Some Thoughts On Pulp Bleaching

with washings in between, to re-

move the products formed by the

Multistage bleaching was restrict-

ed, at the beginning, only to rag

pulps. It was found out in early

twenties, that the multistage bleaching can be adopted even

with greater advantages with other types of pulp. In modern

practice as many as seven stages of bleaching are not uncommon.

the degradation of pulp is com-paratively less and the overall

chemical requirement is reduced.

These advantages more than compensate the initial costs of

plants and equipments, the water

requirements, the labour charges,

the operation expenses, etc.,

needed in a multistage bleaching

A variety of combinations and

concentrations of chlorine is gen-

erally used in the first bleaching

stage. This is followed success-

ively by a stage of alkali extrac-

tion and water washing. The ter-

minating stages may be a series

thorough intermediate and final water washings. Recently, chlorine dioxide, peroxides and chlo-

rites have been used extensively for improving the brightness of the chemical pulps. Though more

costly than the hypochlorites,

their uses as final bleaching

multistage bleaching, the

increased.

the overall

treatments and

bleaching action.

brightness is vastly

In

process.

of hypochlorite

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When first introduced, pulp bleaching was limited to consist-encies of 3 to 4 per cent. It was afterwards found that with a higher consistency, of about 7 per cent, the improvement in colour was remarkable. This led to the modern tendencies of bleaching pulp with still higher consisten-cies. During the developmental period of bleaching, it was found to be of advantage to add only a part of the bleach requirement at the beginning, and that the bal ance of the requirement could be added later, perhaps, in several instalments. This paved the way for the conception of modern multistage bleaching sequence

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agents are based on two important ronsiderations, namely:

(a) their minimum degrading effect on the pulp, and

(b) their capacity of producing maximum final brightness.

The lignin, the predominating impurity in the pulp, is considered to be mainly responsible for the colour. There may, however, be other components like resins, tannins, colouring matters, etc. Lignin contains a large number of phenolic groups. Some of the phenolic groups are free, but others are esterified. It is assumed that by various oxidative processes, some (but not all) of the phenolic groups are converted into quinonelike substances which absorb the visible light.

The colour reversion observed in cellulose and hemicellulose, on aging is attributed mainly due to the formation of the carbonyl groups. Bleaching should, therefore, be carried out under such controlled conditions as to from as little carbonyl groups as possible. These groups are sensitive to alkali, and, if necessary, can be removed by alkali extraction.

The main purpose of bleaching is to remove lignin present in the pulp, and, in a way, bleaching can be regarded as a continuation of the chemical pulping process. The prime object of chemical

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pulping is to remove lignin with minimum dissolution of the carbohydrate components. This is also the object of pulp bleaching. The bulk of the lignin is removed, during chemical pulping, by using chemicals like alkali, sulphides, and sulphites. These chemicals are cheap. They can be used at high temperatures and pressures and are often recovered for reuse.

Chemical pulping process, however, cannot be carried out for complete removal of lignin. Any attempt, to remove lignin completely, by the chemical pulping process, will lead to a serious degradation of a large part of the pulp carbohydrate, namely, the hemicellulose. After removal of the major part of lignin, by a suitable chemical pulping process, the remainder is removed in the bleaching operation by oxidation and dissolution in alkali.

Howsoever effective the cooking may be, the desired amount of lignin, resin and hemicellulose cannot be removed by a single stage bleaching operation. A multistage bleaching is not only a necessity for overall economy, but also for best technical result. Chlorine, the cheapest of an bleaching chemicals, is generally the cheapest of all used to meet the major part of the OXYGEN DEMAND OF LIG-NIN. It is best suited to attack a large quantity of lignin. The chlorolignin compounds formed, as also the oxidised lignin, are removed by alkali extraction. The chlorine treated pulp, however, is not very white; because, the lignin is only chlorinated and oxidised in the process, without much dissolution. Therefore, a Therefore, a second treatment consisting of extration with dilute alkali at a somewhat elevated temperature, is necessary to remove the chlorinated and oxidised products of lignin, which, if present (and not removed), will consume more bleach in subsequent stages. The caustic extraction not only removes these products but also some hemicellulose and resin, if present.

