37. VARIATIONS OF pH WITH DEPTH IN ANTHRACITE MINE-WATER POOLS IN PENNSYLVANIA

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When mining of anthracite coal was a flourishing industry during the 1920's and during the years of World War II, the water pumped from the mines was strongly acid and created pollution problems in the streams. When the coal was exhausted and the mines abandoned, pools of water accumulated in the underground workings. In some mines the pools drained naturally, and in others water was pumped to prevent overflow into adjacent active mine workings. These waters had considerable range in acid content (Felegy, Johnson, and Westfield, 1948) and their action on the pumping machinery required acid-resisting components. Knowledge of the areas or zoning of the acid waters might make control of pollution easier and reduce the cost of handling the water.

During the investigation, under Public Law 162, 84th Congress, of pump projects relating to anthracite mine drainage, it was noted that the pH of the water in certain flooded mines varied with the depth below the surface of the pool. In some pools less acidic or fresh-water zones occurred near the surface above more acid waters at depth.

Vertical shafts penetrating flooded mines were randomly selected in each of the four anthracite fields of Pennsylvania for determining the presence of layering of the acid water. Isolated unpumped pools, pools pumped periodically, and pools having continuous circulation by overflowing were included in the sampling. At each shaft the pool was sampled 25 feet below the pool surface and 75 to 100 feet above the bottom of the shaft. One or two samples were taken at points uniformly spaced between the upper and lower sampling levels.

The sampling was done by lowering a stoppered thick-walled bottle on a measured line to the desired depth. A long and a short open capillary tube through the stopper permitted the water to enter the bottle and the air to be released. The time that the bottle was in position at the sampling site was long compared to the time required to lower and raise it to the pool surface. Large bottles were used at depths of more than 400 feet, medium sizes between 100 and 400 feet, and small sizes for near-surface samples.

The pH of the samples was determined immediately at the shaft collars by a Beckman Model N pH meter. The pH was determined to the nearest 0.01 unit, but in reporting the results in table 1, the determination is rounded to the nearest 0.05 unit.

Table 1 shows the range in pH in eleven mine-water pools in the four anthracite fields. The pools at the South Wilkes-Barre and Henry mines are relatively new pools isolated from other mines and have not been pumped. The pH in these pools indicate more acid water at depth. The Greenwood mine contains an isolated new pool and the level of the pool is rising at present. The pH in this pool indicates more acid water in the lower sections. The pool in the Clearspring mine is about 15 years old and has not been pumped. It reportedly receives recharge from and discharges to the buried valley of the Susquehanna River. The range in pH in this pool does not indicate any significant layering of acid water.

The mine-water pools in the Exeter, Schooley, No. 7, Reliance, and Packer mines are not appreciably layered. The pools have been pumped at intervals either to prevent overflow or to obtain water for processing of prepared coal. Water enters pools at each of these mines at several levels corresponding to the points where the mine shafts intersect water-bearing coal beds. This tends to keep the pool water mixed and helps prevent acid layering.

The mine-water pools in the Hazelton and Locust Gap mines overflow to drainage tunnels. The amount of vertical flow in the shaft is unknown, but is probably significant. Slight differences in pH at depths within the pools of these mines were observed, but they are insufficient to indicate layering of the acid water.

REFERENCE

Felegy, E. W., Johnson, L. H., and Westfield, J., 1948, Acid mine-water in the anthracite region of Pennsylvania: U.S. Bur. Mines Tech. Paper 710.

TABLE 1.—*pH of water at different levels below surface of mine-water pools in anthracite fields of Pennsylvania*

Sampling point		Altitude of collar of shaft (feet above sea level)	Altitude of surface of mine-water pool (feet above sea level)	Date of sampling	Sample number	Altitude of sampling point (feet above or below sea level)	pH	Remarks
Mine	Shaft							
Northern anthracite field								
Exeter	Red Ash	580	485	Jan. 9, 1961	1	460	6.80	Pool formed after 1949 and was pumped to prevent overflow until about July 1959.
					2	330	6.85	
					3	200	6.85	
					4	60	6.65	
Clear-spring	Clear-spring	578	528	Jan. 4, 1961	1	503	6.85	When mine was in operation, the pH of pumped discharge was 6.5 on May 27, 1941. Pool formed before 1944; not pumped since.
					2	473	6.75	
Schooley	No. 1	558	423	Jan. 9, 1961	1	398	6.40	When mine was in operation, the pH of pumped discharge was 6.7 on May 23, 1941. Pool formed after Jan. 1951. Pumping ceased July 1959.
					2	278	6.20	
					3	158	6.40	
					4	33	6.75	
South Wilkes-Barre	No. 5	589	89	do	1	64	7.10	When mine was in operation, the pH of pumped discharge was 5.1 on May 19, 1941. Pool formed after June 1958.
					2	−61	3.65	
					3	−236	4.00	
					4	−411	4.10	
No. 7	No. 2	545	508	Jan. 10, 1961	1	473	6.90	When mine was in operation, the pH of pumped discharge was 3.2 on June 10, 1941. Pool formed after May 1954.
					2	335	6.25	
					3	185	6.50	
					4	72	6.35	
Henry	Red Ash	561	448	April 20, 1960	1	438	7.35	When mine was in operation, the pH of pumped discharge was 3.9 on May 15, 1958. Pool formed after Jan. 1959. Shaft destroyed June 1960.
					2	348	6.00	
					3	148	5.10	
					4	−162	5.30	
Eastern middle anthracite field								
Hazelton	Hazelton	1,580	1,091	Nov. 13, 1957	1	1,070	3.20	
					2	900	3.40	Water rises in shaft and overflows through drainage tunnel at altitude 1,091 feet.
					3	750	3.20	
				Jan. 10, 1961	1	1,066	3.60	
					2	955	3.80	
					3	848	3.60	
Western middle anthracite field								
Locust Gap	Locust Gap	1,284	797	Jan. 11, 1961	1	772	4.55	Mine-water pool overflows through drainage tunnel at altitude 747 feet.
					2	647	4.50	
					3	522	5.85	
					4	284	5.50	
Reliance	Reliance	1,058	979	Jan. 12, 1961	1	954	6.10	When mine was in operation, pH of pumped discharge was 2.7 on Sept. 18, 1941, and 4.0 on Sept. 23, 1946. Water pumped sporadically from shaft.
					2	756	5.85	
					3	556	5.65	
					4	356	5.95	
Packer No. 5	No. 5	1,108	963	Jan. 13, 1961	1	938	6.70	When mine was in operation, pH of pumped discharge was 4.9 on Sept. 16, 1941. Pool formed after Sept. 1957.
					2	678	6.55	
					3	318	6.70	
					4	58	6.55	

TABLE 1.—*pH of water at different levels below surface of mine-water pools in anthracite fields of Pennsylvania*—Continued

Sampling point		Altitude of collar of shaft (feet above sea level)	Altitude of surface of mine-water pool (feet above sea level)	Date of sampling	Sample number	Altitude of sampling point (feet above or below sea level)	pH	Remarks
Mine	Shaft							
Southern anthracite field								
Greenwood.....	No. 10.....	1,002	452	Jan. 12, 1961..	1	427	4.20	When mine was in operation, pH of pumped discharge was 3.6 on July 2, 1941, and 3.1 on Oct. 15, 1946. Pool formed after May 1960. Pumping at shaft ceased Nov. 1960.
					2	372	4.00	
					3	172	3.75	
					4	42	2.80	