Refiner Bleaching of High Yield Pulp Using Hydrogen Peroxide—A Review

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Newsprint grade mechanical, chemi-mechanical Pulp (CMP), thermo-mechanical pulp (TMP), chemi-thermo mechanical pulp (CTMP) and other similar pulps are produced by defibrating the wood chips in refiners. This is done by passing wood chips either directly by making wet or by steaming at 110° to 130°C (TMP) or by giving chemical treatment (CMP) or by treating the wood chips by steam and chemical like alkali (CTMP).

During this treatment the chips are subjected to abrassions. These abrassions are series of compressions and decompressions as the chips rotate between the plate of refiners. This action is not only highly efficient in separating the individual fibres but it also supplies the necessary torque for creating ribbon like structures from these fibres.

Many theories have been put forward and investigations have been carried out to understand refiner pulping[1,2]. According to one of the theories which is based on investigations the chips are broken down into pin chips with brooming heads by coarse breaker bars. The particles become smaller in progressive samples reaching almost complete defibration with full plate. It is also mentioned in above literature[1] that during refining the walls of the fibres are broken down into ribbons. These ribbons not only have more surface available for bonding but being flexible they can conform better to each other in paper sheet.

The literature[1,2] also discuss about types of refiners available for mechanical pulping e g. vertical shaft single disc refiner, single rotating disc refiner, double rotating disc refiner, twin disc refiner etc.

A lot of literature is being published day by day on pulping of various wood species and non-wood species in addition to coniferous woods, eucalyptus, bamboo, kenaf and agro residue like bagasse, etc.

This refining of pulp can be two stage or three stage. The refining consistency can be 16 to 25% in primary and secondary refiner, however, it is almost 4 to 5% or less in tertiary refiner[1]. In refiner mechanical pulp (RMP) the first stage refiner reduces the chips to coarse fibre bundles and second stage refiner reduces these bundles into individual fibres.

During these refining stages enough heat or consequently steam is generated. In one of the pulp mills steam is being used to heat the water used in chip washer[1]. In some of the high yield pulp installations with two stage refining at consistancies 16 to 25% is used and is found to be sufficient to produce good quality pulp for the application. Sometimes the refiners set up in the pulp mill are such that primary and secondary refiners are operating at 8 to 25% consistancies prior to bleaching of the pulp and tertiary refiner is used at lesser consistancy after bleaching the pulp.

The purpose of this paper is to introduce some of the literature published recently on peroxide bleaching at refiner stage.

REFINER BLEACHING

At refiner stage the heat generated could be utilised to bleach this high yield pulp. The amount of heat generated at refiner would depend upon the type of pulping, type of raw material, type and number of revolutions of refiner disc. The heat generated is enough to provide bleaching temperature for high yield pulps.

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With the development of disc refiners working at high consistancy the idea of peroxide bleaching was developed at refiner stage. This process is simple and does not need an additional equipment to switch over to refiner bleaching of high yield pulp using hydrogen peroxide.

High consistancy, high temperature available at refiner stage provides, necessary conditions for peroxide bleaching. Besides, this disc refiners also act as excellent pulp mixer[3]. A comparative study on refiner bleaching and tower bleaching of high yield pulp has been carried out by Solinas[4].

In a paper by published Loras, Carles and Papageorges[5], authors have evaluated the possibilities of refiner bleaching of thermomechanical pulp made from French Softwood—a mixture of fir and spruce prepared from saw mill residue. The authors have carried out this pulping and bleaching test in the laboratory using Sprout-Waldron laboratory disc refiner by using 10% consistancy. The flow sheet of bleaching shows peroxide addition at tertiary refiners. The authors have also discussed the type of the wood pulped, the method of stabilising hydrogen peroxide, the influence of consistancies on the brightness. The authors have also discussed the comparison of tower bleaching and refiner peroxide bleaching. The paper also refers to the studies on temperature dependent rate of peroxide bleaching. This work was extended to pilot plant using TMP on double disc (1500 rpm) SUN-BAUER-400 refiner of capacity 6 TPD. The flow sheet of the process here shows peroxide addition at secondary refiner. The paper also refers to the various level of brightness elevation by using different levels of hydrogen peroxide. The paper shows that the increase in brightness of the order of 14 to 24 points. The other properties of the pulp are also discussed.

