Basic Mining and Processing Principles

Modern-day mining operations extract valuable minerals which containing metals known as ore from underground mines "workings", surface mines "open pits", or previously disturbed areas such as waste rock dumps, stockpile pads, and tailings impoundments.

The economic value of the metals intended for recovery and the chemical and physical characteristics of the ore body determines how the ore will be mined and the processing method that will be used to extract the metal. Because economics play a significant role in mineral and metal recovery mine operators avoid costly process steps such as grinding, and roasting where possible.

Leaching is a relatively low cost and common process that uses chemicals to dissolve the desired metals from the ore for subsequent recovery. Chemical and physical characteristics of the mineral or metal of interest can affect leaching; these include particle size, how the metal is contained within the ore, chemical characteristics of the ore, and the physical and chemical characteristics of the host rock. In some instances the ore can be mined and directly leached without any further processing, this is called run-of-mine ore. In many instances, the ore requires crushing and/or grinding to expose more surface area prior to leaching. Typically, ores with a higher desired metal content (referred to as high-grade ores) are leached in tanks or vats in a mill building, while lower grade ores with a lower desired metal content are normally leached on lined heap leach pads. Because of the characteristics of some ores, an additional pre-treatment step might be necessary. These unique ores are referred to by the industry as "refractory ores" usually require high-temperature roasting to make the ores more amenable to leaching.

Precious metals gold and silver, base metals copper, lead, and zinc, and ferrous metals iron and nickel can be recovered using a weak sodium cyanide solution. Although other chemicals can be used to leach metals, sodium cyanide is preferred for gold and silver recovery because of its low cost and effectiveness. Cyanide leaching has been used worldwide by mining operations for over a century. The leach solution is collected and run through a series of processes to recover the metals from the cyanide solution. These processes may include carbon adsorption, electro-winning, solvent extraction, and refining.

The most common methods for recovery of base metals copper, lead, and zinc include froth flotation and acid leaching. Acid leaching with sulfuric acid is performed on lined heap leach pads in a manner similar to that of cyanide leaching. In froth flotation, chemicals known as surfactants and collectors are added to a slurry mix composed of ground minerals and water in a tank referred to as a flotation cell. Air is injected into the tank to create a thick, bubbly froth, capable of selectively attaching itself to the surface of the desired mineral particle and float it to the surface while the undesired minerals are allowed to sink. The desired mineral froth is mechanically scooped off the surface and collected. The concentrate may be refloated and collected again, to increase the quality of the concentrated material. The final concentrate is processed for final metal recovery. The remaining undesired minerals that are left from the ore are called tailings, and are disposed of by pumping them in a liquid slurry to a lined tailings storage facility designed to prevent the material from leaking into the environment.