Definition - What does Hydrometallurgy mean?

This is a method of metal or metal compound extraction from an ore through pre-treatments that involve the use of a leaching agent, separation of impurities and precipitation. It is used in the extraction of uranium, gold, zinc, silver and copper from low-grade ores. This process has been improved by the development of processes like solvent extraction and ion exchange.

The various techniques used in these processes include:

1.Leaching – autoclave, column, atmospheric and pressure acid depending on the metal ore

2.Recovery – carbon-in-leach and carbon-in-pulp, oxidation—biological or pressure method—and cementation

3.Solution purification – ion-exchange, solvent extraction, electrowinning, precipitation and process simulations to

HISTORY OF SOLVENT EXTRACTION

During the past 10 years, there have been incremental advances in the application of solvent extraction to process hydrometallurgy. The most cited areas in the literature include chemistry, chemical engineering, pilot plants, and plant operation. Within these areas, there were considerable interest in synergism, diluents, degradation, contactors,surfactants, hydrometallurgical applications, environmental and secondary applications, and health and safety.

First Step: Extraction

Fundamentally, solvent extraction (S-X) starts with a mass transfer operation in which a constituent of one solution is transferred to another solution through an interface between the two. Since we are concerned here only with application to extractive metallurgy, the first solution is always a water solution of the desired element and the second is the organic solvent.

Second Step: Stripping

The second major part of the S-X operation is the recovery of the desired material from the organic solvent in a purified and concentrated form in such a way that the organic solvent can be recycled to the extraction operation.This second step is usually called “stripping.”

This introduces two basic concepts used in solvent extraction technology:

1.distribution coefficient and

2.solvent loading

The distribution coefficient (K) is a measure of how well a given solvent will extract and hold in the organic phase a constituent from the aqueous feed liquor.

ION EXCHANGE PROCESS

Ion exchange has traditionally been employed for the purification of water and the removal of metal contaminants from dilute waste streams. More recently, its use in removing trace metallic impurities from hydrometallurgical process streams (with typical background metal concentrations of 50–100 g/L) has increased substantially. It is also used as a primary recovery and concentration unit operation for certain commodities, where both technical and cost advantages become apparent for complex flow sheets. This overview discusses selected modern applications of ion exchange in hydrometallurgical processes for uranium, precious metals, copper, cobalt, nickel and zinc, and identifies some opportunities for the future.Ion exchanges can be unselective or have binding preferences for certain ions or classes of ions, depending on their chemical structure. This can be dependent on the size of the ions, their charge, or their structure. Typical examples of ions that can bind to ion exchangers are:

H^+ (proton) and OH^- (hydroxide).

Singly charged monatomic ions like Na^+, K^+, and Cl^-.

Doubly charged monatomic ions like Ca^{2+} and Mg^{2+}.

Polyatomic inorganic ions like SO_4^{2-} and PO_4^{3-}.

Organic bases, usually molecules containing the amine functional group $-NR_2H^+$.

Applications

Ion exchange is widely used in the food and beverage industry, hydrometallurgy, metals finishing, chemical, petrochemical, pharmaceutical technology, sugar and sweetener production, ground- and potable-water treatment, nuclear, softening,industrial water treatment, semiconductor, power, and many other industries.

A typical example of application is preparation of high-purity water for power engineering, electronic and nuclear industries; i.e. polymeric or mineralic insoluble ion exchangers are widely used for water softening, water purification, water decontamination, etc.