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BACK GROUND OF GOLD LEACHING REAGENT -----FLORREA GOLDIX 567

(Excellent Cyanide Replacement , Environmentally friendly)

Florrea Gold Lixiviant GOLDIX 567--- Environmentally friendly Gold Leaching without cyanide.

The various oxidized gold ore were leached with various lixiviants and Florrea Goldix 567 is the best lixiviant substitute for cyanide as gold lixiviant at present, meanwhile gole leaching speeds with organic chlorine C was 8 times of that with cyanide

Gold cyanidation, also called cyanide leaching, is a metallurgical technique for extracting gold from low-grade ore by converting the gold to a water soluble coordination complex. It is the most commonly used process for gold extraction.
Due to the highly poisonous nature of cyanide, the process is controversial and its usage is banned in a number of countries and territories.
It uses cyanide to dissolve the gold within the rock, which, itself, is not soluble in cyanide.
The gold is then drawn out in a liquid form that can be treated to remove the cyanide. Almost 90% of all gold extracted commercially is done so by cyanidation.
The process has been controversial since its inception due to the poisonous nature of cyanide and the threat it poses to the environment and the people working in the extraction facilities.

Once the gold ore is mined it can be treated as a whole ore using a dump leaching or heap leaching processes. This is typical of low-grade, oxide deposits. Normally, the ore is crushed and agglomerated prior to heap leaching. High grade ores and ores resistant to cyanide leaching at coarse particle sizes, require further processing in order to recover the gold values. The processing techniques can include grinding, concentration, roasting, and pressure oxidation prior to cyanidation.

For heap leaching, the rock is crushed into smaller pieces and placed over a liner. A cyanide solution is introduced, which liquifies the gold, releases it from the rock, and allows it to drain away for processing. This method of gold extraction, also known as gold cyanidation, takes several months.

Processing the ore immediately without crushing it is known as dump leaching. Dump leaching is used to extract mostly lower quality gold and metals. It does not require the rock to be broken into small pieces and is cheaper and less effective.

Each process, however, uses cyanide to remove the gold from the ore.

Depending on what other metals are present in the ore, preliminary processes may be necessary to ensure a productive and effective extraction. One such process is ore washing, or submersion of the ore in water with a high pH, known as an alkaline solution. A calcium oxide alkaline solution is often used to neutralize potential acids, after which, the solution is flooded with air, or aerated. These methods limit the extent to which iron and sulfide, commonly found in ore, interact with the cyanide. The use of calcium oxide pre-cyanidation helps ensure that no hydrogen cyanide, a highly toxic form of cyanide, is released during the process.

The process of gold cyanidation is usually conducted in an outdoor setting, though an indoor facility, that meets safety regulations, is sometimes employed. A cyanide salt, such as potassium cyanide, sodium cyanide, or calcium cyanide, the most popular choice, is mixed with water and then applied to the ore. This part of the process is complete when most of the obtainable gold has liquified and been removed.

The amount of time required for near-complete gold cyanidation ranges from as little as 10 hours to as long as 44 hours and depends on the size of the gold particles present in the ore. The more oxygen present at the time of cyanidation, the less time the process will take. When the gold has sufficiently dissolved, it is recovered by one of two methods. It can be adsorbed onto large carbon particles that are filtered from the ore. In the Merrill-Crowe precipitation process, oxygen is removed from the solution, which is then infused with a zinc powder and passed through a filter.

The environmental hazards of using gold cyanidation are numerous, especially since the process often takes place outdoors. If proper safety precautions are not taken, there can be serious consequences for the workers and the surrounding ecosystems. Although measures are undertaken to ensure that no hydrogen cyanide develops, other forms of cyanide still pose a danger to exposed organisms. Harmful chemicals, including nitrates and thiocyanates, are created during cyanidation, though their impact is far less extensive than a cyanide leak. Gold extraction companies must abide by strict safety measures to prevent the occurrence of such an event.

