

Some correlation needs to be established between soil particle size before and after the use of flocculants to assess the effective quantity of floc logs with more confidence. The extent of the effectiveness of floc logs should be verified by periodically testing settleable solids in the effluent both before and after using the flocculants. Sediment storage capacity in ponds may have to be increased to accomodate the additional sediment deposit that might be discharged with runoff without the use of flocculants.

Literature

Code of Federal Regulations, Mineral Resources, 30 CFR, sections 816.42, 816.46(b)(2) and 816.46(c)(iii)(C).

Moore, James F. 1982. Treatment of Remote Impoundment Ponds with Gel Flocculants, 1982 Symposium on Surface Mining, Hydrology, Sedimentology and Reclamation (University of Kentucky, Lexington, Kentucky, Dec 5-10, 1982).

Neutron Products Inc., Technical Bulletin 87102.

University of Kentucky,College of Agriculture, Design Manual for the SEDIMOT II Hydrology and Sedimentology Model.

TABLE 1
SOIL PARTICLE SIZE DISTRIBUTION