APMP Process - Key to Optical Properties of Mechanical Bagasse Pulp

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ABSTRACT

Plant scale mechanical pulping of Bagasse was studied using Sodium hydroxide and Hydrogen peroxide as impregnating chemicals as being done in Alkaline Peroxide Mechanical Pulping (APMP) process technology. Along with Sodium hydroxide, Sodium silicate and Magnesium sulfate were also dosed. Impregnation and refining were carried out in two stages. It was found that the APMP pulps were having higher scattering coefficient at the equal level of strength properties as compared to conventional CTMP pulps from bagasse where the impregnating chemicals were Sodium hydroxide and Sodium sulfite. However there was not much reduction in shives content. To find a way out laboratory studies were carried out for the reduction in shives content by the pulp after first stage refining and carry out bleaching and second stage refining and compare the shives content of the pulp with the conventional method of first stage refining, second stage refining followed by screening and then bleaching.

INTRODUCTION

Mechanical pulps and Chemi-mechanical pulps play a very important part in the newsprint furnish as it lends Newsprint the important properties of high opacity, rapid ink absorbency, bulk and good printability. These pulps are high yield pulps manufactured with less use of chemicals in pulping but are more power intensive (1).

Conventional Newsprint is made from furnish containing high percentage of mechanical pulp/chemi-mechanical pulp manufactured from softwood. In addition to this they also contain a small percentage of chemical pulp to lend the Newsprint sheet the required strength properties enable the paper web to run smoothly on high speed printing machines (2).

TNPL is a first mill in the world, making baggasse Newsprint having a furnish containing about 30 to 40% Kraft chemical pulp from bagasse about 5 to 10% Kraft chemical pulp from Hardwood and 30 to 35% mechanical pulp from bagasse and supplemented by about 15% long fibred soft wood CTMP. While evaluating the runnability of these furnish in Newsprint machine, it was found that runnability of machine was affected when mechanical bagasse pulp exceeded 40%, lower opacity and show through when chemical Bagasse pulp was increased.

The crux of the problem is that the chemi-mechanical pulp from bagasse was having not only lower strength properties as compared to mechanical pulp from wood and also much inferior optical property. When we tried to increase the optical properties if Newsprint by increasing the mechanical component

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the strength properties suffered a set back resulting in poor runnability of the paper machine. When we tried to increase the chemical pulps to increase the strength properties the optical properties were adversely affected. So a balance has to be struck between the strength and optical properties.

The Mechanical bagasse pulp plant in TNPL, which is the first of its kind in the world, uses a modified CTMP process for the production of chemi-mechanical pulp. The process involves the treatment of depithed bagasse after washing, with impregnation solution containing Sodium hydroxide and Sodium sulfite. The bagasse is passed through a plug screw feeder where it is compressed and the plug screw feeder outlet leads the compressed bagasse in to a streaming tube where the impregnation liquor containing Sodium hydroxide and Sodium sulfite comes in to contact for five minutes. It is steamed and sent in to a pressurized primary 54 inch disc refiner where the pulp freeness is reduced in to about 500 to 600 mlCSF. In the pressurized primary 54- inch disc refiner the pressure is maintained about 2.5 kgs/cm^2. The primary refined bagasse pulp is blown in to a blow tank and from blow tank the pulp is taken in to a Thermo - mechanical pulp intermediate chest (TMPIC)., From TMPIC pulp is taken to a head box and sent through another plug screw feeder where the refined bagasse is compressed again. The compressed bagasse is allowed to expand in to a steaming tube where the impregnation liquor is again dosed. After a retention time of about 5 minutes the impregnated bagasse is subjected to secondary refining in 54-inch refiner (atmospheric). Here the freeness is brought down to 300-350 mlCSF. From there the pulp is taken to the screening stage, the screen accepts are taken to a prethickener and the screen rejects are circulated through rejects refiner in to the screen.

The pre-thickened pulp is taken through a twin roll De-Watering Press (DWP-1) for hydrogen peroxide bleaching. In addition to hydrogen peroxide, Sodium silicate, Sodium hydroxide and Magnesium sulfate are added. After the bleaching in the peroxide tower the pulp pH is brought down to 5.5 by the addition of Sulfuric acid and the pulp is dewatered in a De-Watering Press (DWP-2). This DWP-2 pulp is stored in a high-density storage tower. It was found that this mechanical bagasse pulp has the following properties.

