AS-AQ Pulping for Bagasse

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ABSTRACT

The suitability of AS-AQ pulping of bagasse at two different kappa levels (low and high) was studied for utilizing in the production of writing & printing and Newsprint paper grades. The process offers significant advantages such as higher yield, with lower screen rejects, and higher initial brightness when compared to kraft process.

Introduction

The growing concern of ecologists to conserve forests, non-wood fibres, particularly bagasse have been considered both from the stand point of economic viability and economic feasibility, as an alternative potential fibre source for manufacturing paper This is exactly true in case of developing countries like India that do not have soft wood resources or have meagre hardwood resources to meet the ever increasing demand of paper.

The mill operates two different pulping lines viz, bagasse kraft pulp and hard wood (Eucalyptus hybrid) kraft pulp designed to produce 40,000 MT of printing and writing grades per annum. Besides, TNPL produces 50,000 MT of newsprint per annum utilising mechanical bagasse pulp in the furnish.

In advanced countries, promising developments have been made in the pulping technology to improve the pulp quality and pulp yield. These processes are specially suitable for woody raw materials presumably due to the characteristics of these raw materials. Although, pulping processes have been standardised to a great extent for woody raw materials, they are yet to get established in the case of non-wood raw materials, primarily due to the non-availability of adequate data on the pulping processes. Further, the limited data available on the non-wood pulping processes are scattered and non specific to the Indian context (1). Keeping this in view, we performed a series of bagasse pulping studies involving soda, soda-A Q, sulfite and sulfite-A Q in comparison to the conventional kraft pulping. Out of these studies, the advantages of soda-A Q over kraft pulping were highlighted in our earlier report (2). This paper elucidates the application of alkaline sulfite (AS) and sulfite-A Q (As A Q) pulping processes in comparison to kraft pulping. This approach is towards the development of an approriate economically viable pulping technology which can be commercially exploited in the Indian paper industry. The above said pulping processes are oriented towards high yield and good quality pulps while complying with environmental regulations.

Experimental

Pulping experiments were carried out with commercially, stored, and washed bagasse used in the regular process in the plant. These experiments were performed in 18 L capacity, electrically heated programmable tumbling digester, 500g (o.d) bagasse was used for each pulping experiments Cooked pulps were washed over a muslin cloth kept on a 250 mesh screen and washed pulps were thickened in laboratory hydro extractor. The thickened pulps were shreded in an electrically operated high consistency shredder to a uniform consistency. The pulps were screened over a Sommerville shive analyser fitted with 0.25 mm slot screen. The screened pulps were used for determining the kappa number and brightness. The refining of pulps to a standard freeness level of 300 ml CSF was performed using a PFI mill at 10% consistency. The pulping conditions are shown below :

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		AS	AS–AQ	Kraft
Bath ratio		1 : 4	1 : 4	1 : 4
Steaming time	min.	55	55	55
Cooking time	min.	60	60	20
Cooking temp.	°C	170	170	170
Anthraquinone	%	—	0.05	—

Bleaching

All of the unbleached pulps were bleached with CEH sequence. Chlorination was carried out in a plastic container on 200 g o.d pulp with optimised chlor ne charge. Alkali extraction was performed in polythene bags in a thermostatic water bath. The pulps were manually kneaded for thorough mixing. Hypo stage was also carried out in polythene bags. For alkali extraction, the minimum amount of NaOH required to maintain the final pH above 10 5 was taken as the optimum. The bleaching conditions maintained are given below :

		C	E	H
Consistency	%	3.0	8.0	8.0
Temperature	°C	Amb	60	40
pH	—	2.0	>10.5	8.5–9.5
Time	min.	30	60	120

Analysis

Unscreened pulp yield were determined with a laboratory oven after drying at 105°C to a constant weight. Kappa number, viscosity and other physical properties were evaluated according to the TAPPI standard. Optical properties were evaluated with a Elrepho brightness tester.

