Martinka's State-of-the-Art AMD Treatment Plant

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INTRODUCTION:

The Martinka Coal Company's Tygart River Mine is a subsidiary of Peabody Energy. The mine site is located six miles southeast of Fairmont, West Virginia in the community of Powell. The mine began operation in March 1974 and ran continuously until December 1995. The underground mine area encompassed 5957 acres and consisted of 10 continuous miner units and 2 longwall units. Reject from mining the Lower Kittanning coal seam was disposed of in three coal refuse areas that were developed, which totaled 220 acres of combined refuse fill. All water generated from these refuse areas was collected and pumped to a central treatment plant where hydrated lime was added to adjust the pH and convert the iron. A flocculent was then added to increase the settling rate of the precipitated iron. The clarified water was sent to a final polishing pond before discharging into the Tygart River. The underground mine water was collected underground and then pumped to the surface via three vertical pumps to the Guyses Run Treatment facility. The underground mine water was of sufficient quality that it required no chemical treatment. This water was sent directly through two polishing ponds and then discharged into Guyses Run, which then flowed into the Tygart River. The pH of the mine water prior to its shut down was 7.8 and the iron at the discharge point was 0.23ppm.

In December of 1995 the mine suspended coal production, equipment was removed from underground, ventilation ceased, and the mine was sealed. Treatment of the refuse water continued as necessary and only intermittent pumping of the mine water continued after the mine was sealed.

PROBLEMS WITH MINE WATER TREATMENT

In February 1996, after the mine was sealed, the water at the discharge point was sampled and revealed a pH of 8.5 and an iron of 1.4 ppm. Although this discharge was within the permit parameters of 6.0 to 9.5 pH and iron less than 1.5 ppm, iron staining in Guyses Run began to occur. Upon this occurrence, 50% caustic soda and a flocculent were used to treat the mine water. However, problems continued with iron staining even though the present discharge parameters were being met. In September 1996, the iron staining in Guyses Run ceased when the iron level at the discharge was reduced to less than 1.3 ppm. While water treatment continued at Guyses Run, many different chemical processes were investigated to more efficiently treat the mine water discharge.

Analysis of deposits in Guyses Run showed that the deposits were primarily calcium carbonate with minor iron staining. The iron staining, while minor, made the deposit problem look more severe due to the orange color. Based on this understanding of the issue and through many hours of bench testing, the chemical additives to the treatment process were changed from a caustic soda and flocculent approach to the application of alum, sodium fluorosilicate, and a flocculent. The subsequent treatment was effective in removing the dissolved iron with a minimal adjustment to the pH. This treatment continued until October of 1997, at which time the mine water was pumped down to a predetermined elevation.

Refuse water was treated at the mine site treatment plant utilizing hydrated lime and a flocculant for settling enhancement.

DEVELOPMENT OF THE LEVELS ROAD WATER TREATMENT PLANT

A four-month study showed that the quality of the mine water was progressively degrading after the closure of the mine. The pH had decreased from 8.4 to 7.3 and the iron levels increased from an initial 0.36 ppm to 1.28 ppm. The alkalinity increased from 200 ppm to 500– 600 ppm.

In June of 1998, design of a new treatment facility began. The concept for the design was to blend the highly acidic refuse water with the highly alkaline and calcium rich mine water. Lab studies had shown that mixing both waters, utilizing the refuse water's high acidity to help offset the mine water's high alkalinity, resulted in a reduction of the chemicals required for treatment. This blending of water was to be supplemented with the addition of alum and/or caustic soda and a flocculent as needed.

TREATMENT OF MINE WATER

Construction of the computer controlled and monitored plant began in July 1999. Two 4160 volt, 600 HP, 5000 GPM vertical pumps were installed to pump mine water from the existing mine pool through two 22-inch HDPE pipes. As the mine water was to be pumped through the Treatment Plant, 50% liquid caustic soda was to be injected to maintain the pH to a level determined by the plant operator. The water would then flow to an aeration basin where three 15 HP aerators would further mix and aerate the water. An anionic flocculent was injected to the water as it flowed into a slow three-stage mixing system where the flow was equally split into six sedimentation ponds. Upon discharge from the settling ponds, 35% hydrochloric acid was added at the inlet of the final polishing pond to lower the alkalinity further, keeping the calcium in solution and not allowing the calcium to create deposition in the receiving stream. The Langelier Saturation Index (LSI) was used to determine the amount of hydrochloric acid required to prevent deposition. The LSI of a given water indicates that water's tendency to absorb or deposit dissolved solids. By altering the water's LSI number by chemical addition, the water could be changed from depositing dissolved solids to neutral or absorption tendencies. Sulfuric acid pH reduction was not used due to the concern of calcium sulfate precipitation.

TREATMENT OF REFUSE WATER

The existing refuse water ponds were cleaned to100% of design capacity. Pumping of the refuse water was redirected to the new plant through a combination of old and new lines and pumps. All mine site and refuse water was collected at two distinct points. Each collection point then pumped refuse water through the treatment plant by way of two 100 HP, 1000 GPM pumps, through two 12-inch HDPE pipelines. Caustic soda was added to adjust pH to a level determined by the operator. The water would then proceed to the aeration basins and then follow the same course as previously described for the mine water.