Since the 1890's, cyanide has been used to recover gold from gold bearing ores. And today, over 115 years later, most of the worlds gold is recovered with cyanide playing a large part in the beneficiation of the yellow precious metal. Chemically, it is a rather simple reaction:
$4\ Au + 8(NaCN) + O_2 + 2\ H_2O = 4\ NaAu(CN)_2 + 4\ NaOH$

That presumes that the only elements are the gold, Sodium Cyanide and water. However, as any geologist will tell you, no two ores are the same, and their chemical composition will vary greatly throughout the ore body. These "extra" elements in the mineral compounds will often play havoc with a chemical reaction, as illustrated above.

Copper is definitely worth mentioning, since copper minerals will dissolve in cyanide solutions, and cause a increased use of cyanide, the copper-cyanide complexes formed by the dissolution will tend to inhibit the dissolution of gold in the cyanide solution. Zinc, the element used to precipitate gold from solution, if present in the ore, will bond with the cyanide to form a zinc cyanide compound. Another element that plays with the cyanide chemistry is nickel. Nickel, however does not interfere with the gold going into solution, but rather the precipitation of the gold from the cyanide solution.

Arsenic and antimony do present a larger problem, by reacting with the cyanide and using up all of the excess oxygen, leaving little or no oxygen to effect the dissolution of gold. Carbonaceous gold ores can have the carbon adsorb the gold onto its surface, and as a result will not be recovered from the pregnant solution.

Leaching gold from sulfide ores is difficult, at best. Generally, the recovery for cyanide leaching of sulfide or refractory ores is no better than 30%, which is not a worthwhile venture.

The use of alkalies such as calcium oxide, will prevent the decomposition of cyanide in solution to form hydrogen cyanide gas. It reduces the volume of cyanide required to leach the gold or silver. In addition, hydrogen cyanide is highly toxic to people. So, the few dollars spent on adding a cheap calcium oxide to the ore or solution, prior to leaching is worth the money spent. Most cyanide leaching is carried out at a alkaline pH of between 10 and 11, depending upon lab testing of individual ores and the optimum leaching/chemical use rates.

The cyanide solution strength is also important in leaching gold, with the typical range of solution being in the 0.02% -0.05% NaCN. The gold particle size has a tremendous effect on the time required for dissolution in a cyanide solution. Generally, the finer the gold, the quicker it will dissolve. A 45 micron particle of gold would dissolve in 10-13 hours, while a 150 micron particle might take from 20 to 44 hours to dissolve in the same solution.

Oxygen plays an important role in the leaching of gold in a cyanide solution, also. It has been proven that the rate of dissolution of gold in cyanide solution is directly proportional to the amount of oxygen present. Normal water will have 8-9 ppm dissolved oxygen present in it. If this oxygen is used up by other reactions, it may be necessary to aerate the solution, inducing oxygen into it, to speed up the reaction. With cost being always the determining factor (except in safety), the decision to aerate and speed up the reaction will be made based upon economics and laboratory testing. It is not used much anymore, because most leaching is heap leaching, carried out in the outdoors, where drip emitters or sprays distribute the cyanide solution to a large structure of gold ore, called a "heap". And while the pile of ore is called a heap, it is not a haphazard pile of rocks. Much thought and design goes into the making of a heap leach, to derive the best, most economical solution for recovering the gold from the ore.