Results and Discussion

1 Alkaline Sulfity (AS) pulping of bagasse Vs Kraft pulping

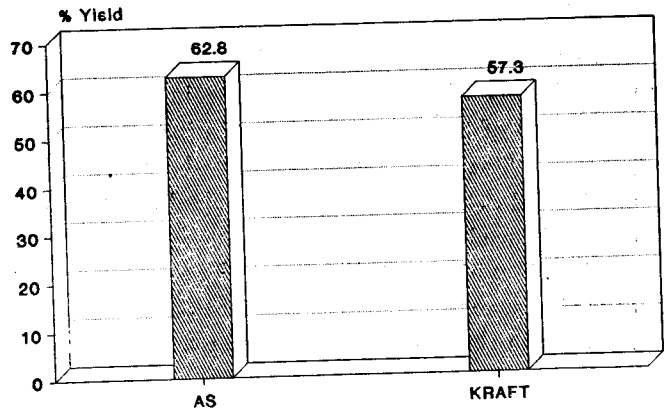
Inspite of an adequate understanding on the adoption of sulfite processes for woody raw materials, not much is however, known of bagasse sulfite process (1). Bagasse emerges as the first choice among the non-wood raw materials as an alternative to the conventional raw materials. Sulfite pulping process being mildly alkaline in nature, it should be more suited for agricultural residues because of their inherent open and loose structure and low lignin content.

By varying cooking time and chemical charge, a wide range of yields and kappa numbers were obtained for bagasse alkaline sulfite pulps. The yield of alkaline sulfite (AS) pulp decreased with an increase in cooking time and chemicals. Laboratory evaluation of both AS and kraft pulps at a similar kappa number is given in Table 1. The most interesting aspect of AS pulping is that it provides comparatively higher pulp yields. The screened yield of AS pulp exceeds that of kraft pulp by 5 – 6% at a target kappa number of 10 (Fig. 1)

Table–1
Alkaline Sulphite Pulping of Bagasse in Comparison to Conventional Kraft Pulping

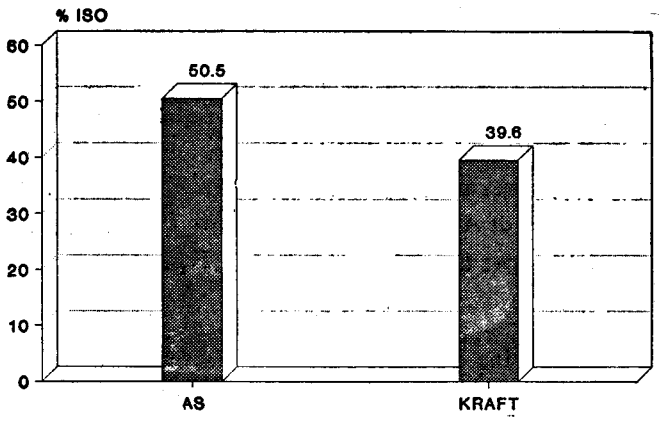
Parameters	Unit	A S Pulpirg	Kraft Pulping
Chemical as Na_2O	%	8 85	12 0
Sulphidity	%	—	19.4
TAA as Na_2O	g/l	—	83.1
Screen rejects	%	1.62	0.26
Screened yield	%	62.8	57.3
kappa number	—	10.9	10.1
Brightness	% ISO	50.5	39 6
Viscosity	cps	24.1	22.8

FIG 1. COMPARISON OF ALKALINE SULPHITE AND KRAFT PULP YIELD AT 10 KAPPA NO.



The high yield of AS pulps are partly attributed to the stabilization of hemicelluloses and partly to the mild alkaline cooking conditions, which preserve the hemicelluloses in the pulp (3, 4). The brightness of unbleached sulfite pulps is very much higher (10 points) than that of kraft pulp (Fig. 2).

