



La Coipa Dry Stack Tailings Facility in the high Atacama Desert in Chile

Conclusion

Dry tailings technologies provide an opportunity for some operations to step away from the historic issues that have plagued tailings disposal facilities and offer an alternative for tailings management in an environment of increased

regulatory scrutiny and public awareness. This could be especially true in locations such as the arid southwest where water quantity, water quality, land use, and visual impacts are becoming more of a concern.



The mission of the Mining Foundation of the Southwest is to promote public understanding and education related to the mining industry, both in the U.S. and abroad. mfsw@dakotacom.net



The Department of Mining and Geological Engineering is a founding department of the University of Arizona, the only mining engineering program in the PAC-10, and one of only 13 such programs in the US. www.mge.arizona.edu

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GOOD INFORMATION = GOOD DECISIONS

factual information from credible sources for public and private decision makers and for all people who care deeply about our state and national economy and our environment

\$3.5B Impact of Copper on the Arizona Economy

Excerpted from Dr. George F. Leaming, Western Economic Analysis Center "The Economic Impact of the Arizona Copper Industry 2005", May 2006

Arizona's copper industry added \$19B to the U.S. economy in 2005. The value of copper produced in Arizona increased 36% in 2005 over 2004. The industry employed 6,900 Arizonans directly, up 8% from last year. Overall, 22,200 jobs exist for Arizonans because of the copper industry. The average annual pay rose to \$59,400 up from \$57,000 last year. Arizona schools received

\$36M in payments from copper mining. The direct and indirect impact of Arizona copper was \$3.518B for the state's economy. Nearly \$223M of the revenues received by state and local governments in Arizona was created by the copper industry. The copper industry in Arizona helped lower the U.S. trade deficit with \$277M in copper and other metals exported.

The Arizona Department of Mines and Mineral Resources reported on July 1, 2006 that the value of Arizona mining including sand, gravel, aggregate, coal and copper for 2005 was \$5B.



Direct Impact of Copper Mining in 2005 Top 8 Counties	
Pima	\$ 580.1M
Maricopa	461.8
Greenlee	184.8
Gila	111.1
Graham	77.8
Pinal	69.0
Yavapai	53.1
Cochise	43.6



New Environmental Management

There is no doubt that mining produces many different and generally large materials management opportunities. As machinery and equipment have become larger through technological advances, the amount of material managed has grown an equal amount. However, technological advances have not only taken place on the equipment side. Advances have also been made in chemistry, materials processing, and in water conservation systems. *Continued on page 3...*



Common Sense and the Use of Cyanide in Gold Mining

Cyanide is a natural substance that rapidly decomposes in the environment in contrast to many man-made chemicals. Cyanide occurs in tobacco smoke, tapioca (tapioca is made from manioc) automobile exhaust and in table salt.

Cyanide is used in gold mining because it dissolves gold when mixed in low concentrations with water. Although a deadly poison when ingested or breathed it is no different than many poisonous substances that we have around our homes; like gasoline, garden sprays and drain cleaner. Knowledge, common sense, sound management procedures, and a responsible attitude allow us to use poisonous substances at home and in industry safely.

Cyanide has a number of properties that allow its safe use. It is a natural substance that rapidly decomposes in the environment in contrast to many man-made chemicals. Cyanide, for example, readily decomposes in air. It produces no known ill effects from repeated exposures in low concentrations. This may be a consequence of our building immunity from ingesting small amounts of cyanide in many of our foods.

Many familiar foods contain cyanide or thiocyanate including:

- Most fruit kernels or seeds (e.g., apricot, apple, plum, papaya, and almonds)
 - Most beans and peas, more if sprouted (e.g., mung, lima, garbanzo)
 - Most berries (e.g., blackberry, huckleberry, raspberry)
 - Flaxseed
 - Tubers (manioc and yams)
 - Buckwheat, millet, sorghum and alfalfa
- Vegetables (e.g., broccoli, kale, sweet potato)

In addition, cyanide occurs in tobacco smoke, tapioca (tapioca is made from manioc) automobile exhaust and in table salt.

Among the richest natural sources of cyanide and thiocyanate are manioc, also called cassava or yucca and true yams (the

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The most common cyanide poisoning is not from industrial use but from smoke inhalation that kills in excess of 5,000 annually.

white tubers grown in tropical (tries). can and Indian diets that are comprised mostly of yam and cassava may contain near lethal amounts of cyanide (up to 0.1 gram). Apparently spacing this amount dosage over several meals avoids any toxic effects. Cyanide is processed into thiocyanate in the body. In pre WW II times, thiocyanate was used to treat high blood pressure. Africans today commonly have high blood pressure, but this was rare a generation ago. It is speculated that the increase in African blood pressure problems is a consequence of eating bread and rice in place of yams and cassava.

Cyanide use in the mining industry raises concerns because of its acute toxic properties. Hydrogen cyanide and cyanide salts are rapidly acting poisons; a dose of 0.3 grams – about the amount in pinch of cyanide salt- can kill a human. Cyanide bonds to iron-containing enzymes (ferricytochrome oxidase enzyme) in the body and prevents cells from using oxygen. Cyanide poisoning can incur by breathing cyanide gas, principally hydrogen cyanide (HCN), by ingestion, and less commonly by adsorption through the skin.

The most common cyanide poisoning is not from industrial use, but rather from smoke inhalation that kills in excess of 5,000 annually in the US. Burning natural fibers like wool, silk and cotton produces hydrogen cyanide gas as does the burning of synthetic materials such as nylon and polyurethane. In contrast, Mark Logston and others (2006) in a review of cyanide use in the US, Canada, Australia and New Zealand gold mining industries found only 3 fatalities related to accidents involving cyanide over the past 100 years.

