

A Mine Water Problem

W. G. KESSEL, Indiana State Teachers College

Any materials that change the nature of natural waters, whether they are from industry or not, offer many perplexing problems to those who may need to use these waters. Today the problem of waste water treatment falls heavily upon the shoulders of many industries. It is most difficult to find satisfactory, economic procedures to treat various wastes. It is desirable that when they are dumped into nearby streams, rivers, and lakes the water does not become too offensive in color, odor, etc.; does not kill aquatic life and is not too difficult for others to purify. As you are probably aware many states now have laws that make it mandatory to treat all waste discarded into public waters. Each industry therefore has particular problems, ones that are peculiar to their own operations. Consequently some have had success and others have spent time, money, and energy on problems of this nature and as yet have no satisfactory solutions.

Such an unsolved problem is the subject of this paper.

About two years ago the author first became aware of the phenomenal change in pH that occurs in "spoil banks" on exposure to air. In Vigo County, strip mining operations cover some 10,000 acres, about 5% of the total area. The problem of reforestation as required by Indiana law is a large one. In these stripping operations the overburden of rock and soil is removed from the coal seams and piled into what the trade calls "spoil banks." The composition of this overburden and the "high wall" in the pits includes considerable iron sulfides as pyrite and marcasite, which oxidize on exposure to the air. The soil then becomes very acid and drainage water and/or strip pit lakes often have a pH on the acid side. One such lake was found with a pH of 2.1. Of course, the planting of trees in these soils is useless but most of the acidity will eventually be leached out.

J. J. Berzelius early noted this acid condition of mine waste water. A more recent statement by Eskell Nordell, "In mines, the free sulfuric acid and metallic sulfates are formed by the oxidation of sulfur containing materials, notably pyrites. The commonest of these as marcasite or brassy iron pyrites, which yields sulfuric acid and ferrous sulfate on oxidation in the presence of moisture."

Early in the spring of 1952 a similar condition was confronted by a mining corporation in this area when they were threatened with a law suit because their acid waters were affecting a creek so much that stock would not use this water.

This is a shaft mine where a pump moves the waters from the underground chambers so the miners can operate. This water then runs into a nearby creek and then progresses toward the Wabash. The pump water is acid and as it flows through calcareous material the pH drops and considerable iron is precipitated on the bottom and is also carried on down stream.

TABLE I

Composition of Pump Water	
Color—usually very clear	
no H ₂ S apparent	
very little dissolved CO ₂	
dissolved solids	3658 ppm
sulfate	408 ppm
iron	200 ppm
aluminum	155 ppm
SiO ₂	6 ppm
calcium	327 ppm
magnesium	845 ppm
mineral acidity	?

TABLE II

March 6	3.5 pH	
13	4.0 pH	
26	3.5 pH	
April 26	4.1 pH	
30	5.1 pH	
May 13	4.9 pH	260 Fe ppm
21	5.2 pH	268 Fe ppm
27	5.0 pH	260 Fe ppm
June 4	5.1 pH	240 Fe ppm
18	5.5 pH	285 Fe ppm
July 19	5.3 pH	300 Fe ppm
Aug. & Sept.—no determinations		
Oct. 2	5.7 pH	240 Fe ppm
14	5.5 pH	

Table I shows the composition of this pump water. Table II shows the changing nature of the pump water.

It is apparent from Table II that the idea of installing a larger pump in order to move the water more rapidly was of some value. For the pH seems to be moving up since May 20. Also at this time a move was made to aerate the water as it came from the pump. This was accomplished by building a wood trough about twelve feet long, four feet wide, and two feet deep. The bottom was then slit into many sections with a saw thus allowing the water to spray through it. The trough was then placed about ten feet from the ground and the water from pump goes directly into it.

After this spray the water passes through a holding basin some twenty feet wide and two or three feet deep about a hundred yards long. Then over some small log dams and cascades into a creek and on to the Wabash. Before this aeration was installed there was no reddish iron precipitate in the basin or in the creek at this point. Now the bottom of

the holding basin and the creek where the pump water enters is covered with the reddish iron.

The sulfur content however is still high, for the water changes in pH very noticeably as it passes on down stream as shown in Table III from the October sample.

TABLE III

<i>sample</i>	<i>pH</i>
No. 1 pump	5.7
No. 2 after spray	5.8
No. 3 creek	7.3
No. 4 pump water in creek	5.8
No. 5 approx. 1 mile	3.6
No. 6 approx. 2 miles	6.0
No. 7 approx. 4 miles	7.2

Some modifications of the aeration operations are now under way, the idea again being to completely oxidize the sulfur at the pump area. Then as the water contacts various limestone containing materials, the iron will be precipitated out and not carried on down the stream.

The idea of neutralizing the pump water as suggested by Eskel Nordell, page 78, "neutralization aerations, settling and filtrations," was tried. It is, as he suggests further on in this consideration, futile, "for they are so high in sulfates hardness and acid that they are practically beyond redemption." Figures indicate that neutralization with the conventional alkalis would cost approximately 5¢ per 100 gallons. This is of course prohibitive. Limestone scrap is also of little value for it soon coats with insoluble calcium sulfate and is worthless.

Neutralization is of little help in this situation unless the sulfur content has been completely oxidized. Samples of the pump water were put in contact with limestone for twenty-four hours and the acidity present was completely neutralized. But when this water was then allowed to stand in the air, not in contact with the limestone, the pH dropped back considerably. This sequence could be repeated again until all of the oxidation had been complete.

Several other ideas are now in progress of consideration that perhaps will help to solve this unique problem for the acid mine wastes.

Literature Cited

1. MELLOR, J. W. 1935. A Comprehensive Treatise on Inorganic and Theoretical Chemistry. Vol. XIV, Part 3, p. 224.
2. NORDELL, ESKEL. 1951. Water Treatment for Industrial and Other Uses. p. 76.