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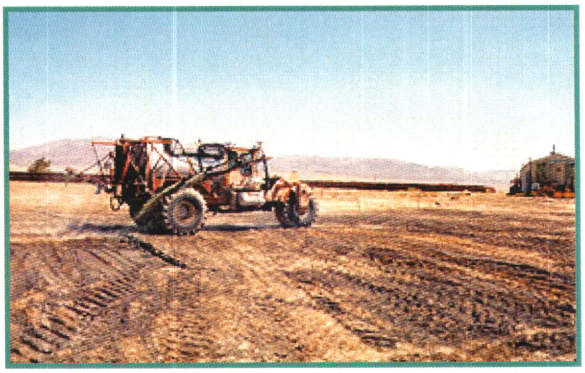
DIV. OF OIL, GAS & MIN

MT2 LLC™

METALS TREATMENT TECHNOLOGIES, LLC



ECOBOND™

www.metalstt.com

MT^2 PROCESS OVERVIEW

- MT^2 offers a portfolio of patented and proprietary technologies that are specifically tailored to solve our clients heavy metals stabilization needs
- MT^2 offers multiple metals stabilization technologies ensuring the best technology for the clients needs
- MT^2 uses proven, EPA approved technologies with long term, successful performance records
- MT^2 technical personnel are experienced in field operations ensuring quick and successful treatment of your metals contaminated waste
- MT^2 treatments are backed by in-house laboratory treatability studies

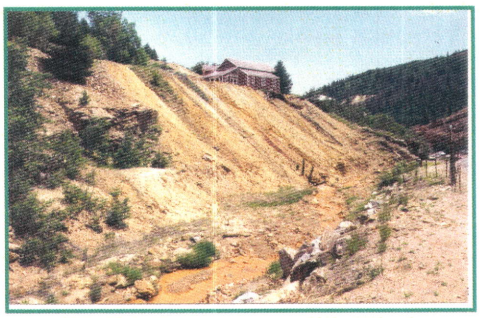
THE COST EFFECTIVE METALS TREATMENT PROCESS

	MT^2 Treatment Costs	Traditional Treatment Costs
Ex-Situ Mixing	**$10–30/ton**	**$30-50/ton**
In-Situ	**$5–25/ton**	**$20-40/ton**

THE MT^2 ADVANTAGE

- Ease of application
- Strong affinity to wide range of metals
- Less than 5% additives, minimal bulking
- Fast reaction and cure time
- No odors or secondary waste streams

ECOBOND™ ARD TREATMENT FOR THE MINING INDUSTRY



Acid rock drainage (ARD) is one of the most serious and persistent pollution problems facing today's hard rock and coal mining industry. ARD is formed when pyrite-bearing rock is mined or exposed to natural weathering conditions. Pyrite weathering results in the generation of sulfuric acid and leads to runoff water that is characterized by high levels of heavy metals and a low pH (acid). Rivers, lakes and groundwater systems that receive runoff water from mines that discharge ARD are in turn contaminated with heavy metals and typically cannot support aquatic life and can result in metals polluted water wells.

In the US, ARD from abandoned coal and hard rock mines has polluted 180,000 acres of reservoirs and lakes and 12,000 miles of streams and rivers. In the western United States there are more than 300,000 abandoned mines and it been estimated that cleaning up the mines and associated polluted waterways will cost US taxpayers between $32 billion and $72 billion. Not only is ARD collection and treatment very costly to the environment, it is a major cost for the mining industry. According T.D. Pearse, Resource Consulting, "Site stabilization costs can be as high as $166,000 per acre." At the Summitville, Colorado mine Superfund site ARD mitigation has cost the state of Colorado and the EPA in excess of $250,000 per acre.

Metals Treatment Technologies, LLC (MT^2) has developed an ARD treatment, EcoBond™ ARD, that effectively inhibits the oxidation of pyrite thus curtailing the pyrite oxidation cycle before it can begin. The significance of this is that EcoBond™ ARD treats the source of the problem and effectively stops the oxidation of pyrite. As shown on Graph One, leachate from ARD generating rocks with an initial acidic pH of 2.3 quickly improved to a basic pH of 8 with the application of EcoBond™ ARD. At a pH of 8, the solubility of metals in water is virtually halted and there is essentially no discharge of metals from the mine site.

