Alkaline Peroxide Mechanical Pulping of Populus Deltoides

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Pulping of Populus deltoides was studied using sodium hydroxide and hydrogen peroxide along with chelating agent as impregnating chemical using Alkaline Peroxide Mechanical Pulping (APMP) process. Steamed chips were dewatered and impergnated with chemicals in two stages followed by dewatering after each stage of chemical treatment in indigenously designed and fabricated impressafiner. The chemical treated dewatered chips were finally refined. It was observed that high pulp yield (≅80%) having adequate strength properties with brigthness (>75%) can be obtained from Populus deltoides using APMP process.

INTRODUCTION

Poplars are fast growing species having low density and light colour. Researches have revealed that wood is suitable for making varieties of paper (1). It is expected that plantations of 3-4 years old poplars wood becoming one of the raw material for papermaking. Hardwoods have been used in mechanical pulping for a number of years, but can the technology be advanced for producing high brightness papers suitable for tissue grades and writing and printing paper. Efforts directed towards finding a pulping process have indicated that high strength; high brightness pulps suitable for writing and printing grades at yield over 80% can be produced from hardwoods (2-6).

APMP process advances the technology of producing Bleached Chemi Thermo mechanical pulping process in its 90s. This has been a successful pulping method for low density hardwoods. It advances over conventional CTMP process include good pulp quality, elimination of bleach plant and energy savings.

APMP uses advanced chip treatment techniques to pulp and bleach wood prior to refining(7). The combination of pulping and bleaching in a single unit operation reduces the capital cost for an installation by decreasing the amount of equipment to produce pulp and significant operating cost like reduced electrical power consumption (8).

The heart of APMP process is a device called is Impressafiner. This unit completely compressed the chips and squeezes out soluble material along with water. The unit was designed and locally fabricated of capacity handling 2-5 kg (wet chips with moisture content 100% attained after steaming) having compression ratio 4:1 (wood:liquor).

Due to its suitability to low density wood, the number of experiments were carried out in the laboratory to enhance the dewatering efficiency and optimised the chemical conditions. In the present paper, the results obtained at different conditions keeping dewatering efficiency 75-80%, are discussed.

RESULTS AND DISCUSSION

Wood chips (10-15% moisture content) were presteamed under pressure as well as atmospheric pressure to attain a moisture level at which the chips are sufficiently softened. It was observed that air dried chips having 10-15% moisture content got softened after attaining about 100% moisture content. The data on prestreaming are recorded in Table 1. It was observed that chips exposed to steam for a long time resulted into yellowing of final product, thus chips of about 100% moisture were taken for the study.

Dewatering of presteamed chips presteamed chips about (100%) moisture content were used in these experiments. For dewtering impressafiner (compression cum dewatering unit) as designed and fabricated locally for a capacity of 2-5 kg per hour. The chips were radially and axially compressed by means of gradually decreasing pitch tapered screw of SS 316 which rotates inside the screw body of cast steel at available speed of 5-10 RPM with the help of set of reduction gear box and electric motor of 7.5 kw. The schematic lay out of the unit is given in the Fig. 1. The chips were compressed at variable pressure of 6000-10000 psi. The compression of chips at desired pressure gives a dryness of 75-80%. The effluent obtained on compression of chips passes through a semicircular slotted screen of SS 316 provided at the bottom of the screw. The chips after compression comes out from the out let of the unit while the effluent is collected in the effluent tray provided at bottom of the unit. The effluent was dark brown in colour and analysed. The results are recorded in Table 2. From that table it can be envisaged that effluent generated is of low concentration and suspended solids in terms of fibre loss in 5.8% of the total solids. The chips after dewatering was loosened mass and bright in appearance. At higher operating rpm (10) there was large generation of fines and at low rpm (5) the water removal efficiency was not to the desired level. Thus the experiment were carried out at 8 rpm.

Chemical impregnation/Deliquoring/Bleaching.

A series of experiments were carried out at different operating conditions (5 to10 rpm) to achieve targeted wood to liquor/water ratio in dewatered chips (4:1). The presteamed dewatered chips were impregnated with varying doses caustic soda caustic soda, hydrogen peroxide and chelating agent at 25% consistency and reaction temperature 80-85°C and retention time 40-60 min to achieve maximum brightness, minimum pulp yield loss with higher strength properties. The chemical impregnated chips were deliquored in the same unit in which dewatering of steamed chips was carried out at

Table 1 Presteaming of chip

Steam Pressure (Kg/cm^2)	Time (min)	Moisture attained (%)	Remarks
8.0	60	209.65	Chips were highly soft
8.0	15	195.86	Chips were highly soft
8.0	5	152.76	Chips were very soft
8.0	4	145.26	Chips were very soft
5	5	142.50	Chips were very soft
5	3	96.27	Chips were mildly soft
Atmospheric	30	176.97	Chips were soft
Atmospheric (over sieve)	30	125.67	Chips were less soft