Freeness	ml CSF	200
Bulk	cc/gm	2.42
Breaking length	Meters	2980
Tear factor		49.5
Burst factor		12.5
Brightness	% ISO	51.5
Opacity	%	90.0
Scatter	m^2/kg	40.0

Many times the optical properties were found to be less (i.e.) less opacity and lower scatter. To over - come the deficiencies like low bulk, low strength, low opacity and low scatter. An attempt has been made to apply the recently developed Alkaline Peroxide Mechanical Pulping (APMP) process technology (3) for the chemi-mechanical pulping of bagasse.

APMP process uses advanced raw material (chip) pretreatment technique pulps and initiating the bleaching prior to wood refining (4). The combination of pulping and bleaching in a single operation reduces the capital costs associated with building and operating a separate dedicated bleach plant (5) It is also found that APMP pulp has higher bulk, better strength properties and better optical properties as compared to CTMP pulp (6). In the APMP of wood, significant operating cost advantage like reduced electrical power consumption were also realized (7).

The heart of APMP process used for chemi-mechanical pulping of wood is a device is called "IMPRESSAFINER" that completely compresses the chips in to uniform perfect mass for complete chemical impregnation (8). The impressafiner completely squeezes out the air and free water available from the chips and the passes the chips in to pool of liquor containing the Sodium hydroxide and Hydrogen peroxide. Thus the chips are allowed to expand by this process and suck the liquor in to every pore of the chips. Normally in the chemical impregnation stage, 20 to 40 minutes will be given as a retention time for chemical uptake. The impressafiner is designed for compression ratios of around 4:1 After the impregnation stage, the impregnated chips were subjected into the refiner, then the whole process is repeated again once or twice. Thus the process utilizes the multistage impregnation of the chips by hydrogen peroxide followed by refiner and conventional fibre processing steps (9).

The major advantage of APMP is this process is required no additional bleaching stage after refining to get a good mechanical pulp at higher brightness (10). However to get a higher brightness mechanical pulp in

the region of 70 to 75% ISO, the conventional bleaching stage available in the mechanical bagasse pulp line can be utilized. Since the impregnation and refining taken place in an alkaline environment the extraction of soluble substances like resins are enhanced and the specific energy consumption also gets reduced. The APMP process technology uses no sulfur content process, which helps the treatment and handling of effluent in a much easier way 11). With this in mind, we have tried the APMP process for pulping of bagasse.

DISCUSSION

FIRST AND SECOND STAGE REFINER BLEACHING

Since facilities were not available in our laboratory to carryout the proper APMP process, we have taken the APMP process plant trial in our regular mechanical bagasse pulp line itself. Even in the plant, the plug screw feeder is available with a maximum compression ratio in the order of 2.2. to 2.4:1 only. The required compression ratio of 4:1 is not achievable with the presently available plug screw feeder. Since bagasse is an open fibre, the present compression ratio itself was considered sufficient.

Sixteen -hour plant trial for APMP process was taken in our pulp mill mechanical bagasse pulp line. Only making minor modifications in the plant used the existing equipments. The existing liquor preparation tanks were thoroughly cleaned and a soup solution containing Sodium silicate, Sodium hydroxide and Magnesium sulfate was prepared. Since this tank was made of mild steel, Hydrogen peroxide was not mixed in the soup. Bagasse after compression in the plug screw feeder was taken to steaming tube where both soup and Hydrogen peroxide were dosed separately and then to the primary refining. The chemical dosages were given in Table -1.

After the primary refining the pulp was blown into the blow tank, from blow tank to TMP intermediate chest to Second stage refining through a plug screw feeder and a steaming tube. Here also the same compression ratio of 2.2 to 2.4:1 was maintained. The chemical dosages were given in table -1. The retention time available before the first stage and second stage refining were only five minutes each which is very low when compared with the regular APMP process of 40 minutes. Then the pulp was subjected to screening and the screen accept was taken to pre-thickener for final touch up with hydrogen peroxide for bleaching. The screen rejects were taken to the reject refiner where also small amount of soup and hydrogen peroxide were added. The pulp characteristics of first stage and second stage refining were given in table -2. Since the trial was taken only for 16 hours we could not taken the assessment for power consumption or for optimizing H_2O_2 and NaOH dosage.

