# TU/NALPAS: WATER TREATMENT TO TOTAL DRAINAGE MANAGEMENT[1]

**T. C. Attaway and S. T. Cooney[2]**

Abstract: Water quality management is a critical task in the mining industry. Wastewater discharge from surface mining is required by Federal and State regulations to be compliant with all wastewater permits. The Texas Coal Mining Regulations state: "no...water quality statutes, regulations, standards, or effluent limitations be violated." While guidelines are provided for meeting these standards, the operator must develop a strategy that best fits a specific site. During the past decade many techniques have been researched to satisfy objectives and regulations ranging from physical treatment (i.e., settling ponds) to chemical treatment. Research led to the conclusion that a combination of methods would best suit the water quality objectives for Texas Utilities in Northeast Texas. A partnering relationship was developed between a major chemical manufacturer and the mining company, investigating from a scientific standpoint, water properties, soil properties, geographic factors, and polymer characteristics. The data collected during a study period was done in conjunction with the actual water treatment program using a package system (TU/NALPAS). The system proved to be highly reliable, continually monitoring parameters and immediately adjusting treatment to match constantly changing water conditions. Parameters including clarity, water volume, peak flow, and pH have been monitored and used in optimizing the logic system. The system has also been used in remote areas by the addition of solar power and radio-controlled activation. This systematic approach has changed difficult and labor intensive water treatment to one which is automated and provides for reliable and cost effective mine drainage management.

Additional Key Words: polymer, mine drainage, sediment pond

## Introduction

A major business factor in a coal mining operation is a successful drainage-management program. Discharges of mine wastewater must meet limitations imposed by state and federal permits. The Railroad Commission of Texas regulations state with emphasis: "no...water quality statues, regulations, standards, or effluent limitations be violated" (Railroad Commission of Texas, 1996) for coal mining operators. In order to meet these criteria, the operator must develop a strategy to maintain environmental commitments and remain within economic constraints.

A first-class water management program has many benefits to the operator above and beyond compliance with regulations. Water is a commodity that is not taken for granted in the south. The drought condition of 1996 in Texas proved that the public places a high priority on a reliable source of high quality water for drinking and recreational purposes. By implementing and maintaining a excellent management program, a coal mining operator is allowed to mine coal, while disturbing large acreage. During this entire process, water quality must be maintained.

The objective of this water treatment program was to develop and continually improve mine-drainage management. This objective was accomplished and is maintained through a partnering relationship formed between the mine operator and a major chemical company. A laboratory environment was created in which all factors of drainage management were investigated, quantified and evaluated to develop an optimized "Total Drainage Management" program. While the basic strategies and compliance objectives have been in place for many years, this paper will focus on advancements in technology and methods used in the last 5 years.

## Materials and Methods

The project location consisted of mining operations located near Beckville, TX, Mt. Pleasant, TX, and Fairfield, TX. Annual precipitation ranges from 40 inches to in excess of 48 inches at the different locations.

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[2]Tim C. Attaway is a District Sales Representative with NALCO Chemical Co., Plano, TX 75903; Scott T. Cooney is an Environmental Supervisor with Texas Utilities Mining Company, Tatum, TX, 75691.