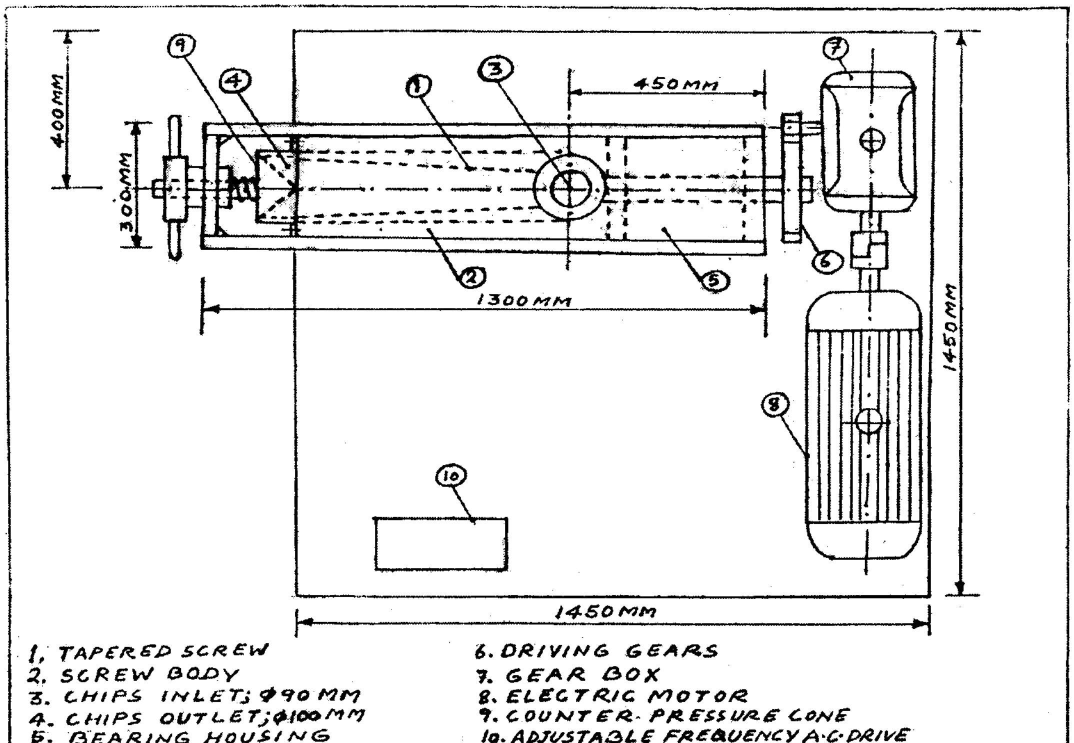

Figure 1. SCHEMATIC LAY OUT OF COMPRESSION-CUM-DEWATERING UNIT

Table-2 Characteristics of effluent generated on dewatering of presteamed chips

(per tonne of O.D. Chips)

Parameters	Value
Effluent generated, m^3	570-590
Total solids, kg	3.8-4.5
Total dissolved solids, kg	3.6-4.1
Suspended solids, kg	0.2-0.4
COD, mg/l	8640
Energy required Kwh	220-250

10,000 psi. The energy consumed during dewatering (I and II stage) was noted. The liquor thus collected after each stage of chemical treatment was analysed. The deliquored chips so obtained were defibrated in 12" disc rafiner. The total energy required in two stage of dewatering chemical treated chips was 410-460 Kwh/t. The conditions adopted during chemical treatment is recorded in Table-3

APMP process pulp quality

The chemical treated dewatered pulp was refined to about 200ml CSF and pulp sheets of 60gsm were prepared for testing. The application of APMP process revealed that Populus deltoides pulp gave higher pulp yield (≅ 85%) at brightness level 75-80% ISO. Pulp exhibited adequate strength properties.

From the table it is observed that at 3% hydrogen peroxide charge along with 4% sodium hydroxide, it is possible to achieve 86% pulp yield at brightness level of 75% ISO. On increasing the hydrogen peroxide and sodium hydroxide doses, there was marginal improvement in brightness, strength properties and minimum reduction in pulp yield. The final brightness of the pulp depends upon the extent of dewatering and

Table 3 Conditions maintained during chemical treatment

Parameters	Ist stage Chemical Treatment				IInd Stage Chemical Treatment			
Code	1	2	3	4	1	2	3	4
Hydrogen Peroxide,%	2.0	2.0	2.0	2.0	1.0	1.5	1.5	2.0
Sodium Hydroxide	2.0	2.0	2.0	2.0	2.0	2.0	2.5	2.5
RPM	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Reaction Temp°C	80-85	80-85	80-85	80-85	80-85	80-85	80-85	80-85
Reaction time, min	60	60	60	60	60	60	60	60
Sodium Silicate, %	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Magnesium Sulphate, %	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
EDTA, %	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04

Table 4 APMP process Populus deltoides pulp

Code	1	2	3	4
Pulp yield, %	86.22	86.12	85.96	85.75
Brightness, % ISO	75.26	75.38	76.83	78.03
Tensile index, Nm/g	42.06	43.68	45.93	46.82
Burst index, kPam^2/g	1.95	1.98	2.00	2.005
Tear index, mN m^2/g	4.32	4.32	4.34	4.35

removal of soluble solids. The doses of sodium hydroxide are very important and make the fibre flexible results in better fibre binding. Increased doses of sodium hydroxide beyond certain limit resulted in yellowing of bleached pulp. All above parameters are needed to be optimised very carefully otherwise at same level of chemical charge it may possible that pulp produced will not have desired brightness, pulp yield and strength properties.

It s observed that application of hydrogen peroxide in two stages i.e. first a chemical impregnation stage and secondly at subsequent at treatment stage of deliquored defibrated material gave better results than applying in three stages. In addition, the increased doses of hydrogen peroxide and sodium hydroxide together in the same ratio beyond certain level marginally improves brightness and strength properties.

CONCLUSION

Alkåline Peroxide Mechanical Pulping/Bleaching uses the combination of pulping and bleaching in single stage unit to produce bleached grade pulp. Presteaming of the chips to increase the initial moisture content of the chips to 100% is essential to soften the chips and to reduce the damage of the fibre during dewatering. Presteaming and dewatering stage are very important to control the quality of final product in terms of pulp yield, brightness and strength properties. It is possible to produce pulp of more than 75% brightness with yield >80% having adequate strength properties using APMP process. The APMP process produces large volume of effluent with low pollution load.

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