# Technology News

***From the Bureau of Mines, United States Department of the Interior***

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# In-line Aeration and Treatment of Acid Mine Drainage

## Objective

Reduce the costs associated with conventional treatment of acid mine water.

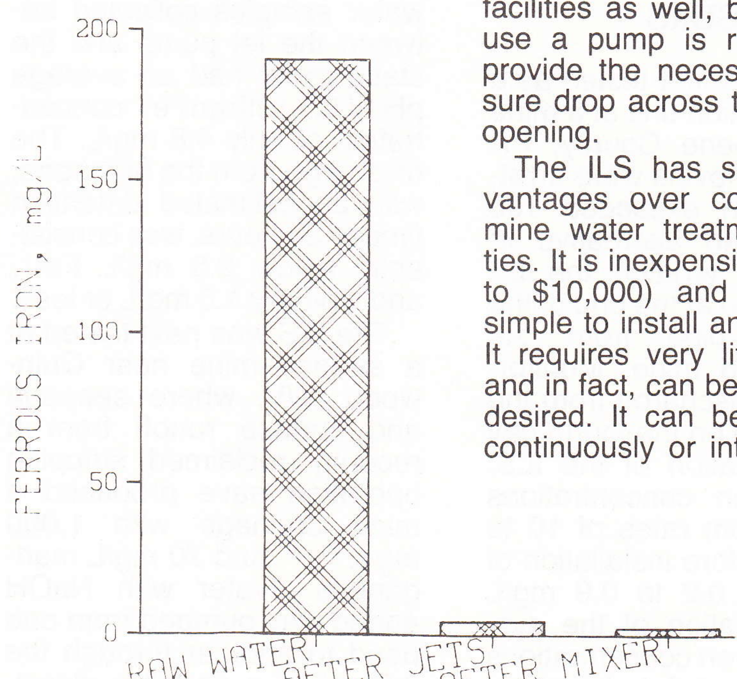
## Approach

Conventional treatment of acid mine drainage consists of plants requiring large mixing and aeration tanks, mechanical aerators and large, shallow settling ponds. Such plants are usually very costly to construct, maintain and operate. The Bureau of Mines has developed a simple, low-maintenance, highly efficient system to treat acid mine drainage which mixes, aerates, and neutralizes mine water simultaneously in the existing discharge pipeline by using the pressure generated by the deep mine discharge pumps. The mixing and aeration action of the in-line system significantly increases oxidation rates of ferrous iron. Iron and manganese are removed, even at near neutral pH levels, due to the high efficiency of this system.

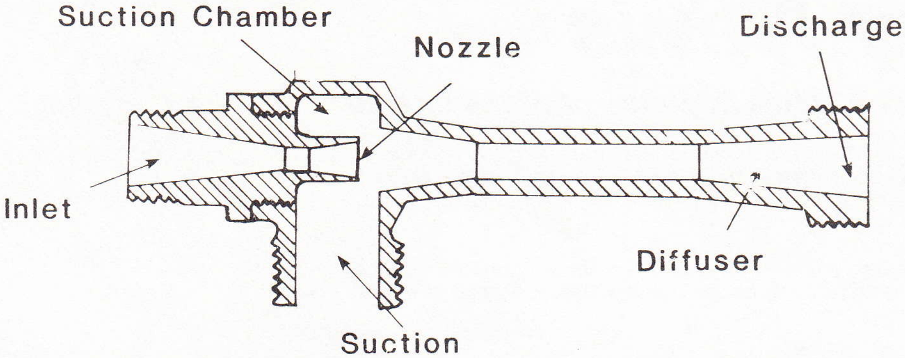
## How It Works

The In-line Aeration and Treatment System (ILS) consists of two commercially available components, a jet pump (ejector) and a static mixer. The jet pump is simply a nozzle that converts water, already under pressure, into a high-velocity stream that entrains air by Venturi action. If neutralization is required, sodium hydroxide or lime is added along with the air at the Venturi opening. The aerated and neutralized water then enters the static mixer, which is a length of internally spiralled pipe that mixes air and water together. The two components, which are both about 8 feet in length, replace the last section of discharge pipe at a point before the mine water is emptied into a pond. Along with the settling pond, these components treat the water so that it meets discharge criteria. The system has been used at surface drainage treatment facilities as well, but in such use a pump is required to provide the necessary pressure drop across the Venturi opening.

