

The 'EnviroLeach' Method:

CURRENTLY A PROCESS ENTERING A SCALEUP PHASE 11-03-2014

Background:

A new environmentally friendly process has been developed for recovering economic (precious) metals from ore concentrates and mine tailings. The process has also been successfully applied to recovering economic metals and deleterious metals from toxic materials such as Coal Combustion Products (CCP). EnviroLeach is currently in a patent pending status.

Current precious metal recovery techniques often involve the use of strong chemicals (cyanide, acids) that are expensive to use onsite and are becoming environmentally controversial. The disposal of CCP has also become a problem because of regulatory issues concerning heavy metals. Over the past several years, the company has been using an advanced ionization process technology to enhance halide solvents for leaching ores.

The new technology is based on the on-site production of mixed oxidants by ionization of source water with appropriate electrolytes. The process is optimized to produce EnviroLeach with specific chemical parameters such as pH, Oxidation Reduction Potential (ORP) and free halides. Additional oxidizing or complexing chemicals are added when appropriate and as dictated by the ore being leached.

The EnviroLeach can be used to replace or enhance the expensive and highly regulated strong chemicals that must be shipped to and stored at the site. For some cases such as gold sulfide ores, where cyanide meets its challenges, EnviroLeach has been successfully used to recover gold (EnviroLeach leaches 20-60 times faster than cyanide). For ore leaching applications where cyanide has already been used, EnviroLeach can be used to neutralize the residual cyanide. The EnviroLeach process not only accelerates the gold and silver leaching processes, but also leaches out the platinum group metals that are not soluble in cyanide.

The process is not used for the liberation of free gold but is used to leach ores and high grade concentrates of fine gold unless the free gold is in a microscopic state.

The benefits of this process and lixiviants are as follows:

- a. Onsite production.
- b. User, environmental, storage, transportation and disposition safety.
- c. Cost effectiveness.

- d. Exponentially effective over cyanide.

As each ore bears a unique and individualized finger print, a proprietary lixiviant is created for each ore and for each mining operation.

Basics of Electrolysis from [Wikipedia](#)-the free online encyclopedia:

Electrolysis is the passage of a direct electric current through an ionic substance that is either molten or dissolved in a suitable solvent, resulting in chemical reactions at the electrodes and separation of materials.

The main components required to achieve **electrolysis** are:

- An **electrolyte** : a substance containing free ions which are the carriers of electric current in the electrolyte. If the ions are not mobile, as in a solid salt then electrolysis cannot occur.
- A **direct current (DC)** supply : provides the energy necessary to create or discharge the ions in the electrolyte. Electric current is carried by electrons in the external circuit.
- Two **electrodes** : an electrical conductor which provides the physical interface between the electrical circuit providing the energy and the electrolyte

Electrodes of metal, graphite and semiconductor material are widely used. Choice of suitable electrode depends on chemical reactivity between the electrode and electrolyte and the cost of manufacture

Process of electrolysis

The key process of electrolysis is the interchange of atoms and ions by the removal or addition of electrons from the external circuit. The required products of electrolysis are in some different physical state from the electrolyte and can be removed by some physical processes. For example, in the electrolysis of brine to produce hydrogen and chlorine, the products are gaseous. These gaseous products bubble from the electrolyte and are collected.

A liquid containing mobile ions (electrolyte) is produced by

- Solvation or reaction of an ionic compound with a solvent (such as water) to produce mobile ions
- An ionic compound is melted (*fused*) by heating

An electrical potential is applied across a pair of electrodes immersed in the electrolyte.

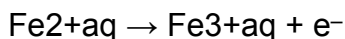
Each electrode attracts ions that are of the opposite charge. Positively charged ions (cations) move towards the electron-providing (negative) cathode, whereas negatively charged ions (anions) move towards the positive anode.

At the electrodes, electrons are absorbed or released by the atoms and ions. Those atoms that gain or lose electrons to become charged ions pass into the electrolyte. Those ions that gain or lose electrons to become uncharged atoms separate from the electrolyte. The formation of uncharged atoms from ions is called discharging.

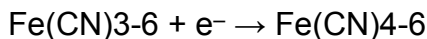
The energy required to cause the ions to migrate to the electrodes, and the energy to cause the change in ionic state, is provided by the external source of electrical potential.