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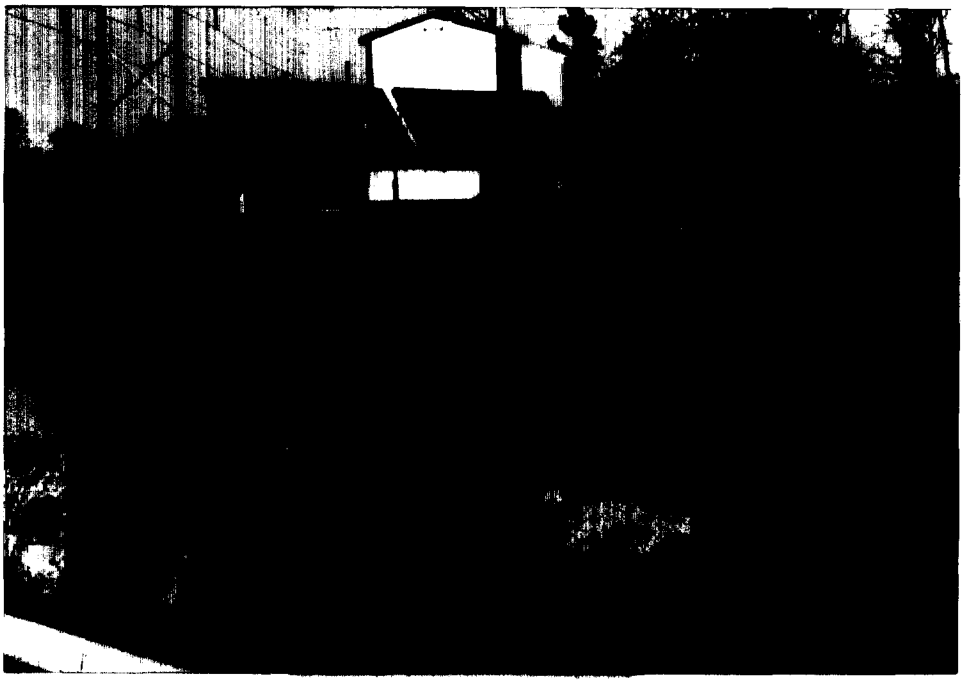


Figure 1 TU/NALPAS self contained unit in operation with solar power option.

At the beginning of the study period, water-treatment programs included settling ponds, total containment ponds, drip-feed polymer applications and circulation systems. All of the programs in place involved the effective treatment of the mine drainage; however, technology being developed at this initial stage offered many areas to improve the efficiency of the treatment programs. As the "state of the art" technology became available, the partnering relationship with the chemical manufacturer allowed the mining operator to take immediate advantage of improvements in technology. This was accomplished by providing the correct product with the correct feed systems and data-acquisition methods.

Cationic Coagulant

The mining company historically selected and utilized a cationic coagulant (polymer) to aid in water treatment. Cationic coagulants are injected into mine drainage to encourage flocculation of colloidal material, thus employing a means to speed settling of suspended solids from water (Kemmer, 1988). Choice of a coagulant was based on effectiveness of the product, cost per unit of product, cost of delivery and it's ability to be metered in a pumping/injection system. A concentrated product was selected that would meet all of these goals.

System Description

In order to introduce the polymer into the water, a system was designed to inject the coagulant. Expertise from the mining industry and the chemical engineering side of the business was required to prototype a self-contained package for efficient single-component, high viscosity polymer injection (Figure 1). The system was coined the Texas Utilities/Nalco Automated Liquid Polymer Application System (TU/NALPAS). The TU/NALPAS was designed to automatically adjust liquid-material feed, ranging from very low to very high flow rates (3.0 ml to 35,000 ml per minute), allowing the system to adjust immediately to changes in rainfall and drainage flow patterns. The system utilizes two methods for chemical feed control. The original unit utilized an ultrasonic devise coupled to a microprocessor base unit to interpret flow and translate a non-linear function to a linear signal. The signal activates a pump or series of pumps based on changes in actual flow in a real-time fashion, thus insuring that enough chemical is injected, and from a cost standpoint, that excess chemical is not injected into the treatment system. The second mode of control, developed later in the project, consists of coupling the ultrasonic device with an in-line suspended solids monitor. This device now allows the computer processor to optimize not only water flow, but also to allow the unit to estimate the solids volume contained in the water being treated in a real-time situation. This resulted in treatment of water based on two variables: water flow and amount of soil material in the water. The result was more accurate delivery of polymer.