Once the gold has been dissolved in the cyanide, and the ore body has been reasonably depleted of its gold, there are two main processes for recovering the gold from the pregnant cyanide solution. One is the Merrill-Crowe zinc precipitation process and the other is the adsorption of the gold onto activated carbon. The oldest method, Merrill Crowe, involves first removing the oxygen from the solution, then mixing a fine zinc powder with it (-200 mesh), and recovering the very fine gold precipitate on a precoat filter, since the gold precipitate is very fine, ranging from a few microns to 50 or so microns. The zinc reacts with the cyanide:
$2Au(CN) + Zn = 2Au + Zn(CN)4^{-2}$

Other chemicals have been used to leach gold, and they include bromine, chlorine, and thiourea. There has also been a lot of experimentation with various biological media for recovering gold from ores, but no one has come up with a more cost effective and productive method than leaching with cyanide. In some special circumstances, some of the other methods may show promise, but for a good oxide gold ore, CN leaching is usually the best of the leach methods for the yellow precious metal. Silver is also leached easily using cyanide, however much silver ore is in sulfide forms, and at higher concentrations (several ounces per ton and above), so other methods such as gravity concentration and froth flotation may be employed.

To prevent the creation of toxic hydrogen cyanide during processing, lime (calcium hydroxide) or soda (sodium hydroxide) is added to the extracting solution to ensure that the acidity during cyanidation is maintained over pH 10.5 - strongly alkaline. Lead nitrate can improve gold leaching speed and quantity recovered, particularly in processing partially oxidized ores.

Effects on the environment

Despite being used in 90% of gold production, gold cyanidation is controversial due to the toxic nature of cyanide. Although aqueous solutions of cyanide degrade rapidly in sunlight, the less-toxic products, such as cyanates and thiocyanates, may persist for some years. The famous disasters have killed few people — humans can be warned not to drink or go near polluted water — but cyanide spills can have a devastating effect on rivers, sometimes killing everything for several miles downstream. However, the cyanide is soon washed out of river systems and, as long as organisms can migrate from unpolluted areas upstream, affected areas can soon be repopulated.

Cyanide leaching produces many hazardous waste products that must be disposed of properly. Some of these hazardous materials are acids and heavy metals, but the most hazardous compounds are the cyanide compounds. The cyanide compounds are extremely toxic to most animals and can destroy an ecosystem if significant amounts of the solutions escape. If the solutions get into soils, plants absorb the cyanide-bearing solutions [Noble and Howe, 1980]. Cyanide accumulates in the plants and often proves deadly for grazing livestock.
Only with careful handling of wastes are these hazards kept from the environment. The Homestake Mine in Lead, South Dakota, is an example of a mine using cyanide leaching techniques that operates without having a negative environmental impact. The Homestake Mine produces about twelve tons of gold each year [Bachman and Caddy, 1990]. Large amounts of gold also result in large amounts of hazardous waste. At the mine, the Grizzly Gulch tailings dam is used to settle out hazardous solids and offers a large reservoir for hazardous liquids to degrade naturally. To prevent water from infiltrating the reservoir and creating more contaminated water, a trench was dug around the mine to capture surface runoff. Another trench was dug downstream to capture ground water flowing from under the reservoir. These trenches act as safety measures that isolate hazardous materials from the surrounding environment. In an effort to further reduce the amount of contaminated liquids, Homestake Mine uses water from the tailings dam in gold extraction processes. Recycling reduces the amount of fresh water that becomes contaminated by mine wastes.

Year	Mine	Country	Incident
1985-91	Summitville	US	Leakage from leach pad
1980s-present	Ok Tedi	Papua New Guinea	Unrestrained waste discharge
1995	Omai	Guyana	Collapse of tailings dam
1998	Kumtor	Kyrgyzstan	Truck drove over bridge
2000	Baia Mare	Romania	Collapse of tailings dam (see 2000 Baia Mare cyanide spill)
2000	Tolukuma	Papua New Guinea	Helicopter dropped crate into rainforest[10]

Such spills have prompted fierce protests at new mines that involve use of cyanide, such as Roşia Montană in Romania, Lake Cowal in Australia, Pascua Lama in Chile, and Bukit Koman in Malaysia.

