Disinfectants Hydrogen peroxide

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Hydrogen peroxide
Most people know hydrogen peroxide as a compounds that bleaches hair. It can also be used for water disinfection.

When was hydrogen peroxide discovered?

Louis Jacque Thenard discovered hydrogen peroxide in 1818. Hydrogen peroxide consists of oxygen and hydrogen atoms. These can be found everywhere on earth. Hydrogen peroxide contains a combination of two hydrogen atoms and two oxygen atoms.
In the environment, hydrogen peroxide can be found in very low concentrations. Gaseous hydrogen peroxide is produced by photo chemical reactions in the atmosphere surrounding the earth. It can also be found in water in small quantities.

What are the characteristics of hydrogen peroxide?

Peroxide is a chemical compound that contains the peroxide ion (O_2^{2-}).
The peroxide ion consists of a single bond between two oxygen atoms: $(O\text{-}O)^{2-}$. It is a strong oxidiser.
Hydrogen peroxide has the chemical formula H_2O_2 and the following structural formula:
H-O-O-H

The hydrogen peroxide molecule contains one extra oxygen atom, compared to the more stable water molecule. The bond between the two oxygen atoms, the so-called peroxide bond, is broken while two H-O radicals are formed. These radicals quickly react with other substances, while new radicals are formed and a chain reaction takes place. Hydrogen peroxide solutions look like water and can be dissolved in water unrestrainedly. At high concentrations these solutions give off an irritating, acidic smell. Hydrogen peroxide is inflammable. At low temperatures it becomes solid. The amount of hydrogen peroxide in the solution is expressed in weight percentage. For water treatment, concentrations of 35 or 50 % hydrogen peroxide are used.

Selectivity

Hydrogen peroxide is used for different applications, because it is very selective. By changing the reaction conditions (temperature, pH, dose, reaction time and the addition of a catalyser), hydrogen peroxide will attack different pollutions.

Corrosiveness of hydrogen peroxide

The corrosiveness of process water due to hydrogen peroxide depends on the amount of dissolved oxygen that is produced. Oxygen corrodes iron-containing metals. The amount of iron and the pH are a greater influence on corrosiveness than the concentration of hydrogen peroxide is.

Destruction of hydrogen peroxide

Hydrogen peroxide can disintegrate during transport. Oxygen and heat are released. Hydrogen peroxide itself is inflammable, but the oxygen can enhance the inflammation of other substances. In diluted solutions, the heat is absorbed by water. In concentrated solutions, the temperature of the solution is increased, accelerating hydrogen peroxide destruction. The rate of destruction is multiplied with 2,2 for every 10 °C of rise in temperature. The alkalinity and presence of pollutions also accelerate the destruction of hydrogen peroxide.
For the production of hydrogen peroxide, special catalysers are used to make sure that hydrogen peroxide is not destroyed by pollutants in the water.

How is hydrogen peroxide produced?

Since 1880, hydrogen peroxide is a commercial product. It was first produced in the United Kingdom by burning barium salt (Ba), which produced barium peroxide (BaO_2). Subsequently the barium peroxide was dissolved in water and hydrogen peroxide was produced. Since the 19th century the production of hydrogen peroxide has largely increased. Nowadays about half a billion kilograms are produced annually.

How is hydrogen peroxide transported and stored?

Hydrogen peroxide must be transported in polyethylene, stainless steel or aluminium containers. When hydrogen peroxide comes in contact with flammable substances, such as wood, paper, oil or cotton (cellulose), spontaneous ignition may occur. When hydrogen peroxide is mixed with organic matter, such as alcohols, acetone and other ketones, aldehydes and glycerol, heavy explosions may occur.
When hydrogen peroxide comes in contact with substances, such as iron, copper, chromium, lead, silver, manganese, sodium, potassium, magnesium, nickel, gold, platinum, metalloids, metal oxides or metal salts, this may result in powerful explosions. This is why hydrogen peroxide is usually transported in diluted form.

What are the applications of hydrogen peroxide?

The eldest known application of hydrogen peroxide was bleaching straw hats, which were fashionable in the beginning of the twentieth century. From 1920 to 1950, hydrogen peroxide was produced through electrolysis. This method produced pure hydrogen peroxide. Nowadays, self-oxidation processes are used to produce hydrogen peroxide. During these processes, hydrogen is the raw material.

Versatility of hydrogen peroxide

Hydrogen peroxide is versatile, it can be used for many applications. It can be used in all media; air, water, waste water and soils. It is sometimes used combined with other agents, to enhance and accelerate processes. Hydrogen peroxide is most commonly used to remove pollutants from waste water and from air. It contests bacterial growth (for example bio fouling in water systems) and it can enhance bacterial growth (for example bio remediation of polluted soils and ground water) through oxygen addition. It can also be used to treat pollutions that can be easily oxidized (for example iron and sulphides) and pollutions that are difficult to oxidise (for example dissolved solids, gasoline and pesticides).
Finally, it can be used to bleach paper, textile, teeth and hair or to produce food, minerals, petrochemical substances or washing powder. In pure form, hydrogen peroxide is used as an oxygen provider to drive Russian submarines.

Can hydrogen peroxide be used as an oxidiser?

Hydrogen peroxide is a strong oxidiser. It is more powerful than chlorine (Cl_2), chlorine dioxide (ClO_2) and potassium permanganate ($KMnO_4$). Through catalysis, hydrogen peroxide can be converted into hydroxyradicals (OH). The oxidation potential of hydrogen peroxide is just below that of ozone.

Table 1: Oxidation potentials of various oxidisers

Oxidiser	Oxidation potential
fluorine	3,0
hydroxyradicals	2,8
ozone	2,1
hydrogen peroxide	1,8
potassium permanganate	1,7
chlorine dioxide	1,5
chlorine	1,4

How is hydrogen peroxide dosed?