FIG.2 COMPARISON OF UNBLEACHED PULP BRIGHTNESS



The alkaline and neutral sulfite pulping processes are well known among many wood based paper mills in view of their higher yields (5, 6). Hitherto, kraft process which superceded all other chemical pulping processes viz, sulfite and soda, is now being seriously considered for its modifications/replacement due to heavy pressure from the strict environmental regulations and relatively lower pulp yields. In fact, quite a few wood based kraft paper mills in Europe have been converted into sulfite process (7).

2. Alkaline sulfite (AS) pulping of bagasse reinforced with Anthraquinone (AQ)

AQ as a proven catalyst in sulfite pulping, offers scope for investigating its suitability in extended delignification of bagasse using the alkaline sulfite pulping process. The advantages claimed with AQ are, accelarated delignification, higher yields, strong pulps, and enhanced bleachabiltity than the sulfite pulps produced without AQ (8, 9). Tnerefore, here our objective was to examine the benefits derived from AQ addition in the AS pulping of bagasse.

Table 2 shows that addition of 0 05% AQ enables to delignify the material to a very low lignin content as indicated by the kappa number of the pulp. AS–AQ pulping claimed pulp cleanliness with respect to screen rejects and with marginal gain in the pulp yield (0.8%) over the sulfite pulping.

Table—2
Alkaline Sulphite Pulping of Bagasse in Comparison With AS–AQ Pulping

Parameters	Unit	AS Pulping	AS–AQ Pulping
Chemical as Na_2O	%	8.85	8.15
Screen rejects	%	1.62	1.20
Screened yield	%	62.8	63.60
kappa number	—	10 9	8.10
Brightness	% ISO	50.5	51 10
Viscosity	cps	24.1	25 60

3. Bleaching response of low kappa sulfite pulps in comparison to low kappa kraft pulp

Table 3 illustrates the response to bleaching of sulfite and kraft pulps at low kappa levels (8-11). The unbleached AS and AS—AQ pulps showed higher pulp brightness at similar kappa number. A brightness level of 85% was easily obtained for sulfite and kraft pulps with a three stage C—E—H bleaching sequence. Due to high initial brightness and low starting kappa (8), the total chlorine consumption was lower for AS—AQ pulp than the kraft pulp. Inspite of its high initial brightness, C—E—H bleaching of sulphite pulps with otpimised chlorine charge, yielded the same final brightness of kraft pulp with low initial brightness.

4. Pulp evaluation of low kappa sulfite pulps in comparison to low kappa kraft pulp

The unbleached and bleached pulps of sulfite and kraft pulps were refined in a PFI mill and their strength properties were evaluated at 300 ml CSF, Table 4 shows the strength properties of unbleached and bleached pulps. It can be observed that sulfite pulps prossess higher viscosity and showed comparatively higher values of bonding properties than the kraft pulp.

In the production of bleachable grade pulps from bagasse, one common disadvantage encountered is the presence of uncooked and unbleachable shives. Bagasse is heterogenous in nature and contains both soft and hard fibres. In the pulping of bagasse, preferential chemical reactions occur with soft fibres resulting in unbleachable hard shives and specks from hard fibres. These undesirable components affect final quality of pulp produced for the cultural papers.

Table—3
Bleachability of Sulphite Pulps in Comparison to Conventional Kraft Pulp

Parameters	Unit	AS Pulping	AS–AQ Pulping	Kraft Pulping
Brightness	% ISO	50.50	51.10	39.60
kappa number	—	10.90	8.10	10.10
Total chlorine applied	%	2.50	2.20	2.50
Total chlorine consumed	%	2.35	2.02	2.34
Final brightness	% ISO	84.80	85.50	84.00
Viscosity	cps	18.80	19.20	16.80

Table—4
Evaluation of Sulphite Pulps in Comparison to Kraft Pulps at 300ml CSF

Parameters	Unit	AS Pulping	AS–AQ Pulping	Kraft Pulping
Unbleached Pulps				
Tensile Index	Nm/g	76.60	78.30	76.90
Tear Index	mNm^2/g	5.40	5.12	5.12
Burst Index	KPm^2/g	4.73	4.78	5.00
Bleached Pulps				
Tensile Index	Nm/g	78.80	82.20	78.10
Tear Index	mNm^2/g	5.15	4.73	4.84
Burst Index	KPm^2/g	5.32	5.08	4.80

However, such low kappa number may not be required for newsprint production. It is our experience that unbleached bagasse pulp with higher kappa number (20) is satisfactory for the newsprint grade.