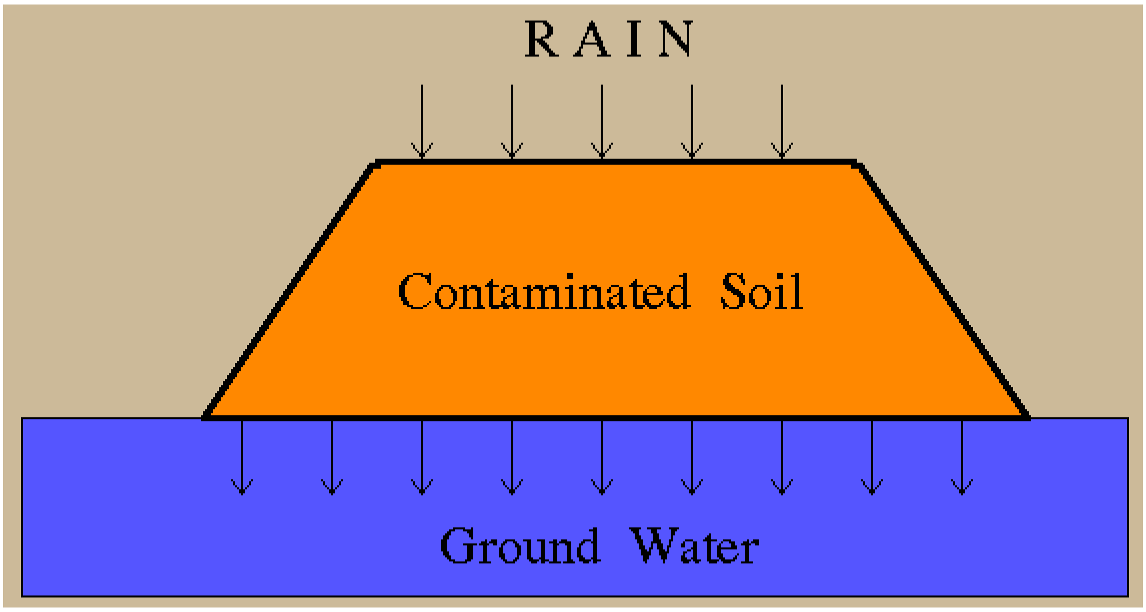
Precious metals method

The crushed ore is irrigated with a dilute cyanide solution. The solution percolates through the heap and leaches out the valuable metal. This may take many weeks.

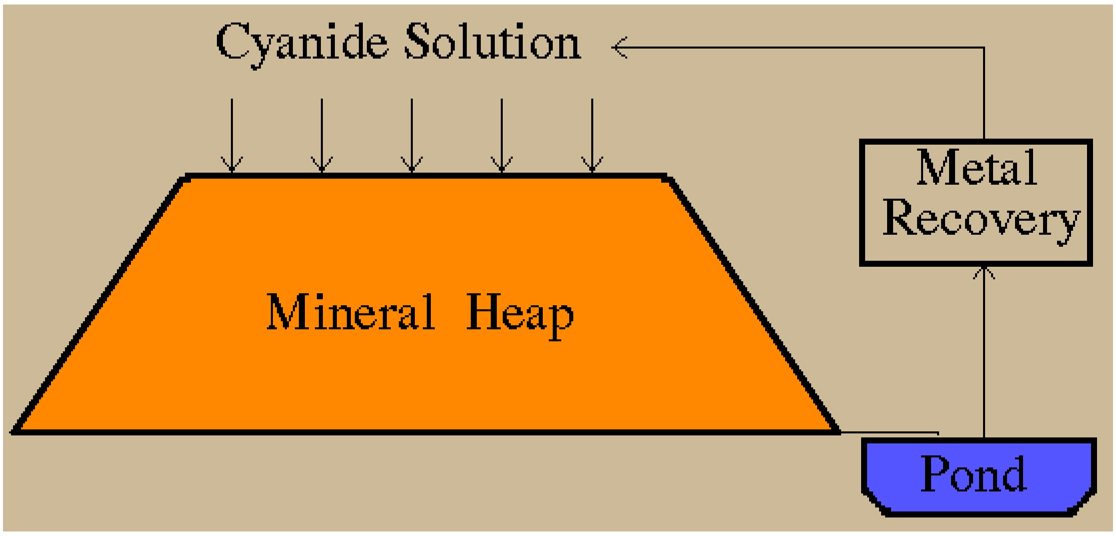
The solution containing the precious metals ("pregnant solution") carries on percolating through the crushed ore awaiting it reaches the liner at the underneath of the heap where it drains into a storage space (pregnant solution) pond. After unraveling the precious metals from the pregnant solution, the dilute cyanide solution (presently known as "barren solution") is usually re-used in the heap-leach-method or infrequently sent to an industrial water treatment ability where the residual cyanide is treated and residual metals are taken out. The water is then released to the environment, posing likely water pollution.