The ILS has several advantages over conventional mine water treatment facilities. It is inexpensive ($5,000 to $10,000) and extremely simple to install and operate. It requires very little space, and in fact, can be portable if desired. It can be operated continuously or intermittently




**The graph shows tremendous drop in ferrous iron levels after mine water was run through in-line aeration and treatment system.**




**Components of the jet pump used in-line aeration and treatment of acid mine drainage**

and requires no electric power (though it does add slightly to the load on the mine water discharge pump). The entire system is made of polyvinyl chloride (PVC) and copolymer polypropylene resins to resist corrosion, and the system contains no moving parts, so maintenance requirements are minimal. Perhaps most important, it is effective over a wide range of water quality and can be easily modified in design to cover a wide range of flow and pressure conditions.

## Test Results

The ILS was first tested as a simple aeration unit at a mine site in Greene County, PA where $Fe^{2+}$ levels were erratic but often exceeded 100 mg/L. As an alternative to mechanical aeration, the ILS was installed at the end of the discharge pipe from the underground mine. Monitoring of the discharge from the pond began on the fourth day after installation of the ILS. Ferrous iron concentrations dropped from rates of 10 to 20 mg/L before installation of the ILS to 0.2 to 0.9 mg/L after installation of the system. Total iron concentrations fell from 20 mg/L to less than 2 mg/L.

Subsequent aeration tests were conducted with more acidic water. Iron oxidation continued to be impressive despite an influent pH of 4.6 to 5.6.

To raise the pH, NaOH was dripped into the jet pumps of the ILS. As a result, iron oxidation rates accelerated tremendously. The graph plots almost complete oxidation of $Fe^{2+}$ in the 4-second transit time of the ILS, from an average influent concentration of 190 mg/L (at an average pH of 4.5) to 2.4 mg/L (at an average pH of 6.9) after passing through the static mixer. Most of this oxidation occurred in the jet pump section of the ILS; water samples collected between the jet pump and the static mixer had an average pH of 6.7 with an $Fe^{2+}$ concentration of only 4.8 mg/L. The discharge from the first pond, with an estimated detention time of 24 hours, was consistently below 2.5 mg/L $Fe^{2+}$, and typically 1.0 mg/L or less.

The ILS was next tested at a surface mine near Quinwood, WV, where seepage and surface runoff from a recently reclaimed stripping operation have produced a mine drainage with 1,000 mg/L $Fe^{2+}$ and 70 mg/L manganese. Water with NaOH added was pumped from one pond to another through the ILS using a portable diesel-powered 6-inch trash pump. At an estimated flow rate of 1250 gpm, $Fe^{2+}$ was reduced by 283 to 369 mg/L as it passed through the ILS. Pond retention (48 hours) lowered iron concentrations to 18.5 mg/L and manganese to 17.5 mg/L as colloidal particles settled. Additional settling time lowered these numbers still further (removing all of the manganese after 11 days). In one test, the process was hastened by passing the water through the ILS again.

At a site near Indiana, PA, the ILS was tested against an existing mine water treatment facility, using the same lime slurry in both tests. Influent pH was about 3, with a ferrous iron concentration of about 75 mg/L and manganese concentrations of about 10 mg/L. Dissolved iron and manganese were below detectable limits after a single pass through the ILS at pH of about 7. Retention in ponds was required to settle the suspended iron and manganese. The ILS required use of significantly less lime than the conventional treatment.

Design specifications for various flow rates and water quality characteristics will be determined during additional field tests in northern West Virginia and southwestern Pennsylvania.

## Patent Status

The U.S. Department of the Interior is currently applying for a patent on this technology.

## For More Information

Additional information can be obtained by contacting Mr. Terry Ackman at the Bureau of Mines, Pittsburgh Research Center, P.O. Box 18070, Pittsburgh, PA 15236 or telephone him at 412/675-6566.