A paper based on refiner peroxide bleaching work carried out at one of the Norwagian Paper mills was presented by Soteland, Sandberg and Morris[6] at EUCEPA, Oslo in June, 1981. The mill produces marketable pulp with the capacity of 30,000 TPA. Refiner peroxide bleaching had increased the brightness of the pulp from 60—62° ISO to 70° ISO using 1.5% hydrogen peroxide on O.D. pulp basis. No additional equipment were used except hydrogen peroxide soup preparation tank, stock solution]pumps, dosing pump and piping.

Number of patents are also filed in Japan. In one of the Japanese Patents[7] inventors have mentioned the addition of magnesium salt at primary refiner and hydrogen peroxide bleaching is carried out at secondary refiner onwards. The patent also mentions that the quality of the pulp produced is superior to that of conventionally bleached mechanical pulp. Inventors have given some examples of refiner peroxide bleaching using local wood called Ezo Todomatsu. The brightness of pulp was increased from 47° to 67° ISO by refiner peroxide bleaching.

Yotsuya and others[8] have claimed that the strength, flexibility and surface smoothness etc. obtained by this refiner peroxide bleached pulp is far superior to conventionally bleached pulp. The patent also discusses about sodium hydroxide staining of pulp. It has given detail procedure of stabilising hyrogen peroxide, suitable consistancy at the refining stage, suitable pH condition, position of dosing hydrogen peroxide etc. The patent also discusses the mineral acid addition to control pH and to open the fibres. Some of the laboratory experiments are also discussed in the patent indicate that the brightness has increased from 55° ISO to 70° ISO in refiner peroxide bleaching.

In another Japanese Patent[9] Yotsuya and other discuss about similar aspects of refiner peroxide bleaching. The patent has given examples that brightness could be elevated from 50° to 67° ISO using refiner peroxide bleaching.

The literature[10] is also published on Kenaf TMP and CTMP for newsprint where authors have mentioned about refiner peroxide bleaching. Basic hydrogen peroxide treatment of poplar wood produced Chemi-thermomechanical pulp (CTMP) with 79% whiteness[11]. This can be similar to refiner peroxide bleaching. The literature has also been published on refiner peroxide bleaching of bagasse[12]. The authors have mentioned that pulp produced by this method is of improved mechanical properties.

Most of the literature published deals with refiner peroxide bleaching of coniferous wood which is normally used for newsprint and other allied products. In case of bagasse also some literature[12] has been published. However, in case of the tropical hardwood like eucalyptus and other the literature is limited. Perhaps the high yield pulp of tropical hardwood and bamboo may

be difficult to bleach. Some laboratory work on hypochlorite peroxide (HP) bleaching was carried out few years back in India. A detailed report has been published on laboratory tower bleaching of this type of pulp[13]. Recently, work carried out by Mohan Rao, Harikishore and Pant[14] on bleaching of cold soda bamboo pulp shows that presence of small amount of hydrogen peroxide (0.5%) at pre-alkali stage improves the brightness in two stage hypochlorites bleaching of the above pulp.

Chemi-mechanical Eucalyptus pulp produced in southern India is generally having brightness of 30—35° ISO. Newsprint grade CMP is expected to have 50—55° ISO or more brightness. It is very difficult to bleach this pulp economically using only hydrogen peroxide. Gennerally this pulp is bleached by using two stage hypochlorite. However, one can always explore the possibility of refiner peroxide bleaching by using stabilised hydrogen peroxide. The temperature generated under normal conditions is 80—110°C and under pressure is 120—140°C at primary refiner. This temperature could be utilised to bleach pulp at refining stage using hydrogen peroxide. High consistancy available at refinning stage would also help the peroxide bleaching. The pulp coming out from secondary refiner can be further bleached by washing or without washing using hypochlorite to the required brightness. By using hydrogen peroxide at refining stage the pulp would have higher brightness and requirement of hypochlorite may reduce at conventional tower bleaching.

ACKNOWLEDGEMENT

The author wishes to thank Dr. C.J. Dadachanji, President and Dr. S.K. Datta, General Manager, Technical Development, National Peroxide Limited for their encouragement and guidance.

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