5. High kappa AS-AQ in comparison to high kappa kraft pulping process

Over the past decades, high yield and high kappa AS—AQ pulping of hard wood has been investigated to produce a low cost pulp (10, 11). Hence, to maximise the potential advantage of bagasse AS—AQ pulping, a high yield and a high kappa process has been investigated as a means of making a low cost pulp for the production of newsprint grade.

Sulphite pulping with anthraquinone to produce a high kappa pulp was performed to study the suitability of high kappa pulp for newsprint manufacture. The results are detailed in the Table 5. As expected, reduction in the cooking chemical led to significant gain in the screened yield, in the case of high kappa AS—AQ, in comparision to high kappa kraft pulp. It can also be noted that even at higher kappa number (20) sulphite pulp retains its brightness (46.4% ISO) similar to low kappa (11) sulphite pulp (50.5% ISO). Though the screen rejects of high kappa AS—AQ pulp are comparatively higher than high kappa kraft pulp, it pales in to insignificance, when the other advantages like high yield, and high unbleached pulp brightness are considered.

The strength properties of the above are compared in Table 6. At high kappa number, the strength properties of unbleached pulp of AS—AQ are comparable to that of high kappa kraft pulp. Hence it is suggested

that for newsprint grade, high kappa AS—AQ pulping may be desirable.

Table—5
High Kappa AS–AQ Pulping of Bagasse
In Comparison to High Kappa Kraft Pulping

Parameters	Unit	High Kappa AS–AQ	High Kappa Kraft
Chemicals as Na_2O	%	7.38	10.00
Screen rejects	%	1.80	.95
Screened yield	%	64.80	59.18
kappa number	%	18.30	20.40
Brightness	% ISO	46.40	30.80
Viscosity	cps	30.30	27.90

Table—6
Evaluation of Unbleached High Kappa AS–AQ
Pulp in Comparison to High Kappa Kraft Pulp
At 300ml CSF

Parameters	Unit	High Kappa AS–AQ	High Kappa Kraft
Tensile Index	Nm/g	72.9	81.3
Tear Index	mNm^2/g	5.84	5.17
Burst Index	kpa m^2/g	4.50	5.11

The final brightness of newsprint is generally governed by the brightness of the mechanical pulp in the furnish. It is our experience that, irrespective of the brightness of the chemical bagasse pulp (60-80% ISO) the ultimate brightness of newsprint is only few points above mechanical pulp brightness, which is the most influential component for newsprint. Therefore, it may be adequate to bleach the chemical bagasse pulp to a brightness level of 65-70% ISO, for acceptable newsprint brightness. Since AS—AQ bagasse unbleached pulp prossesses 46 4% ISO brightness, even mild (1 5–2.0%) single stage hypochlorite should be sufficient to elevate the brightness to the desired level. The mild bleaching also maintains high pulp viscosity while having less impact on environment, because of very low bleach chemical requirement.

Conclusion

1. The results of the present investigation demonstrate the advantages of bagasse AS—AQ process compared to the conventional kraft process.

2. AS—AQ process has significantly increased screened pulp yield at low and high kappa levels. Hence, the AS—AQ bagasse pulp can be utilised in the writing & printing as well as newsprint furnish,

3. AS—AQ process at low and high kappa levels yield unbleached pulp with higher brightness than the kraft pulp.

4. Since the initial brightness of the AS–AQ pulp is very high, the final target brightness can be achieved with lower chemical dosage compared to kraft pulp.

5. Strength properties of both low and high kappa AS—AQ pulps are comparable to the kraft pulp.

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