Under the normal conditions of chlorine treatment, namely, at a low temperature of chlorination and a brief period of treatment, some resins and highly condensed lignin fractions are not reacted; hence, they are not removed by the alkali extraction. Although chlorine will not cause much harm to the carbohydrate, under the mild conditions of bleaching normally followed, a severe condition of treatment

necessary to remove the last (or residual) part of lignin and resin, will do much harm to the carbohydrate. Therefore, a hypochlorite stage is introduced to the bleaching sequence to give an oxidative treatment to the impurities (that is, residual lignin and resin) left over.

In the hypochlorite bleaching, the lignin and colouring matters left unaffected by chlorine, are chemically reacted and removed and such a degree of brightness is achieved, as cannot be obtained by chlorine treatment followed by alkali extraction. The hypochlorites are effective in making the pulp whiter; but beside oxidising lignin, the carbohydrate is also oxidised. However, the rate of oxidation of the carbohydrate is comparatively much slower than that of lignin. Further, in order to minimise the risk if carbohydrate degradation in the hypochlorite bleaching, the pH is kept high by making the medium alkaline, and by keeping the reaction time and temperature under control.

Inspite of all these precautions, during the hypochlorite bleaching, some of the alcohol groups of cellulose are oxidised to carbonyl groups, and a lowering of viscosity takes place due to ruptures in the cellulose molecular chains. It can be said in general, that an ideal oxidising agent, during bleaching is expected to behave in the following two ways—

(a) It should meet the bleach demand of noncellulosic substances present in the pulp, that is, by chemically reacting with lignin and other noncellulosic fractions (e.g. resins, colours, etc.), and,

(b) It should cause minimum degradation of the carbohydrate fractions (cellulose and hemicellulose) of the pulp.

The relative rate of these reactions will decide the amount of whiteness produced and the degree of degradation the pulp has undergone. In an ideal condition, the OXYGEN DEMAND of the noncellulosic fraction (mostly lignin) will be adequately met by the bleaching agent, and it will have least degrading action on the carbohydrate constituents. An optimum will have to be set for the bleaching agent, in consonance to the nature of the chemical pulp, its consistancy, the temperature, time and pH of bleaching, in such a way as to effect a maximum rate of reac-

tion with lignin and a mimimum degradation of cellulose and hemicellulose.

In recent years the demand for brightness has increased to such an extent, that even with well buffered hypochlorite treatment, it is not possible to achieve the required state of brightness, without causing excessive damage to the carbohydrate fraction of the pulp. It has, thus, become necessary to introduce, what may be termed as a SUPER BLEACHING STAGE, with chlorine dioxide or the peroxides. Under normal conditions of bleaching, chlorine dioxide is probably the nearest to the ideal bleaching chemical. It is unique in oxidising lignin and causing least damage to the carbohydrate. It may, however, be mentioned that the level of brightness which can be achieved with minimum degradation from pulp to pulp, and is not directly related to the oxygen de-mand of lignin. Since improvement in the brightness of the pulp is interrelated with the reactivity and accesibility of the main im-purity, lignin; it may be desir-able to duplicate the treatments of chlorine, hypochlorite and dioxide, in that order, chlorine with an alkali extraction.

It has been found that by combining two bleaching chemicals or using one chemical after another, without washing in be-tween, the bleaching effect can be improved in many cases. For example, when chlorine, in admixture with a small amount of chlorine dioxide, is used for bleaching, the drop in the visco-sity will be sufficiently low, as compared to the viscosity drop obtained by use of chlorine alone. Again, a small amount of hypochlorite when used with caustic soda solution for extraction, also accomplishes some bleaching. Chlorine dioxide can be used after the hypochlorite stage without washing to produce more brightness. By using sodium peroxide after the chlorine dioxide stage, with or without washing, the rithout washing, the can be greatly inbrightness creased.

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