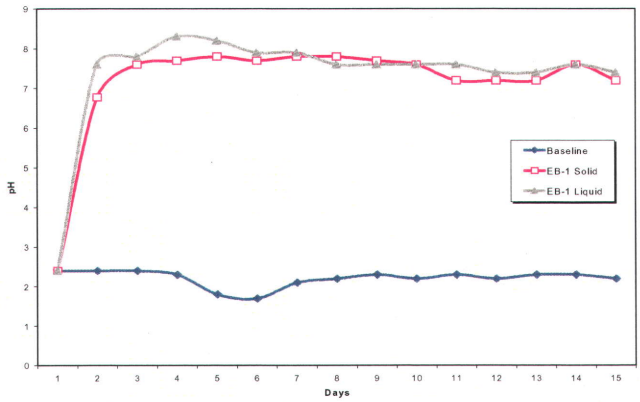
There are technologies that compete with EcoBond™ ARD such as hydrated lime and potassium permanganate. However, unlike EcoBond™ ARD, these technologies treat the symptoms of ARD rather than the source of the problem – oxidizing pyrite. They also have application problems. Lime treatment is consumed by the ARD acid and generally has to be reapplied annually (Graph Two). Potassium permanganate can only be applied at a pH of 12 or more. Pyrite bearing rocks at a mine with an ARD problem typically have pH's in the 2 to 3 range and are not receptive to treatment with potassium permanganate.

CORPORATE OFFICE

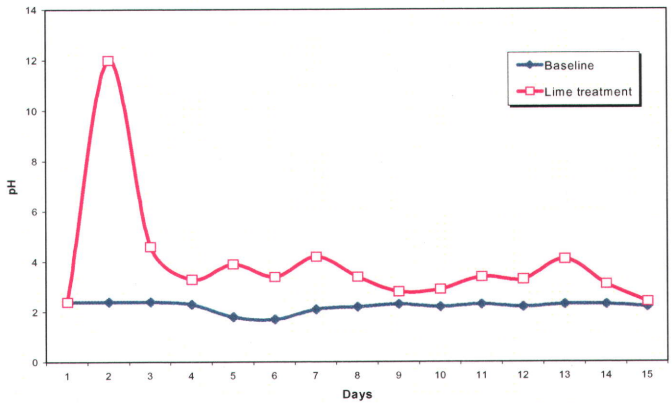
12441 West 49th Avenue, Suite 3
Wheat Ridge, CO 80033
(303) 456-6977 (303) 456-6998 Fax
metalstt@msn.com

WASHINGTON D.C. OFFICE

7928 Bayberry Drive
Alexandria, Virginia 22306
(703) 765-3510
www.metalstt.com



Graph One
pH increase in EcoBond™ ARD treated rock versus baseline ARD



Graph Two
Lime consumption by ARD versus baseline ARD

Some of the potential applications of EcoBond™ ARD is to treat mine waste rock dumps and newly exposed rock surfaces that contain pyrite, mine pit highwalls and underground mine workings where oxidizing pyrite is contributing metals to mine water prior to discharge from the mine. By treating these point sources of metals at an ARD producing mine with EcoBond™ ARD, industry can realize significant savings in environmental monitoring, water treatment and reclamation costs – not to mention a reduction in the discharge of metals to the environment.

EcoBond™ ARD can be deployed as a solid and tilled into acid generating mine waste or it can be applied as a liquid and sprayed from a hydroseed cannon that is capable of spraying the EcoBond™ ARD treatment onto mine pit highwalls, high angle mine slopes and waste piles and environmentally sensitive areas such as riparian zones located along streambeds.

Currently the EcoBond™ ARD technology is undergoing Proof of Technology testing at two mine sites, the Gilt Edge mine NPL site and the Golden Sunlight mine. This work is being conducted through a collaboration between US EPA Region 8 and the EPA Office of Research and Development's Mine Waste Technology program

After a one-year field-tests period at the Gilt Edge mine which began in 2000, the EPA will use the data gathered to help formulate the Record of Decision (ROD) for the site. The ROD may recommend that the EcoBond™ ARD technology be incorporated into the multi-million dollar cleanup of the Gilt Edge mine site.

At the Golden Sunlight mine, the EPA will test EcoBond™ ARD's unique ability to be spray applied to mine pit highwalls to halt the formation of ARD. EPA's contractor, MSE, has indicated that there are few if any technologies other than EcoBond™ ARD that are as effective and can be applied to difficult ARD generating topographies such as mine pit highwalls or high angle slopes.

