Liquid Filtration Applications for Mining Processes

Introduction

Mining processes vary extensively depending on the material being mined, such as iron, copper, and gold, and the nature of the ore body. These processes include conventional milling, grinding, and smelting processes as well as leaching and extraction processes. All of the above processes require significant amounts of process water for a wide range of uses. This customer application brief describes common applications within mining processes where process water quality is critical, identifies the benefits of filtration, and provides guidelines for selection of the appropriate 3M Purification Inc. filter solution.

Mining

Two common types of mining operations are Surface and Underground Mining. Surface mines usually extend to a depth of about 500 feet, below which it is usually more cost effective to extract the ore from underground. The economics of surface mining are dependent on the ore to waste ratio, which is determined by factors such as the shape of the ore body and the amount of overburden to be reduced. Surface mining operations consist of drilling/blasting and then lifting of the broken ore either into trucks or onto conveyors for transportation to the processing plant. In underground mines, the target ore body is accessed via vertical shafts and/or inclined roadways. At the desired mining location, horizontal tunnels are driven to reach the ore deposit. There are many different extraction techniques including room & pillar, longwall, and block caving. Although some waste rock can be stored underground, for uses such as roof supports, most has to be taken to the surface.

Mineral Processing

After reduction of the ore from the ground, the valuable metal needs to be separated from the surrounding waste material. Conventional initial mineral processing stages usually involve crushing and grinding of the ore to reduce the material to finer sizes. Classifiers, think of giant sieves, are used to control particle sizing, with the oversize material being reprocessed. These processes are designed to maximize the surface area enhancing the ability of recovering the valuable metal elements.

The next processing steps normally involve processes that increase the concentration of the desired metal elements. Depending on the mine specifics, these operations may take place at the mine site or at a separate mineral processing facility. The most common concentration processing methods involve the use of flotation processes, which have been used to separate minerals since the early 1900s. The processes involve treating the ground ore in a bubbling mixture of water and specific chemistries. The target metals bond with the chemicals and float to the surface where they are skimmed off.

After the concentration processes, the metals laden "concentrate" material is sent to metals recovery and purification processes. Common examples of these purification processes for specific types of metals include:

- *Aluminum:* Mined ground bauxite is mixed with caustic soda to form a slurry. After further treatment, the particles are smelted to form alumina. Oxygen is driven off by electrolytic action to produce aluminum.
- *Copper:* Ore concentrates are smelted in a furnace to create copper matte. Impurities such as iron and sulfur are then reduced in a converter where heated air is blown through the material to create blister copper which is electrolytically-refined to produce copper cathodes.
- *Zinc:* Ore concentrates are roasted and the resulting calcine is leached and purified. Electrolyte zinc is deposited on sheets, stripped from the sheets and then melted in a furnace. The molten metal subsequently cast in slabs.

The waste material from these processes is usually transported to “tailings” facilities for disposal/storage. These facilities are expensive to maintain and must content with environmental issues such as contamination of nearby water sources and air pollution causes by dust.

There have been many advancements to mineral processing methods. As an example, for certain type of ore bodies, many copper mines have switched to a leaching process for recovery of the copper. This process involves percolating a chemical solution through stacked “heaps” of material to dissolve the contained copper. Depending on the nature of the ore body, the heap can consist of crushed or uncrushed ore. The leached copper is then sent to a solvent extraction and electrowinning processes (SX-EW) for recovery. This process is usually much less costly than conventional floating/smelting/refining processes.

Mining Processes and Water Quality Problems

Within mining operations, process water is used extensively for a number of functions. Due to the large quantities of water required for the processes, generally the water sources such as rivers, lakes, and wells are not filtered, or, at best, subject to coarse filtration methods like screens.

Typical contaminants found in process water streams include:

- Silt, Sand, Organic Matter - originating from the water source
- Corrosion & Scale Products - generated and transported through the piping systems

While the tolerances for suspended solids fouling are high in several of the large water systems used with milling and grinding operations, there are some process water uses which can be significantly impacted by water quality.

Dust Control Systems

Dust control systems using water sprays are used extensively in the mining industry to reduce air-borne dust levels in the various work environments. For maximum effectiveness, nozzles with small orifices are used to distribute spray water. These small orifices can become plugged with process water contaminants. Dust control spray nozzle pluggage will reduce the effectiveness of the system dust control leading to unsafe working environments due to higher airborne dust levels and/or fines due to excessive dust emissions.

Heat Exchanger Systems

Heat exchanger systems are utilized to reduce heat generated from the processes. Oftentimes, the application requires the use of plate & frame heat exchange equipment which can be susceptible to fouling. Process water contaminants can foul the heat exchange surfaces reducing heat exchange effectiveness. Potentially, this can limit processing capabilities, and, if severe enough, result in process interruptions for heat exchanger cleaning.

