OPTIMIZING THE DOSAGE OF STABILIZING CHEMICAL

Tomi Harjula

Bachelor's thesis
May 2013
Degree Programme of Paper Technology
Option of International Pulp and Paper Technology

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ABSTRACT

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Bachelor's thesis 26 pages, appendices 3 pages
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A chemical company provides chemical treatment at customer mill in paper industry. This thesis work was done to determine the optimum dosage of stabilizing chemical.

The theoretical framework explains the basics of paper brightness and bleaching and how these topics are connected to each other.

The knowledge gained is very valuable and can possibly be used in the future in other similar applications as well.

This thesis work contains confidential back ground information.

Key words: paper making, microbiological contamination

TIIVISTELMÄ

Tampereen ammattikorkeakoulu
Paperitekniikan koulutusohjelma
International Pulp and Paper Technology suuntautuminen

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Opinnäytetyö 26 sivua, josta liitteitä 3 sivua
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Kemian alan yritys toimii kemikaalitoimittajana asiakastehtaalla paperiteollisuudessa. Tämä työ tehtiin stabilointikemikaalin annostelun optimoimiseksi.

Teoriaosuus selittää perusteet paperin vaaleudesta ja valkaisusta ja kuinka nämä liittyvät toisiinsa.

Suurin hyöty on kerätty tieto, jota voidaan mahdollisesti hyödyntää tulevaisuudessa samankaltaisissa kemikaalisysteemeissä.

Työ sisältää luottamuksellista tausta-aineistoa.

Key words: paperinvalmistus, mikrobinhallinta

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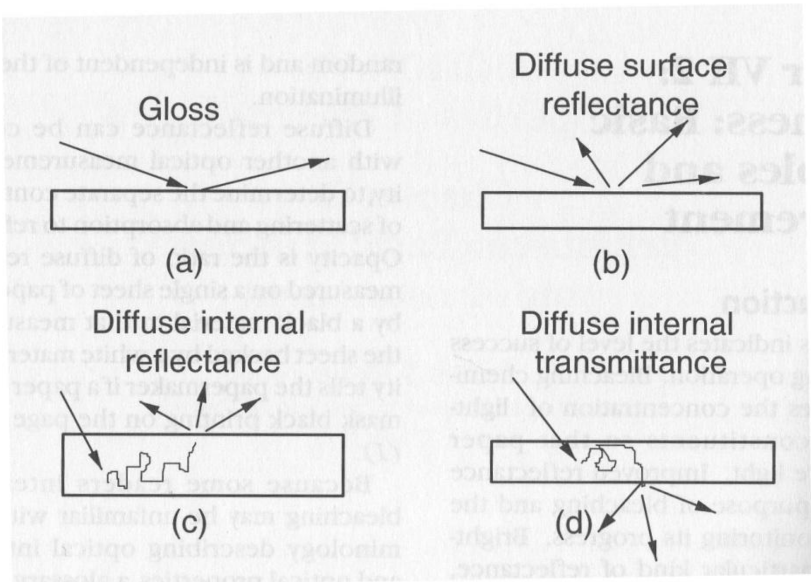
1 THEORETICAL FRAMEWORK

1.1 Brightness of paper

Brightness is one of the optical properties of paper, which are defying the appearance of the paper perceived by the human eye. Optical properties are defying the relation between paper sheet and light, and brightness is light reflectance factor of the sample. (Kappel 1999, 34) Brightness can also be seen to indicate the level of success in pulp bleaching, since bleaching controls light-absorbing contaminant allowing paper to reflect more light. When light is directed into paper sheet, it interacts with the surface in various ways; it may reflect from first surface contact as gloss, diffuse and reflect in many forms or absorb and convert into energy. Dence & Reeve (1996, 698) illustrates different ways of light to interact with paper as follows in Picture 2



Picture 2. Different light reactions on paper sheet (Dence & Reeve 1996, 698)

Brightness measurement follows standardized procedure ISO 2470-1:2009, which is the measurement of diffuse blue reflectance factor (ISO brightness) of pulps, papers and boards. (www.iso.org)

1.2 Bleaching pulp

Bleaching is a complex chemical process applied to cellulosic material to increase their brightness either by reducing the amount of lignin or decolorizing the lignin in pulp. Bleaching is done to satisfy the quality targets in color, whiteness, lightness, brightness, purity and stability. Furthermore, bleaching increases the capacity of paper for accepting printed images and so increases its usefulness. The absorbance of visible light by fibers is caused mainly by the presence of lignin, which by nature is colored and turns darker with age. Brightness is the reflectance of visible light from paper sheet measured by standard method. (Dence & Reeve 1996, 3)

Lignin is a polymeric molecule built on ring compounds having double oxygen bond, which is the chromophore group. Chromophore is a part of a molecule responsible for forming the color, in the case of lignin, the yellowish color. (Kappel 1999, 264)

The most commonly used bleaching chemicals include, but are not limited to; oxidants such as chlorine, chlorine dioxide, oxygen, ozone, and hydrogen peroxide, sodium hydroxide and for mechanical pulps only; reductive sodium dithionite. (Dence & Reeve 1996, 3). Kappel (1999, 264) shows a lignin molecule and effects of bleaching as follows in Figure 1