Heap leaching

Leaching of toxic materials into groundwater is a major health concern.



Heap leaching is also used in recovering metals from their ores. Bacterial leaching is first used to oxidize sulphide minerals. Cyanide solution is then used to leach the metals from the mineral heap.



Sustainability

The threat to ecosystem composition and biodiversity has been commented on repeatedly in terms of these mines, and it is noted that, while they do have a higher yield, they also have tendencies to accumulate wear and tear from being outside, and pose a threat to the immediate environment by crushing and dumping dirt that would otherwise have been left untouched. As noted earlier, with the reduction of readily available Rare Earth Minerals, there has been increased in the amount of ore piled onto these pads, suggesting that there may come a time when the amount of ore dumped is not worth the amount of returned mineral collected. Therefore, alternatives need to be considered in the near future. Currently, depths are being mined faster than research can provide information about the effects of more ore on the system.

There is also very little study for long-term viability of liners, as this type of mining and the increased ore depths are still a relatively new field, especially given the changes in depths that have been put into practice. With the increase in weight, pressure, and chemicals put on this method of mining, as well as the already small level of knowledge regarding long term benefits, it is difficult to predict the extent of damage from previous leaks, as well as the durability of present day pads and mining sites

Examples of Case Studies

Rum Jungle Mine

One of the oldest and most famous uranium mines in the world, the Rum Jungle Mine in Northern Australia was constructed in the 1950s, and is today experiencing extreme amounts of environmental degradation and acid rock drainage that are leading to further negative impacts on the surrounding river and ecosystems (Ferguson et al 2011)This mine includes three overburdened heaps, two flooded open cuts, and a backfilled open cut, as well as numerous former tailings and heap leach pads. These leach pads caused considerable contamination to soils as chemicals seeped through them. There was attempted rehabilitation in the 1980s, but there are still high evidences of environmental problems today (Mudd and Patterson 2010) These waste sites caused the local river to maintain water that is highly unsafe due to its acidity, high concentrations of target minerals, and other toxic chemicals, many of which are said to have originally leached out of (Ferguson et al 2011). While the highest concentrations have stayed near the buffer zones of the mine and in the East Finniss River, those that did make it into the Finniss River pose a serious and ongoing public threat to those living nearby who used the river daily (Ferguson et al 2011). Now, years later, it is still posing a serious environmental risk to those around the mine (Mudd and Patterson 2010).

Ranger Uranium Mine

Ranger Uranium Mine in Northern Australia showed a significant increase in erodibility of lands when in contact with materials treated from chemical mining (Riley 1995).[11] This could manifest itself in landslides and loss of habitat, as well as an increase in gravel composition that could cause other potential problems. If these lands can be planted with vegetation that can survive more acidic conditions, however likely that may be, they may be able to avoid eroding materials into other, less mine-contaminated ecosystem (Riley 1995). Given the likelihood of this, though, more rehabilitation measures are being sought after. This case study, however, shows the complexities of mining and the necessity to factor in more preventative measures when dealing with toxic chemicals in natural settings.

