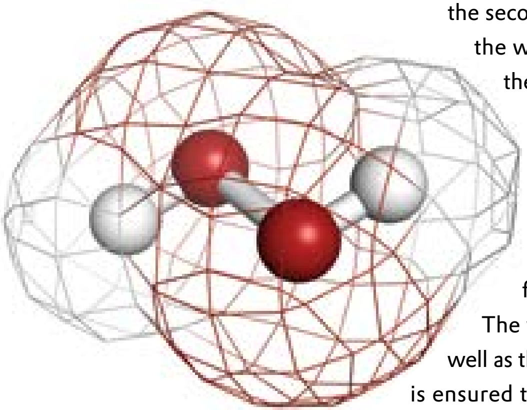
How H_2O_2 is produced: The anthraquinone process

The industrial production of hydrogen peroxide began in the town of Weißenstein in the Austrian state of Carinthia. This is where the Österreichische Chemische Werke company operated the world's first hydrogen peroxide factory using electrolysis. Today this production plant is part of Evonik. The Weißenstein process made it possible to produce hydrogen peroxide on an industrial scale for the first time. Today this plant uses the autoxidation process, as do almost all the other hydrogen peroxide factories in the world. This process was developed by Georg Pfleiderer and Hans-Joachim Riedl at IG Farben in Ludwigshafen between 1935 and 1945, and since then it has been continuously refined. The process is based on the cyclical reduction and oxidation of an alkylated anthraquinone.

The first step, hydrogenation, takes place in a reactor full of a solution of the anthraquinone (the "working solution"). "In the reactor, in the presence of a palladium catalyst hydrogen combines with the reaction carrier, a quinone derivative, to form a hydroquinone," explains Dr. Jürgen Glenneberg, Head of Process Engineering at the Active Oxygens Business Line. The catalyst is then completely filtered out of the working solution. In the second step, the oxidation stage, huge compressors pump air into a bubble reactor that is full of the working solution. When the hydroquinone in the organic phase comes into contact with the oxygen in the air, it oxidizes spontaneously back into quinone, forming hydrogen peroxide in the process. Because this reaction takes place without the presence of a catalyst, it is called an autoxidation process.

In the third step, extraction, the working solution is poured into a separation column. The H_2O_2 in the working solution is extracted by adding water to the solution in a counter-current process. The result is a 35 to 50 percent aqueous solution that can be processed further by means of vacuum distillation or additional purification steps, for example.

The working solution in itself poses a special technical challenge to the process. The quinone as well as the hydroquinone must remain dissolved in the solution without flocculation. Their solubility is ensured through the choice of a suitable alkyl substituent and the composition of the solvent mix. "Typical alkylated anthraquinone derivatives such as 2-ethyl-, 2-tert-butyl-, and 2-amylanthraquinone are used for this purpose," says Glenneberg. In order to keep the quinone in solution, nonpolar substances such as C9/C10-alkylbenzenes are often used as part of the working solution. Polar substances such as tris(2-ethylhexyl) phosphate, diisobutyl carbinol or methyl cyclohexyl acetate take over this function for the hydroquinone.



Oxygen (red) and hydrogen (white) form an energy-rich compound: a molecule of hydrogen peroxide

To make sure the process unfolds successfully, it's important to regularly purify the working solution in the facility. Theoretically, the working solution can be used indefinitely. However, if only 0.1% of the quinone were to be irreversibly damaged in each cycle, the entire process would break down within two months. The oldest working solution at Evonik is being used at the plant in Antwerp. It was originally mixed in 1969.