As indicated, acid rock drainage is a worldwide problem facing the industry. The MT^2 group has already received inquiries about the EcoBond™ ARD technology from Canada, the United States, South America, Japan and Australia. To help in the remediation of your ARD problems, MT^2 will gladly conduct an EcoBond™ ARD treatability test on your ARD generating materials. Contact Metals Treatment Technologies at (888) 435-6645, e-mail us at info@metalstt.com or visit our web site at www.metalstt.com.

GOLDEN SUNLIGHT MINE ACID ROCK DRAINAGE (ARD) HIGHWALL DEMONSTRATION

Client: U.S. Environmental Protection Agency and MSE, Inc.
Location: Whitehall, Montana
Date: Ongoing

Site Description
Golden Sunlight Mine (GSM) is an operating gold mine near Whitehall, Montana evaluating closure options. The mine's average discharge for the highwall exceeds State of Montana human health standards for pH, copper, iron, manganese, nickel, zinc and sulfate.

Project Objectives
The primary objective of the field demonstration is to evaluate the technologies applied to the highwall at the GSM for their ability to decrease or eliminate acid generation from treated areas as compared to untreated areas. More specifically, the project objectives include:

- Determine the impact that treated areas of the highwall have on the pH of wash residual samples as compared to the pH in wash residual samples from the untreated areas
- Determine the impact that treated areas of highwall have on the total metal (Al, Cu, Fe, Mn, Ni and Zn) loading per unit area in wash residual samples as compared to the total metal loading in wash residual samples from the untreated areas.

Technology Description
EcoBond™ ARD is a phosphate based ARD treatment process developed to stop the oxidation of pyrite on mine dumps, highwalls and in underground mine workings. By combining Fe^{+3} with EcoBond™, a stable, insoluble compound is formed. The new compound renders the Fe^{+3} in the pyrite unavailable for oxidation by permanently coating all surfaces that it contacts. EcoBond™ also reacts with $Fe+^{2}$ ion to form a second stable compound that coats all surfaces it contacts.

EcoBond™ will be sprayed in a liquid form on the open pit highwall. Once applied to the acid generating rock, the reaction of the EcoBond™ with the pyrite should be complete within 24 to 48 hours. The pH will stabilize at an environmentally safe level with available ferrous iron in the system experiencing a significant decrease. The minimum required air and highwall surface area temperature is 32 degrees Fahrenheit. There is some evidence that warmer temperatures support better reaction kinetics. This will be tested during the demonstration.

KEY DATA

Problem: ARD is one of the most serious and persistent pollution problems facing today's hard rock and coal mining industry

Remedy: Use EcoBond™ ARD to stop the oxidation of pyrite before it can begin, thus curtailing the pyrite oxidation cycle

Result: EcoBond™ ARD stops the oxidation of pyrite and removes the ferric iron from the ARD system, drastically reducing the discharge of acid and metals

Contract Value: Pending

ADVANTAGES

EcoBond™ ARD treats the source (oxidizing pyrite), not the symptoms of ARD (acid and metals)

EcoBond™ ARD can be applied in a wet or dry form and can be sprayed onto or tilled into ARD

EcoBond™ ARD can be applied to difficult reach areas such as highwalls and steep slopes

Technology Application
MT^2 will apply our liquid form of EcoBond™ ARD onto a 50' high and 40' wide highwall area at the GSM. The site-specific formula will be applied by spraying at a high pressure utilizing a low volume of water. This application method will ensure comprehensive coverage of the highwall and provide sufficient contact of the EcoBond™ to the site rock.

GILT EDGE MINE ACID ROCK DRAINAGE (ARD) DEMONSTRATION SITE

Client: U.S. Environmental Protection Agency (USEPA)
Location: Lead, South Dakota
Date: Ongoing

Project Overview:
In 2000, MT^2 was invited by USEPA to demonstrate the EcoBond™ ARD prevention technology at the Gilt Edge mine located in South Dakota. The Gilt Edge mine is undergoing substantial reclamation. The EPA's demonstration objectives included identification of a new technology that would reduce or eliminate the generation of ARD thereby reducing mine closure and reclamation costs including long-term operation and maintenance costs. This demonstration of EcoBond™'s ARD technology is expected to yield treatment results that will be used to solve ARD problems at the Gilt Edge mine on a project-wide scale in the future.

Project Objectives
The project was established to accomplish dual purposes: 1) provide valuable research findings that foster the development of potentially viable mine waste remediation technologies, and 2) provide site-specific information from field treatability studies to aid in the development of remedial planning options for cleanup of the Gilt Edge NPL Site.

