

Applications of Hydrogen Peroxide

Hydrogen Peroxide for Pulp and Paper Industry

HYPROX® is a very versatile pulp bleaching agent. Under alkaline conditions it is applied to bleach mechanical pulp, chemical pulp and recycled fibers.

Typically the same reaction mechanism applies in all applications. The nucleophile attack of the perhydroxyl anion oxidizes chromophores by an alkaline cleavage of conjugated side chains in lignin or other chromophores. The resulting chemical structures become more hydrophilic through the oxidation and are at least in part removed by washing processes.

1. Application in chemical pulp bleaching

The versatility of hydrogen peroxide allows its application in different positions within a bleaching sequence. There are several options for the application of hydrogen peroxide:

- Hydrogen peroxide can lower the demand for other bleaching chemicals, namely chlorine dioxide.
- Hydrogen peroxide can minimize the overall bleaching cost.
- Hydrogen peroxide allows to boost the final brightness.
- Hydrogen peroxide helps to overcome a shortage of on-site produced bleaching compounds.
- Hydrogen peroxide can help to push the capacity of a bleach plant.
- Hydrogen peroxide will decrease the effluent color.

Typically the conditions used in an extraction stage are suitable for the application of hydrogen peroxide. The temperature range for the application is between 60 °C and 85 °C. The required retention time is depending on the amount of hydrogen peroxide that has to be consumed. The normal range is between one hour and two hours. Special conditions with high consistency at low temperature bleaching could result in prolonged retention time, for example in steep bleaching. The consistency range is relatively narrow. At low consistency the number of side reactions will increase. Thus, medium consistency starting at 10 % is the normal value for effective peroxide application. In special cases (final bleaching) a consistency higher than 30 % may be suitable.

1.1 ECF bleaching

In kraft pulp bleaching the ECF technology has established itself as the most preferred process worldwide. It typically means the start of the bleaching sequence with an oxygen delignification stage. The application of chlorine dioxide in the next bleaching stage results in a high degree of oxidation of the residual lignin. A subsequent extraction stage is typically reinforced with the addition of small amounts of hydrogen peroxide and oxygen. The addition of these chemicals helps to oxidize the lignin residual further, thus making it more hydrophilic. In addition the application of hydrogen peroxide boosts the brightness very early in the sequence, a benefit which will show through even at the end of the full bleaching sequence. Peroxide application in the E stage in addition decreases the color of the effluent. In the first extraction stage the range of H₂O₂ is between 2 and 5 kg/t applied. Final bleaching for softwoods uses either two or three stages: The combination of chlorine dioxide and hydrogen peroxide in for example the stages D1-P respectively D1 Ep D2. The amounts of hydrogen peroxide applied are typically relatively low. In final bleaching between 2 and 3 kg/t are applied. Typical sequences are OD0EopD1Ep-D2 or OD0EopD1P.

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1.2 TCF bleaching

Sulfite pulps are very easily bleached with hydrogen peroxide. Single stage bleaching or two stage delignification and bleaching are the state-of-the-art to bleach sulfite pulp. The sequences are Eop-P or just a high consistency peroxide stage. With these conditions the brightness range above 85 % ISO to 88 % ISO is easily reached. Typically the amount of peroxide applied is between 2 and 3 %. TCF bleaching of kraft pulp is more complicated. Typically already pulping is done under modified conditions in order to lower the Kappa number as much as possible. High intensity oxygen delignification is followed by a chelation treatment to remove the transition metals still present in the pulp. Activation stages with ozone or peracids are used to allow an effective final brightening with high charges of hydrogen peroxide. In order to consume the high peroxide amounts a high temperature treatment is required. The requirements in terms of brightness and strength, respectively viscosity have to be balanced to produce an acceptable pulp quality. Typical sequences are OOQZP or OOPZP.

2. Application in mechanical pulp bleaching

The mechanical defiberization of wood yields fibers rich in lignin which can be bleached only with mild bleaching agents. Hydrogen peroxide is capable to oxidize dominantly the chromophores of the lignin, thus keeping the pulp yield very high. Reductive bleaching with sodium dithionite (hydrosulfite) similarly keeps the yield high. However, reductive bleaching only has a limited brightening effect. Peroxide bleaching of mechanical fibers typically requires high consistency conditions (consistency higher than 20 %) and buffered conditions in order to avoid wide pH swings. The typical reaction conditions are a temperature between 60 and 80° C, a retention time of at least 2 hours and up to 5 hours. The buffering of the process typically is achieved with the addition of sodium silicate solutions. In order to avoid decomposition with transition metals associated with wood, a chelation treatment with EDTA or DTPA typically is conducted directly after the defiberization. The brightness increase is depending on the bleachability of the fiber source, which is in function of the defiberization conditions and the raw material. The maximum brightness increase typically is about 20 points ISO, very high brightness increases are achieved with two stage hydrogen peroxide processes using the excess of hydrogen peroxide from the main bleaching stage for a pretreatment. Small additional brightness corrections can be made with a reductive post-treatment.

3. Application of hydrogen peroxide in paper recycling

Repulping of waste paper with the target of ink removal typically is conducted under mild alkaline conditions. In order to avoid alkaline yellowing and achieve a bleaching effect, small amounts of hydrogen peroxide are added to the pulper. If higher brightness increases are required, hydrogen peroxide can also be applied in a post bleaching stage for example under the high consistency conditions of the disperser. In order to fully developed brightness a retention time of about one hour is required.

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