The Australian government, who has recently had to deal with negative environmental effects from many historic mines, has taken now to requiring measures that require accounting environmental and social concerns. Alternative locations should be listed and analyzed in mining proposals, as well as rehabilitation plans, externalities (and possible solutions), groundwater and infrastructure changes, gained or lost opportunities, socio-economic impacts, and any risks, as well as any measures taken to reduce or eliminate said risks (Department of Natural Resources, Environment, the Arts and Sport 2009).[12]

Fort Belknap, Montana

Located on the Fort Belknap Indian Reservation, the Zortman-Landusky gold mine in Montana was one of many early heap leach mines that experienced problems with spills and contamination of surface and groundwater. Although the leaks happened in the 1980s, and the mine was eventually shut down in 1996, health problems on the reservation continue to be a problem, and, as not all of the mine was properly cleaned up, could potentially cause further damage to the people of Fort Belknap (Woody et al 2011) Zortman-Landusky eventually filed bankruptcy when the Bureau of Land Management stepped in to assist the lawsuit that was not heard by the residents of the reservation. Once the bankruptcy was filed, however, all health care and studies ceased, and compensation for the destruction of culturally significant mountain peaks to the local Assiniboine and Gros Ventre people was never achieved (Klauk 2012) Today, there are still abnormally high reports of health problems including thyroid problems, lead poisoning, chemical burns, and emphysema (especially in children) (Klauk 2012).

Idaho

In a victory for anti-heap leach endeavors, in 2006, Idaho legislatures were failed to allow the Canadian-based Atlanta Gold Company to use cyanide-leaching on a mountain top to extract predicted gold placed at the headwaters of a main river, especially after the State of Montana had so many problems with water contamination in leach mining endeavors. However, Atlanta Gold was able to buy public lands, and is now attempting to clean up toxic levels of arsenic dripping from previous mining endeavor in order to proceed with less stringent permit processes for mining. Those chemical levels have affected local species, as well as the small group of citizens residing in Atlanta, Idaho.

Yet another mining endeavor that lead to the increased health risk of neighboring citizens includes the Coeur d'Alene Mining District in Coeur d'Alene, Idaho. Dozens of various mines in a close area started leaking contaminants to the surrounding streams, poisoning local biodiversity, including the Salmon populations, many species of which were already struggling or else a key source of nutrition for local populations (Woody et al 2011). These populations eventually experienced countless health problems until the Department of Health and Welfare stepped in to take measured to promote awareness and demand clean up measures, which ultimately cost the government $212 million (Woody et al 2011).

Tank leaching

In metallurgical processes tank leaching is a hydrometallurgical method of extracting valuable material (usually metals) from ore.

Tank vs. vat leaching

Factors

Tank leaching is usually differentiated from vat leaching on the following factors:

1. In tank leaching the material is ground sufficiently fine to form a slurry or pulp, which can flow under gravity or when pumped. In vat leaching typically a coarser material is placed in the vat for leaching, this reduces the cost of size reduction;
2. Tanks are typically equipped with agitators, baffles, gas introduction equipment designed to maintain the solids in suspension in the slurry, and achieve leaching. Vats usually do not contain "internal" equipment;
3. Tank leaching is typically continuous, while vat leaching is operated in a batch fashion, this is not always the case, and commercial processes using continuous vat leaching have been tested;
4. Typically the retention time required for vat leaching is more than that for tank leaching to achieve the same percentage of recovery of the valuable material being leached;

In a tank leach the slurry is moved, while in a vat leach the solids remain in the vat, and solution is moved.

Processes

Tank and vat leaching involves placing ore, usually after size reduction and classification, into large tanks or vats at ambient operating conditions containing a leaching solution and allowing the valuable material to leach from the ore into solution.