Solar Power

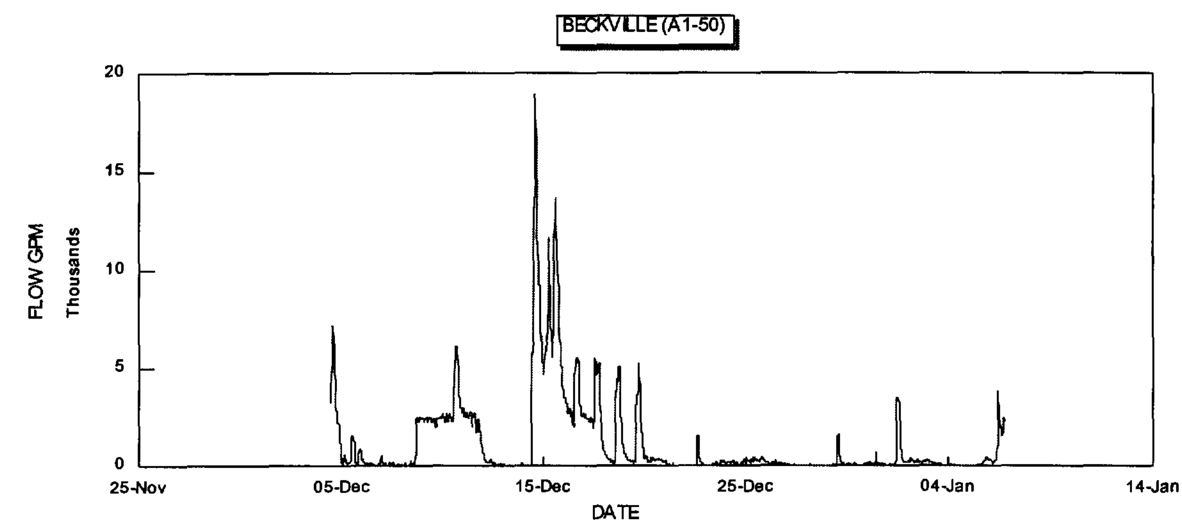
As the project progressed, the systems were continuously modified. One of the distinct advantages of the units became the incorporation of solar power to the systems. Equipping the package with solar power allowed location of a self-contained unit in remote locations where electrical service was not available. This allowed the systems to be located in the most optimal treatment location rather than an area in which electrical power was available, thus increasing the efficiency and the diversity of the "Total Water Management" objective. The solar powered units operate in a similar manner to the conventional systems.

Radio Controllers

Remote location of the units brought about a unique addition to the TU/NALPAS. In order for the systems to function properly, the injection location must be at a point in a stream representative of the water conditions. The proper injection location does not always allow for a good area for polymer tank access. Polymer is received in large bulk tanks; therefore, all weather areas are needed for tank location. This problem was solved by using a solar-powered radio controller at the injection point. Flow readings were transmitted by radio to the microprocessor controlling the pumps. Accurate polymer injection was accomplished with over ½ mile distance between the injection point and the tank location. The radio transmission was verified by use of any VHF radio unit equipped with the proper frequency.

Additional Devices

Microprocessing equipment was selected with capability of adding many monitoring devices to the system. While the processor collects data from various probes, the only additional device needed to date has been a pH probe. Similar to the ultrasonic device and the solids meter, the




| | | | |
|---|---|---|---|
| TOTAL FLOW | 56,124,324 GAL | GALLONS 8799 USED | ******* |
| TREATED FLOW | 50,071,984 GAL | CALCULATED PPM | 0 |
| AVG. TREATED FLOW | 3,894 GPM | INVENTORY | 1875 GAL |
| PEAK FLOW | 19,015 GPM | | |

**COMMENTS AND RECOMMENDATIONS:**

Pump #1 stroke setting =25% ******** Proprietary Information

Pump #2 stroke setting =73%

Figure 2 Example of report for AI-50 Pond for December 1996 showing monitored parameters reported by the data management system.

pH probe signals any fluctuation in water pH and activates a set of pumps to apply the proper additive to correct pH.

The only other device under review is a rainfall monitor; at the time of this publication, the systems have not been implemented with any reportable conclusions.