Oxidation and reduction at the electrodes

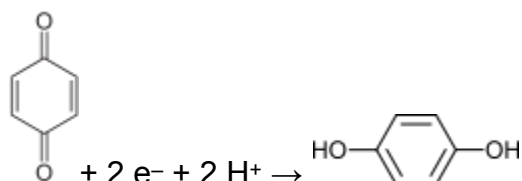
Oxidation of ions or neutral molecules occurs at the anode, and the reduction of ions or neutral molecules occurs at the cathode. For example, it is possible to oxidize ferrous ions to ferric ions at the anode:



It is also possible to reduce ferricyanide ions to ferrocyanide ions at the cathode:



Neutral molecules can also react at either electrode. For example: p-Benzoquinone can be reduced to hydroquinone at the cathode:



In the last example, H^{+} ions (hydrogen ions) also take part in the reaction, and are provided by an acid in the solution, or the solvent itself (water, methanol etc.). Electrolysis reactions involving H^{+} ions are fairly common in acidic solutions. In alkaline water solutions, reactions involving OH^{-} (hydroxide ions) are common.

The substances oxidised or reduced can also be the solvent (usually water) or the electrodes. It is possible to have electrolysis involving gases.

Energy changes during electrolysis

The amount of electrical energy that must be added equals the change in Gibbs free energy of the reaction plus the losses in the system. The losses can (in theory) be arbitrarily close to zero, so the maximum thermodynamic efficiency equals the enthalpy change divided by the free energy change of the reaction. In most cases, the electric input is larger than the enthalpy change of the reaction, so some energy is released in the form of heat. In some cases, for instance, in the electrolysis of steam into hydrogen and oxygen at high temperature, the opposite is true. Heat is absorbed from the surroundings, and the heating value of the produced hydrogen is higher than the electric input.

Related techniques

The following techniques are related to electrolysis:

- Gel electrophoresis is an electrolysis using a gel solvent. It is used to separate substances, such as DNA strands, based on their electrical charge.
- Electrochemical cells, including the hydrogen fuel cell, utilise differences in Standard electrode potential in order to generate an electrical potential from which useful power can be extracted. Although related via the interaction of ions and electrodes, electrolysis and the operation of electrochemical cells are quite

distinct. A chemical cell should **not** be thought of as performing "electrolysis in reverse".

Faraday's laws of electrolysis

Main article: [Faraday's laws of electrolysis](#)

First law of electrolysis

In 1832, Michael Faraday reported that the quantity of elements separated by passing an electric current through a molten or dissolved salt is proportional to the quantity of electric charge passed through the circuit. This became the basis of the first law of electrolysis:

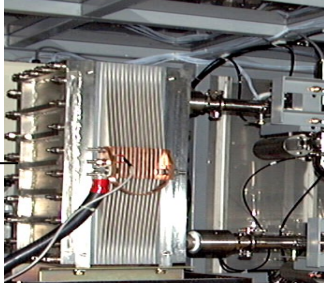
$$m = k \cdot q$$

Second law of electrolysis

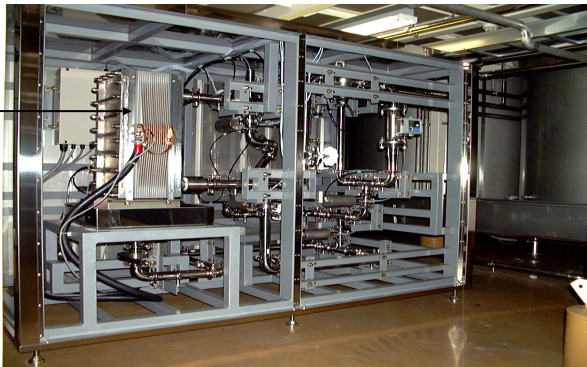
Faraday also discovered that the mass of the resulting separated elements is directly proportional to the atomic masses of the elements when an appropriate integral divisor is applied. This provided strong evidence that discrete particles of matter exist as parts of the atoms of elements.



50 GPM Electrolysis Unit



25 GPM Electrolysis Chamber



25 GPM Electrolysis Unit