Project Description
Test cells were constructed 40' long and 10' wide. The floors of the cells have a 3% grade. Site rock was placed into each cell having a field paste pH ranging from 1-6 and a size distribution of 90% minus-6" and 80% minus-2", with the size extending down to silt-size. The cells receive meteoric precipitation. Effluent water will be analyzed periodically for metals, sulfate and pH.

Technology Description
EcoBond™ ARD is a phosphate based ARD treatment process developed to stop the oxidation of pyrite on mine dumps, highwalls and in underground mine workings. By combining Fe^{+3} with EcoBond™, a stable, insoluble compound is formed. The new compound renders the Fe^{+3} in the pyrite unavailable for oxidation by permanently coating all surfaces that it contacts. EcoBond™ also reacts with $Fe+^{2}$ ion to form a second stable compound that coats all surfaces it contacts.

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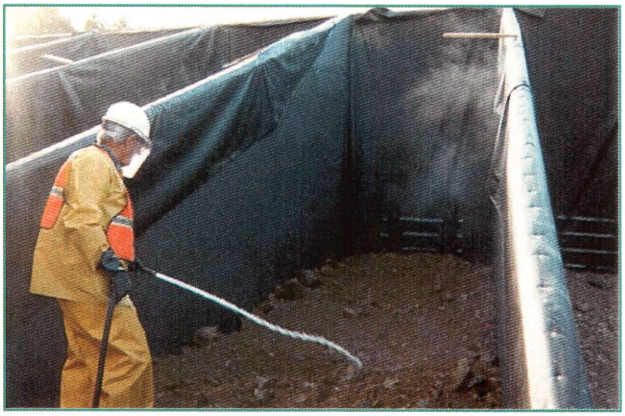


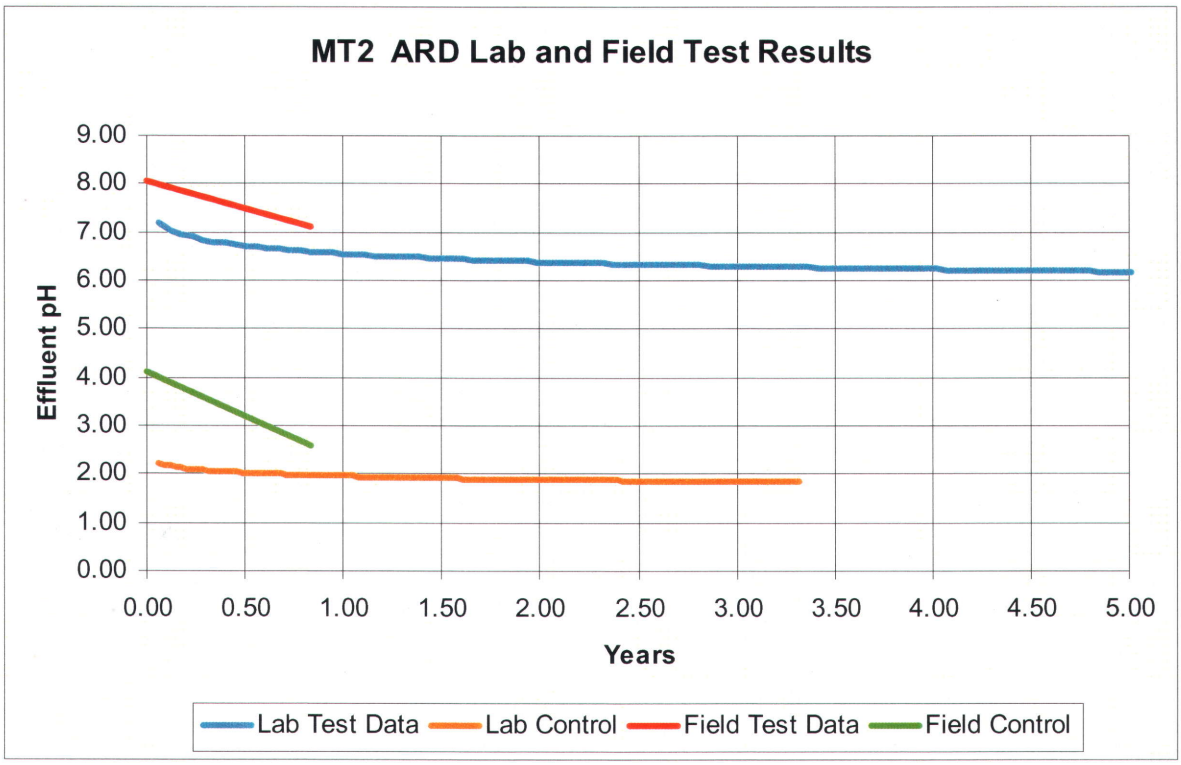
Once applied to the acid generating rock, the reaction of the EcoBond™ with the pyrite should be complete within 24 to 48 hours. The pH will stabilize at an environmentally safe level with available ferrous iron in the system experiencing a significant decrease.