Data Management

The systems are equipped with a self-contained data-management system. Parameters including water volume, peak flow, polymer injected, treated flow, water clarity and pH are routinely monitored, and models are developed to optimize the system logic, thus insuring that treatment is adjusted based on real-time environmental variables. In addition to providing long-term data in optimizing the system, the data-logging function allows for management reports to be completed on a routine basis to monitor performance of the systems (Figure 2)

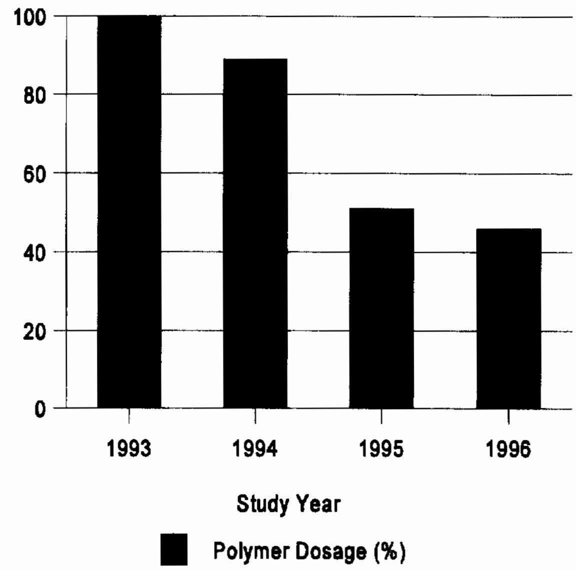



Figure 3 Polymer utilization decreased as systems were optimized and additional components were added.

## Summary and Conclusions

The concept of "Total Drainage Management" was developed in a real environment. The systems described were tested and proven in a compliance regulated atmosphere, and billions of gallons of mine drainage have been successfully treated during the past 5 years. Compliance was never compromised during the development or implementation phases of the project; however, significant operating parameters were impacted as the logic systems were optimized. Reduction of the work force historically utilized to treat water, decreased polymer utilization, and less freight handling were the significant efficiencies realized by implementing the systems.

The systems design allowed 100% automation; however, this option was not implemented. This was due to the cost of additional equipment outweighing the benefit of 100% automation. A premise was developed that 100% automation could place undue risk on compliance. The level of automation did allow restructuring of the workforce required to manage water treatment due to the systems making adjustments electronically rather than physical adjustment of feed pumps. This allowed labor to be directed toward overseeing final effluent results rather than adjusting pumps.

Polymer utilization (Figure 3), the most significant indicator of system performance, was dramatically impacted as the systems were optimized. While providing actual dosage numbers could jeopardize proprietary information, Texas Utilities found that the systems performed by decreasing the amount of polymer required to treat comparable water by 54% from 1993 to the end of 1996. Constant monitoring of stream/drainage parameters (flow and solids) insured correct polymer dosage change during a rainfall or pumping event. Not only were dosages precise in volume measurement, the change in dosage was made instantly as water conditions changed. Prior to this technology, the gradual feed changes typical of manual adjustment and visual estimations led to overfeeding the polymer to insure that the primary goal of compliance was accomplished. Again, while compliance was never compromised, a cost was incurred which has now been reduced with this new technology.

Another efficiency realized was in freight management. By implementing precision injection of polymer and complete monitoring of the system, a decision was made to use a more concentrated polymer. The gain in this efficiency was decreasing the amount of freight required to deliver the product by a factor equal to the increase in concentration. Up to this point, the pump technology did not possess the tolerance to effectively deliver the concentrated product.

In addition to these significant efficiency gains, other benefits were realized during the study period. The data collected during drainage events were used to continually optimize the systems. In addition, the data was used to influence design parameters of sediment ponds and drainage patterns. The use of additional monitoring devices, such as pH probes, allowed the technology to be used concurrently to address multiple water parameters. The data-management systems also provided an accurate planning tool for predicting and planning economic parameters. With the implementation of each additional device or system, long-term data were used to predict the feasibility of use, based on return on investment calculations compared to polymer utilization or labor adjustments. In one example, the addition of a solids monitor paid for itself in less than one year. The addition of solar power to the units allowed a testing environment for other applications of solar power in remote areas not dealing with mine drainage.

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