BLENDING OF REFUSE AND MINE WATER

Blending of the mine water (high alkalinity, low iron) with the refuse water (high hot acidity/high iron) proved to be a worthwhile venture. If blended in a pre-determined proportion, the alkalinity could be used to reduce acidity and the low iron mine water would dilute the high iron concentration of the refuse water. This was done by the use of two two-channel, ultrasonic flow meters, two 22-inch electric valves and two 12-inch electric valves. The computer system monitored the flow from each pump and the electric valves opened or closed to adjust the blend mixture to the ratio selected by the plant operator.

CONTINUAL TESTING AND IMPROVEMENT

The chemical program at the new treatment facility continued to evolve. Blending the two waters and treating with caustic soda, a flocculent and hydrochloric acid proved to be effective in meeting the goal of compliance water, but not very cost effective, considering the volume of water often approached 10,000 GPM. Also, the quality of water was changing as the plant worked through its break-in period. A significant amount of grading and vegetation of the refuse area greatly reduced the amount of refuse water generated. This resulted in a significant amount of alkaline mine water to be available for processing than the hot acid refuse water. At this point it was recognized that "the older chemistry approaches" were not cutting it. An extensive testing campaign based on going "back-to-basics" was conducted over a six-month period. Tests included bench jar tests, 55-gallon pilot tests and finally a $1/50{,}000^{th}$ scale continuous pilot unit. The chemical program that was selected focused on treating only the soluble iron and NOT the total water processed. This was accomplished by adding an oxidizing agent. The breakthrough came with the help of West Virginia University and Kroff Chemical Company. The addition of hydrogen peroxide to the water is still added prior to the flocculator. This process allowed the reduction in feed rate of hydrochloric acid that was used to trim the final pH.

The treatment process was later enhanced by the elimination of the use of hydrochloric acid and the use of an anti-scaling agent to hold the calcium in suspension and prevent it from depositing in the discharge stream. The final solution is extremely environmentally friendly since this process reduced the amount of dissolved solids added to the treated water and the reaction by-product from the hydrogen peroxide is water.

THE FINAL PLAN

In the end, the chemistry involving the environmental problem was unique to the coal industry. The mine pool water is a carbon dioxide rich environment due to the dissolution of the limestone. Upon pumping the water to the surface, the carbon dioxide is released to the atmosphere and the pH of the water gradually rises as it degasses. The chemical equilibrium shifts resulting in the precipitation of calcium carbonate. Although the ferrous iron would eventually precipitate on its own, the process is too slow to be economical without the aid of mechanical aeration and chemical additives to accelerate the precipitation of the soluble iron.

PLANT FEATURES

The present system still allows for treatment of mine water and refuse water separately or to blend them in a prescribed way. This is accomplished by the use of ultrasonic flow meters and electric acuator valves to set the prescribed flow. The plant has two independent sides, which allows for the treatment of various blends or treatment of each source separately, with treated volumes ranging from 1000 GPM to 12,000 GPM. The plant is fully automatic, complete with start-up and shutdown capabilities.

OPERATIONAL CONTROLS

The computer, which provides constant monitoring and adjustment to the system controls all major chemical additions to the water. The system is further enhanced by an automated phone system that, when a preset parameters is out of limit, the computer notifies the phone and a call is made to notify a responsible person that an alarm does exist and that the treatment plant has shut down.

The pH of the water is controlled by a probe in each aeration basin and is monitored on each side of the flocculator and once again at the inlet to the final pond. The plant operator designates a specific ppm vs. flow total to control hydrogen peroxide injection. This is done by the computer system, which determines the speed in which the peroxide injection pump must run to meet the designated quantity. The effectiveness of the treatment process is monitored by an ORP (oxygen reduction potential) probe in each aeration basin. A plant shut down will occur if the ORP drops below a pre-determined level indicating incomplete ferrous iron conversion.

FLOW CONTROLS

Satellite PLC's at all remote pumping locations are connected to the main computer at the treatment building by way of fiber optic cable. The computer controlled mine water system starts and stops the vertical turbine pumps, provides a mine water elevation, and controls pump motor amperage monitoring and shut down. The computer controlled refuse water system allows pumping to start and stop from the major collection points by use of a miltronics multi range II sonic device. This system is programmed for automatic start-up determined from high water level indicators and shut down from low water indicators.

As previously mentioned, the mine water and refuse water flowing through the treatment building is computer controlled by electronic flow control valves and ultrasonic flow meters.

TYPICAL WATER QUALITY

Raw mine water: pH 6.4-6.7, Iron 6-12 ppm and an alkalinity of 560-580 mg/l.
Refuse water: pH 2.0-3.0, Iron 200-800 ppm and acidity 900-1100 mg/l.
Treated water: pH 7.5-8.0, Iron 0.3, and alkalinity 300 - 500 mg/l.

AWARDS

2000 – West Virginia Coal Association – Reclamation Award
2002 – West Virginia Business Environmental Leadership Award

CONCLUSION

The development of this state of the art treatment plant solved a very complex environmental problem, as well as demonstrated the value of a partnership with other entities to solve a complex problem.

This partnership is progressing further with West Virginia University working closely with Martinka Coal Company to explore the development of an aquaculture site at the closed Guyses Run Treatment Plant as well as at the Levels Road Treatment site where trout, bass, catfish and bluegill inhabit the polishing ponds.

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