CYANIDE: Quick Facts

18% of the cyanide produced is used in gold extraction. The remainder is used in the production of nylon and acrylics, steel hardening, and synthetic rubber.

In pre-WWII times, thiocyanite was used to treat high blood pressure

Cyanide leach solutions contain low amounts of cyanide—similar to the amount in bitter almonds and cassava

Cyanide is used in the gold mining industry with sound risk

management. Cyanide leach solutions contain low amounts of cyanide – concentrations about those in bitter almonds and cassava. Poisoning requires drinking 3-4 glasses of cyanide solution or more. A splash of gold leach solution on the face or some on your hand is harmless. Cyanide is recaptured and reused booth for safety and because it is expensive. Typically gold mine wastewater has a concentration of about 0.0001 grams cyanide per liter, far less than that in raspberries. The little cyanide in mine waste is rapidly destroyed by sunlight and oxygen. Also, waste is kept in well-lined impoundments in order to prevent seepage, and ground waters nearby are monitored.

About 1.4 million tons of cyanide is produced annually for use in a wide range of industrial processes. About 18% of the total cyanide produced is used in gold extraction. The remainder is used in manufacturing that includes: the production of nylon and acrylics, steel hardening, and the production of synthetic rubber. Cyanide chemistry and environmental impacts are well known. Risk management plans are used that address the possibility of exposure to humans and the environment to spills during transport, exposure to cyanide gas in enclosed spaces, and release of cyanide to surface and groundwater. Good management plans have minimized the risk of cyanide poisoning for all industries using cyanide.

Mark J. Logsdon MSc, Karen Hagelstein, Ph.D., CIH, Terry I. Mudder, Ph.D. (2006) The Management of Cyanide in Gold Extraction, ICMM; www.icmm.com/library_pub_detail.php?rcd=15



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Dry Tailings – An Alternative to Conventional Tailings Management

Dry tailings are the consistency of damp sand. They are more common in arid environments where water is limited. The low moisture content also mitigates long-term risks like acid rock drainage.

Historically, when engineers looked at tailings management, there were few options other than designing and constructing large impoundments designed to manage tailings slurries with an initial solids content between 25 and 40%. The management of the impoundments became an exercise in recovering water and maintaining stability and impoundment integrity. These facilities have operational disadvantages such as high water losses through evaporation and long-term impacts such as leachate seepage. Additionally, conventional tailings ponds require careful design and must be managed to maintain physical stability to prevent potential for catastrophic structural failure.

The technological development of large vacuum and pressure filter technology has presented the opportunity for dewatering tailings, resulting in some tremendous environmental advantages over impounded slurried tailings. The primary advantages include limited seepage, enhanced structural stability, and water conservation.

Technology

A number of “thickened” tailings options exist depending upon the technology implemented. Two of the most commonly discussed tailings disposal practices are described below.

Paste tailings are the thickest of the thickened tailings options that are still saturated and therefore pumpable. Their consistency is best compared to toothpaste. The water content is still approximately 25% but it does not segregate from the solids.

Dry cake, or simply dry, tailings are unsaturated and must be moved by truck or conveyor. Their consistency is best compared to damp sand where the water content is approximately 12-25% and almost no free liquid is present.

Dry tailings have become more common where water is limited due to arid conditions and in climates where freezing is

common. However, dry tailings will not work for all applications and is particularly dependent upon mineral types and the necessary grind size to promote efficient flotation.

Issues

If dry tailings exceed all of the technological hurdles for a particular project, one additional hurdle will be the economic impact to the project. Because the dry tailings process requires a number of added processing and management steps, it is considerably more expensive per ton than conventional tailings. However, even the economic issues presented by increased handling may be overcome by the reduction in water consumption costs, the elimination of costs associated with construction of containment dams, and typically lower closure costs.

In general, most issues associated with dry tailings are not negative; some of those positive issues are listed below:

- Dry tailings operations are less invasive since less storage space is necessary resulting in a smaller project footprint. Dry tailings can be more effectively managed and placed than conventional tailings;
- Dry tailings stacks are more physically stable and secure and almost immune to catastrophic failures because they are placed in a much denser and dryer state and will not be mobilized in case of containment loss, even during earthquake events;
- Progressive reclamation is possible as the dry tailings can be placed in configurations appropriate for capping and reseeded; and
- Long term environmental risks, such as acid rock drainage and seepage issues, are almost non-existent due to the low moisture contents and low potential for oxidation. There can be potential air impacts from dry tailings management; however, this can be mitigated using cover and other operational controls.

One final issue is the regulatory environment and the view that is historically taken with regards to mining. In general, it is easy to point at an operation that is 50 or more years old, see the bad and ignore the technological advances that have been made. The issue for dry tailings use in this environment is to educate the regulators, and the community, as to the benefits and changes that have been made since legacy mining operations were first developed. The regulatory environment is generally becoming less tolerant with the mining industry, so development of new technologies that are viewed as lower risk to public health and environment and less invasive to land use is positive.

Examples

As stated earlier, dry tailings are primarily found in arid environments and cold climates. Greens Creek, Alaska and Raglan Quebec are examples found in cold climates and La Coipa, Chile is an example found in an arid environment.

The La Coipa facility shown on the back page is one of the largest operating dry tailings stacks. The region is also well known as a high seismic region and is in the arid environment of the Atacama Desert. Tailings at this facility are stacked using a conveyor system on tracked crawlers that move constantly.

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