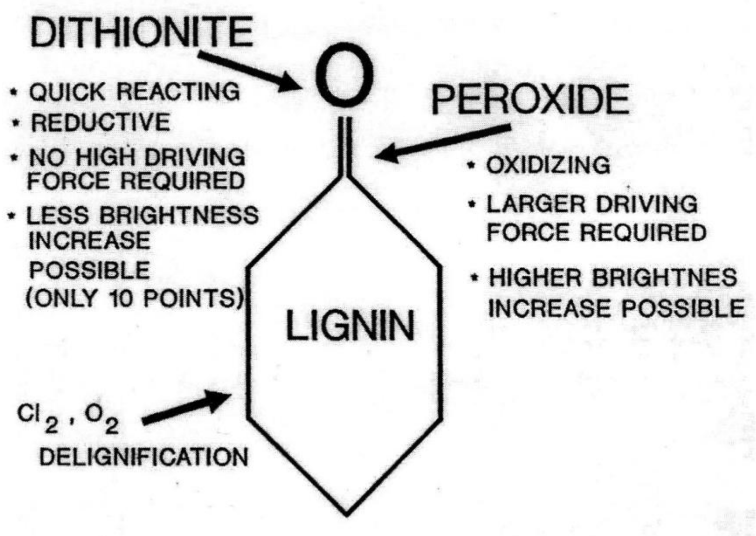


Figure 1. Lignin molecule and effects of bleaching (Kappel 1999, 264)

1.3 Bleaching mechanical pulp

Depending on numerous variables including selected raw material and processes used, the first state brightness in mechanical pulps before bleaching can vary between 50 and 68 % ISO. First-class Scandinavian softwood typically used to produce groundwood pulp (GWP) is having very high initial brightness, when lower quality raw materials and high temperature defibration can be seen as explanation for lower brightness in thermo mechanical pulp (TMP) (Kappel 1996, 263) Bleaching typically increases brightness by 10-20 % ISO, reaching 70, up to 80 % ISO. (Seppälä & Klemetti & Kortelainen & Lyytikäinen & Siitonen & Sironen 1999, 53)

Bleaching chemicals used in mechanical pulp bleaching are lignin-retaining, removing only the color, not the entire lignin molecule. This is the only rational way, since chemical lignin removal after mechanical defibration would be very expensive and total disaster quality-wise. (Kappel 1999, 264) Chemicals typically used are either reductive Dithionite with brightness increase potential 4-10 % ISO, or oxidizing Peroxide with brightness increase potential 10-20 % ISO. (Seppälä & Klemetti & Kortelainen & Lyytikäinen & Siitonen & Sironen 1999, 53-54)

1.3.1 Peroxide bleaching

Peroxide bleaching in industry refers to hydrogen peroxide H_2O_2, which is able to oxidize the chromophore groups in the lignin molecule and by so remove the color of the lignin. This reaction to take place it is required to have alkaline process condition in the bleaching tower, and typically some stabilizers, such as silicate, since peroxide is unstable by nature and could decompose before bleaching the pulp. The reaction goes as follows in formula (2) (Kappel 1999, 266):

$$H_2O_2 + OH \rightarrow OOH + H_2O \qquad (2)$$

Peroxide reacting with alkali OH forms hydroxyl peroxide OOH, which actually is the active component in oxidizing the chromophore groups in the lignin. (Kappel 1999, 266) Furthermore, reaction speed is one of the main parameters, and the following conditions can lead to a higher speed:

High peroxide concentration
high caustic concentration
high temperature

Peroxide can also decompose into water and oxygen. This decomposition is mainly catalyzed by heavy metals such as manganese, iron and copper, but can be prevented by adding complexing agents to complex the free heavy metals. (Kappel 1999, 269)

1.3.2 Dithionite bleaching

Sodium dithionite ($Na_2S_2O_4$), sometimes referred as hydrosulfite, is reductive bleaching agent, capable of decolorizing chromophore groups. Sodium dithionite transforms into sodium bisulfite SO_3^{2-} and sodium salt of unstable sulfoxylic acid. Sodium bisulfite also appears as a bleaching reaction product, as shown by Kappel (1999, 297) below (Figure 2)

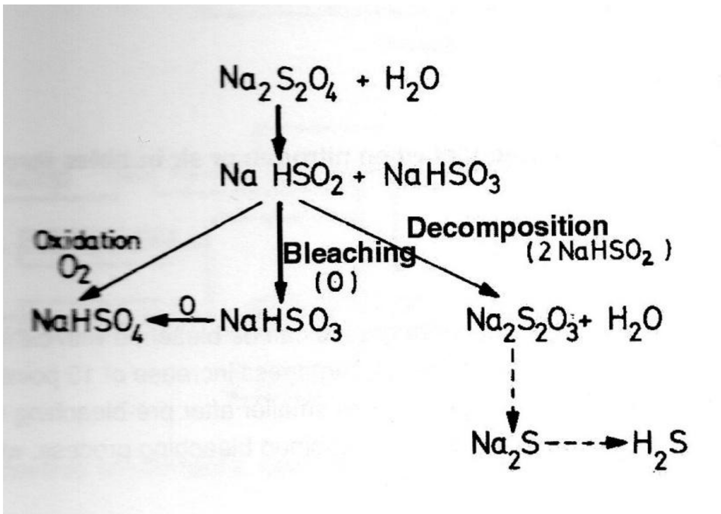


Figure 2. Reactions of sodium dithionite (Kappel 1999, 297)

Dithionite bleaching process is very sensitive for oxygen, which reacts with sodium sulfoxylate and can cause severe drop in pH and spread unpleasant smell, unbearable for example food packaging. (Kappel 1999, 298)

The brightness gain after peroxide pre-bleaching is very modest, jet important in order to achieve the highest brightness. (Kappel 1999, 298)

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