Technology Application

EcoBond™ ARD was applied in a liquid form to allow for complete coverage of the rock. The site-specific formula was mixed on-site and then applied with a low volume of water spray over the rock in the test cells. This was repeated as each layer of rock was added to the test cell.

Comparison of Lab and Field Testing Results

The following reveals that the field data is tracking similarly to the lab results. While testing ceased at an equivalent five years during lab testing, overall longevity of treatment is undetermined and will be impacted largely by physical, erosion and environmental conditions.

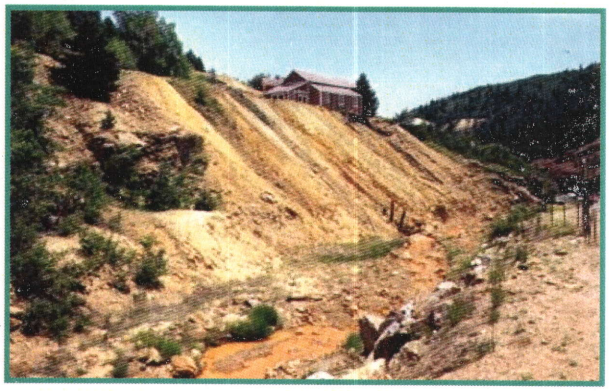


Notes:

1. Lab years are simulated equivalent moisture events run through columns (16.6 inch per year), field is actual time duration.
2. Field data as of 07/16/01 reveals MT2 total iron effluent at 0.04 and 0.07 ppm as compared to control data of 1220 and 129 ppm.

WASTE TYPES TREATED

- **Metals contaminated soil**
- **Mining and smelter wastes**
- **Industrial process wastes**



TECHNOLOGICAL EXCELLENCE

- **Achieves EPA stabilization standards**
- **Reduces metals bioavailability**
- **Passes simulated 1,000 years of leaching (MEP tests)**

WHO BENEFITS FROM USING MT^2?

Commercial and Industry

- Mining and smelting operations
- Battery recycle and disposal sites
- Military and private firing ranges
- Brownfield/Real estate development
- Process wastes and sludges
- Electric arc steel manufactures

Government Agencies and Programs

- Environmental Protection Agency
- State Environmental and Health agencies
- Department of Energy
- Department of Defense
- Bureau of Reclamation
- US Army Corps of Engineers

MT^2 TREATMENT PROCESS REDUCES METALS LEACHABILITY TO EPA STANDARDS

Metals Treated	Pre-Treatment TCLP (ppm)	Post Treatment TCLP (ppm)	EPA RCRA Standard (ppm)	EPA UTS Standard (ppm)
Arsenic	2,200	1.03	5	5.0
Cadmium	160	0.10	1	0.11
Chromium	14	<0.05	5	0.65
Barium	249	0.03	100	21
Lead	980	0.25	5	0.75
Zinc	108	2	NS	4.3
Selenium	190	0.89	1	5.7
Mercury	10.6	<0.01	0.2	0.025

MT^2 SERVICES INCLUDE:

- **Investigation/Feasibility Analysis**
- **Technology Evaluations**
- **Treatability Studies**
- **Treatment Cost Optimizations**
- **Turn-key Remediation (In Situ/Ex Situ)**
- **Chemical Reagent Supply and Supervision**
- **Innovative Field Analytical Methods**
- **Technology Licenses to Others**

MT^2 is a business specializing in providing innovative and economical solutions for the treatment and remediation of heavy metals contamination found in wastes and soil. MT^2 was formed to offer the professional services of our highly qualified technical staff and broad portfolio of proprietary and patented technologies. MT^2 operates a treatability laboratory in our Wheat Ridge, Colorado corporate office. We provide clients with tailored metals solutions that are optimized for each specific project, from regional offices nationwide. Contact us toll-free at (888) 435-6645.

CORPORATE OFFICE

12441 W. 49th Avenue, Suite 3
Wheat Ridge, Colorado 80033
(303) 456-6977 Phone
(303) 456-6998 Fax
(888) 435-6645 Toll-Free
info@metalstt.com

www.metalstt.com