In tank leaching the ground, classified solids are already mixed with water to form a slurry or pulp, and this is pumped into the tanks. Leaching reagents are added to the tanks to achieve the leaching reaction. In a continuous system the slurry will then either overflow from one tank to the next, or be pumped to the next tank. Ultimately the “pregnant” solution is separated from the slurry using some form of liquid/solid separation process, and the solution passes on to the next phase of recovery.

In vat leaching the solids are loaded into the vat, once full the vat is flooded with a leaching solution. The solution drains from the tank, and is either recycled back into the vat or is pumped to the next step of the recovery process.

As mentioned previously tanks are equipped with agitators to keep the solids in suspension in the vats and improve the solid to liquid to gas contact. Agitation is further assisted by the use of tank baffles to increase the efficiency of agitation and prevent centrifuging of slurries in circular tanks.

Extraction efficiency factors

Aside from chemical requirements several key factors influence extraction efficiency:

- Retention time - refers to the time spent in the leaching system by the solids. This is calculated as the total volumetric capacity of the leach tank/s divided by the volumetric throughput of the solid/liquid slurry. Retention time is commonly measured in hours for precious metals recovery. A sequence of leach tanks is referred to as a leach "train", and retention time is measured considering the total volume of the leach train. The desired retention time is determined during the testing phase, and the system is then designed to achieve this.
- Size - The ore must be ground to a size that exposes the desired mineral to the leaching agent (referred to as “liberation”), and in tank leaching this must be a size that can be suspended by the agitator. In vat leaching this is the size that is the most economically viable, where the recovery achieved as ore is ground finer is balanced against the increased cost of processing the material.
- Slurry density - The slurry density (percent solids) determines retention time. The settling rate and viscosity of the slurry are functions of the slurry density. The viscosity, in turn, controls the gas mass transfer and the leaching rate.
- Numbers of tanks - Agitated tank leach circuits are typically designed with no less than four tanks and preferably more to prevent short-circuiting of the slurry through the tanks.
- Dissolved gas - Gas is often injected below the agitator or into the vat to obtain the desired dissolved gas levels – typically oxygen, in some base metal plants sulphur dioxide may be required.
- Reagents - Adding and maintaining the appropriate amount of reagents throughout the leach circuit is critical to a successful operation. Adding insufficient quantities of reagents reduces the metal recovery but adding excess reagents increases the operating costs without recovering enough additional metal to cover the cost •of the reagents.

The tank leaching method is commonly used to extract gold and silver from ore.

Leaching

Leaching involves the use of aqueous solutions containing a lixiviant which is brought into contact with a material containing a valuable metal. The lixiviant in solution may be acidic or basic in nature. The type and concentration of the lixiviant is normally controlled to allow some degree of selectivity for the metal or metals that are to be recovered. In the leaching process, oxidation potential, temperature, and pH of the solution are important parameters, and are often manipulated to optimize dissolution of the desired metal component into the aqueous phase.

The three basic leaching techniques are in-situ leaching, heap leaching, and vat leaching.

In-situ leaching

In-situ leaching is also called "solution mining." The process initially involves drilling of holes into the ore deposit. Explosives or hydraulic fracturing are used to create open pathways within the deposit for solution to penetrate into. Leaching solution is pumped into the deposit where it makes contact with the ore. The solution is then collected and processed. The Beverley uranium deposit is an example of in-situ leaching.

Heap leaching

In heap leaching processes, crushed (and sometimes agglomerated) ore is piled in a heap which is lined with an impervious layer. Leach solution is sprayed over the top of the heap, and allowed to percolate downward through the heap. The heap design usually incorporates collection sumps which allow the "pregnant" leach solution (i.e. solution with dissolved valuable metals) to be pumped for further processing.

Vat leaching

Vat leaching involves contacting material, which has usually undergone size reduction and classification, with leach solution in large tanks or vats. Often the vats are equipped with agitators to keep the solids in suspension in the vats and improve the solid to liquid contact. After vat leaching, the leached solids and pregnant solution are usually separated prior to further processing.