FINAL APMP PROCESS PULP QUALITY

The application of APMP process reveals that in comparison to the regular mechanical bagasse pulp made by the CTMP process, APMP process bagasse mechanical pulp exhibited a) slightly higher strength, b) Same brightness, c) Higher opacity, d) Higher bulk

TABLE 1

Conditions maintained in the First stage and Second stage refining.

Particulars	Units	First stage refining	Second stage refining
Pulping conditions			
Consistency	%	25.0	25.0
Reaction temperature	°C	120.0	85.0
Reaction time	min	5.0	5.0
Chemical dosage			
H_2O_2	%	1.5	1.5
NaOH	%	3.0	3.0
Na_2SiO_3	%	1.5	1.5
$MgSO_4$	%	0.05	0.05

TABLE 2

Two stage series refiner bleaching

S. No.	Parameter	Units	First stage refining	Second stage refining
1.	Freeness	ml CSF	360	260
2.	Bulk	cc/g	4.18	3.44
3.	Breaking length	Metres	1010	1585
4.	Tear factor		50	40.4
5.	Burst factor		4.5	5.7
6.	Brightness	% ISO	34.4	38.5
7.	Opacity	%	97.8	97.1
8.	Scatter	m^2/kg	37.3	43.6
9.	Yellowness	%	40.3	43.3

TABLE 3

APMP process bagasse mechanical pulp.

S. No.	Parameter	Units	Two stage refiner bleaching APMP	Regular Bagasse CTMP
1.	Freeness	ml CSF	200	200
2.	Bulk	cc/g	2.56	2.42
3.	Breaking length	Metres	2940	2980
4.	Tear factor		47.1	49.5
5.	Burst factor		12	12.5
6.	Brightness	% ISO	54.1	51.5
7.	Opacity	%	91.6	90.0
8.	Scatter	m^2/kg	45.6	40.0
9.	Yellowness	%	32.3	35.0

and e) higher scatter. These results were given in table -3. We did not find reduction in shives as compared to conventional mechanical bagasse pulp. This could be the fact that we could not be able to give enough retention time for chemical impregnation as in the conventional APMP process.

REDUCTION IN SHIVES BY BLEACHING AND REFINING

To cut down the shives content we have carried out the some experiments in laboratory. The plant pulp from first stage refining which was thoroughly washed with water to free from sodium sulfite was taken for hydrogen proxide bleaching to a final brightness level of 50 to 55% ISO and then refiner to a level of freeness 250 to 300 ml CSF as we get after the second stage refining. But in this bleaching and refining we found there was a very substantial reduction in shives content of 44% from first stage refining to 3.6% after bleaching and refining was compared to 15% shives content with only second stage refining without bleaching. These results are given in table -4. Similarly when the pulp after second stage refining was bleached and then

TABLE 4

Reduction in shives by bleaching and refining.

S. No.	Parameter	Units	Primary refining From the plant	After Lab Bleaching & Refining
1.	Freeness	ml CSF	660	300
2.	Bulk	cc/g	4.41	2.67
3.	Breaking length	Metres	1070	3150
4.	Tear factor		61.1	48.3
5.	Burst factor		4.4	13.3
6.	Brightness	% ISO	41.4	54.9
7.	Opacity	%	95.4	88.9
8.	Scatter	m^2/kg	35.2	41.1
9.	Yellowness	%	32.2	32.4
10.	Shives	%	44.0	3.6

refined third time brought the shives content to a much lower level which is similar to other mechanical pulps from agricultural residues.

CONCLUSIONS

Thus it can be seen the results presented above a combination of APMP and refining after bleaching open new possibilities for producing high yield, high brightness pulps from Bagasse better strength and optical properties has compared to corresponding chemi-mechanical pulps.

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