Pump Seal Systems

Many mining processes utilize high pressure water pumps for descaling and /or vacuum pumps. These pump systems have critical water systems for the pump seals. Process water contaminants can cause pump seal failure resulting in process interruptions for pump repair and premature pump replacement.

The results and impacts of insufficient process water quality are summarized in Table 1.

Table 1: Results and Impact of Poor Process Water Quality

Result	Impact
Spray Nozzle Pluggage	Insufficient dust control protection - higher airborne dust levels
	Increased nozzle maintenance/replacement
Heat Exchanger Fouling	Reduced process efficiency
	Increased heat exchanger cleaning requirements
Pump Seal Failure	Premature pump replacement
	Process interruptions

The Solution

3M Purification offers a wide range of liquid filtration solutions for process water applications. The selection of the optimum filtration solution depends on a number of operating conditions such as flow, temperature, process water quality, nature of contaminants, final

quality requirements, and equipment protection requirements. For spray nozzle applications, it is recommended to use a filter with a micron rating that is smaller than the diameter of the spray nozzle opening. Typically filters with 10 micron ratings work well in these applications.

Two of the more common 3M Purification filtration solutions for process water applications are discussed in detail below:

A. **3M™ DF Series Filtration System:** This filtration system is an improved alternative to the use of conventional nominally rated liquid filter bag systems. Compared to conventional bag filters, 3M DF series filter elements offer the following features:

- Greater than 60% more filter surface area - for increased contaminant capture capacity
- Graded-porosity structure - for cost effective capture of contaminants of wide ranging sizes and shapes
- Innovative new geometry of both filter element and basket for 100% support of the filter media - reducing the potential for element/bag rupture and subsequent downstream contamination

The unique design of the 3M DF series filter system can provide for up to 2 - 5 times more service life and 2- 3 times more contaminant capture capacity than conventional bag filters translating into reduced change-out requirements.

The materials of construction (polypropylene or polyester) make 3M DF series compatible with most all process water applications. 3M DF series filter elements come in Size #1 and #2 configurations, capable of 75 and 150 gpm of process water flow respectively, and in a wide range of grades from 1 to 200

Figure 1. 3M™ DF Series Filter system

Using baskets providing 3-dimensional support, 3M DF series elements can be retrofitted into most major manufacturer's bag housings. For new applications, 3M Purification has a complete line of 3M DF series filter housings available in a wide range of sizes including single element as well as multi-elements, and both steel and stainless steel materials of construction.

For more information about the 3M DF series filtration system, request 3M Purification literature LITCDUOF1.

B. **Micro-Klean™ RT Series Filtration System:** For process water applications where higher contaminant capture capabilities are desired and/or smaller system flows, such as point-of-use applications, are involved, Micro-Klean RT series filter cartridges represent an excellent choice. Micro-Klean RT series cartridges offer the following features & benefits:

- Grooved filter surfaces - for increased contaminant capture and subsequent filter life
- Rigid construction - preventing by-pass and unloading of captured contaminants and subsequent downstream contamination

The unique design of Micro-Klean RT series cartridges can provide for up to 2 - 10 times more service life than competitive melt blown filters translating into reduced change-out requirements.

The all polypropylene Micro-Klean RT series cartridge construction is compatible with most all process water applications. Micro-Klean RT series filter cartridges come in a wide range of grades, from 1 to 70u), cartridge lengths from 10 to 40 inches, and double or single open end configurations.

Micro-Klean RT series cartridges can be used in most major manufacturer's cartridge filter housings. For new applications, 3M Purification has a complete line of cartridge filter housings to accommodate a wide range of flow and material of construction requirements.

Figure 2. Micro-Klean™ RT Series Filter Cartridges

For more information about the Micro-Klean RT series filters, request 3M Purification literature LITCPOLYKLN.

Conclusions

Mining processes utilize large amounts of water. Some of the process water applications involve critical equipment that is susceptible to fouling/plugging from contaminants found in the process water. These applications include Spray Nozzle Systems, Heat Exchanger Systems, and Pump Seal Systems.

The use of 3M Purification products for filtration of the process water utilized in the above applications can result in process improvements and/or cost savings. 3M DF series filter elements and Micro-Klean RT series filter cartridges represent excellent choices for these applications.

The potential benefits of process water filtration using these products in the above applications include:

- Helps improve dust control protection
- Helps reduce heat exchanger fouling
- Helps improve pump seal protection

Case Studies of mining process water filtration applications where the use of 3M Purification filtration solutions provided for process improvements and cost savings are available. Contact your local 3M Purification representative for copies.

3M Purification Inc.
400 Research Parkway
Meriden, CT 06450
U.S.A.
Phone (800) 243-6894
(203) 237-5541
Fax (203) 630-4530
www.3Mpurification.com

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