Applications of Hydrogen Peroxide

Hydrogen Peroxide for Mining

Hydrogen peroxide is used as an oxidant, recovery agent or oxygen source in metallurgical process steps like ore leaching, concentrate preparation or effluent treatment. Depending on the ore composition as well as the leaching conditions, utilization of hydrogen peroxide results into savings of eluents and acids, simplifies management of chemicals or wastes and improves the overall process control.

For gold production the most common method, used nowadays, is the cyanidation process, which involves the leaching of gold containing ores by dilute aqueous cyanide solutions in the presence of lime and oxygen.

$$4\ Au + 8\ NaCN + O_2 + 2\ H_2O \rightarrow 4\ Na[Au(CN)_2] + 4\ NaOH$$

Depending on the leaching conditions, overall concentration of suspended ore as well as concentration of the oxygen consumers in the ore, hydrogen peroxide can be added to increase the total oxygen concentration in the system and to promote deeper leaching by direct oxidation.

$$2\ H_2O_2 \rightarrow O_2 + 2\ H_2O$$
$$H_2O_2 + 2\ Au + 4\ NaCN \rightarrow 2\ Na[Au(CN)_2] + 2\ NaOH$$

Oxygen is a crucial reagent in gold leaching. The ore leaching efficiency depends strongly on the level of oxygen dissolved in the leaching solution. Pulps may contain organic and inorganic components that consume oxygen, reducing the overall level of the dissolved oxygen in the pulp and thus reducing the leach kinetics. The unique chemical properties of hydrogen peroxide allow not only eliminating the side reactions, which consume dissolved oxygen, but also provide a simple method to control and to increase its overall concentration in the leaching liquor. As a result of the induced and catalyzed hydrogen peroxide decomposition, which leads to molecular oxygen and water, it can be considered as the chemical source of oxygen. The total economics of a gold mine can be increased by fine tuning of the concentration of dissolved oxygen.

On the downstream side hydrogen peroxide is often used for removal of the cyanides from the waste water. The cyanide oxidation takes place in a single step, without the formation of toxic intermediates.

$$H_2O_2 + NaCN \rightarrow NaCNO + H_2O$$

The reaction product hydrolyses slowly to give ammonium and carbonate ions. The detoxification procedure allows reducing the concentration of free cyanide and results into low toxicity of the treated waste water. The unique advantage of the hydrogen peroxide treatment is that it is a clean chemical. As the waste water is being treated, no substances are introduced along with the oxidizing agent that might impact the quality of detoxified water.

For more complex waste waters a Caro's acid detoxification step might be required. Caro's acid, produced on-site by mixing of hydrogen peroxide with sulfuric acid in special generators, has a higher oxidation power and can destroy even stable CN-complexes.

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The reagent is prepared as follows:

$H_2O_2 + H_2SO_4 \rightarrow H_2SO_5 + H_2O$

Hydrogen peroxide and sulphuric acid are pumped via dosing pumps on a continuous basis into a mixing tank and cooled down. The ratio of addition of both reagents is dictated by the Caro's acid control module. The resultant Caro's acid is fed directly into the pulp or into an agitated reaction vessel. By the Caro's acid assisted cyanide detoxification the residual cyanide levels in the range of 1 - 2ppm can readily be achieved. Low capital costs along with high reaction speed and low cyanide residues are the main advantages of the treatment.

Caro's acid is also used for selective precipitation of cobalt(III) hydroxide from aqueous solutions, containing salts of such metals as nickel and manganese. The resulting cobaltic hydroxide is re-dissolved in sulfuric acid and hydrogen peroxide as reducing agent and used for further cobalt refining. Caro's acid is also used in the recovery and purification of valuable metals such as vanadium and tungsten from waste materials such as superalloy scrap and spent catalysts.

In uranium mining the In Situ Leach (ISL) approach is one of the most important methods used. The compounds of tetravalent Uranium, like uraninite or coffinite, have however a very low solubility in both acidic and alkaline media. For their successful extraction Uranium atom need to be oxidized to the hexavalent state to yield much more soluble substances. In acid uranium ore leaching, the uranium compounds are oxidized by ferric iron, which in turn is reduced to ferrous iron.

$UO_2 + Fe_2(SO4)_3 \rightarrow UO_2SO_4 + 2FeSO_4$

The reduced iron needs to be oxidized to the ferric form to allow the uranium dissolution reaction to proceed. Along with such oxidants like atmospheric oxygen, hydrogen peroxide or Caro's acid are frequently used as the ferric ion recoverers.

$H_2O_2 + 2FeSO_4 + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 2H_2O$

Hydrogen peroxide is also applied for precipitation of uranium as uranyl peroxide instead of the more traditional ammonium diuranate. That not only eliminates the use of ammonia as precipitation reagent, but also yields a compound, which is easier to thicken, filter and process.

For mining applications Evonik recommends to use HYPROX® - standard grade hydrogen peroxide.