

Lo-Solids Soda pulping of Eucalyptus with additives

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The Kraft pulping process purpose is the individualization of cellulosic fibers and removal of lignin by white liquor, that the main components are sodium hydroxide and sodium sulfide. This process based especially on the hydroxyl group (OH⁻) and hydrosulfide ion (HS⁻) action. The OH⁻ is implicated on degradation of lignin and also aggressive to carbohydrates, while the HS⁻ ion, derived from the sodium sulfide hydrolysis, is selective for lignin. Additives such as surfactants and anthraquinones (AQ) can be used to improve the Soda pulping and compensate the lack of hydrosulfide ion. The Soda process is an alternative for pulp production without sulfur compounds, which cause odorous pollution and increase the black liquor recovery system costs. This study has made a comparison between Soda control pulp, Soda pulp with additives (AQ, Surfac. and AQ+Surfac.) and Kraft control pulp. Anthraquinone allowed higher pulping yield to Soda process than Kraft control pulping, however increased the rejects content for the same kappa number. Anthraquinone mixtures of surfactant (AQ-S and AQ-S 2) added to Soda pulping also got higher yield than Kraft control pulp. However, the surfactant did not produce good results for yield as AQ, but kept low the shive content. AQ decrease the alkali charge and residual for Soda pulping, especially for mixtures AQ-S and AQ-S 2. No additive tested has got better viscosity results than Kraft control pulp.

Keywords: Soda Pulping, Kraft, anthraquinone and surfactant.

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INTRODUCTION

The Kraft pulp has good strength characteristics, however produce odor pollution because sulfur compounds. The Brazilians Pulp mills, especially that mills close urban centers has researched solutions about this problems with Environmental organizations.

The Soda process was widely used at past, however was replaced by Kraft process. The Soda pulping is an alternative to produce sulfur free pulp, but can lose viscosity and paper strength because the high alkali charge and temperature.

The pulp additives market has been under continuous innovation and improvement with high investment in research and production of new products. This new products can increase the soda pulping quality, getting closer the Kraft pulp characteristics.

OBJECTIVES

In this study a better comprehension about soda with additives pulping was performed. Trying to produce soda pulp similar closer than Kraft pulp in mechanical properties. Improving the quality using additives (AQ and surfactants) and modern methods of pulping (Lo-Solids).

MATERIALS AND METHODS

Lo-Solids Pulping

Were used *Eucalyptus sp.* wood chips from Brazilian pulp mill Cenibra. It was screened following SCAN-CM 40:94 methods.

Lo-Solids technology was performed for cooking all samples. This method consists at keep low the dissolved solids concentration on black liquor with constant liquor replacements. Lo-Solid pulping is the most commonly and modern method used by Brazilians pulp mills. Kappa number 18 was used for delignification degree, a common number for eucalyptus pulp.

The cooking were performed at M&K digester of 7 liter capacity, with pump and heater for circulate the liquor. This reactor was connected to a group of heated and pressured accumulator vessels, enabling replacement of white liquor. Time and temperature was controlled with a computer, which was possible plot H-factor against temperature.

Steam treatment was used for 20 minutes on wood chips before added the white liquor, 50% of total effective alkali. The impregnation zone occurred at 115°C for 30 minutes. After this step, 30% of effective alkali was added for first cooking zone and 20% for second cooking zone. The cooking time was 50 minutes for each zone, but the final temperature change between Kraft and Soda pulping.

The pulp was washed with water until neutral pH and screened at Voith Sulzer screener with 0,2 mm size perforation.

Additives and liquors

To produce the Kraft control was prepared white liquor at laboratory mixing sodium hydroxide and sodium sulfide, with 100 g/L of effective alkali and 30% of sulfidity, without additives. To produce Soda control was diluted sodium hydroxide until 120 g/L of concentration.

Ashland gave 3 additives for increase the soda pulp properties, anthraquinone (AQ), a mix of surfactants (Surfac.) and a mix of anthraquinone and surfactant (AQS).

The AQ dosages were 0,015%, 0,03%, 0,06%, 0,12%, 0,24%, 0,36% and 0,48%. The Surfac. dosages were 0,003%, 0,006%, 0,012%, 0,024%, 0,06% and 0,12%. The AQS

dosages were 0,06%, 0,12%, 0,24%, 0,36% and 0,48%. Pulping was performed at duplicate with 500 g oven dry wood chips.

Pulp analysis

Kappa number, screened yield (%), reject content (%), viscosity (cm^3/g) were performed at pulp and effective alkali residual (g/L) was performed at black liquor.

For Screened yield and rejects content were used gravimetric method. Kappa number was determined by TAPPI T236 cm-85 method and viscosity by TAPPI T230 om-94 method. Using ISSO 5351 method, the viscosity was changed for intrinsic viscosity. The black residual liquor was characterized by SCAN N-33:94 method.

RESULTS

Control

The pulping conditions to produce the control are given in Table 1.

Table 1- Pulping conditions.

Pulping parameters	Kraft Control	Soda Control 1	Soda Control 2
Sulfidity	30%	-	-
Effective alkali	100 g/L	120 g/L	120 g/L
Liquor/wood ratio	4	4	4
Steam	20 min	20 min	20 min
Impregnation temperature	115°C	115°C	115°C
Impregnation time	30 min	30 min	30 min
Time to temperature	15 min	15 min	15 min
Pulping temperature	155°C/160°C	155°C/160°C	172°C/172°C
Pulping time	50 + 50 min	50 + 50 min	50 + 50 min
Alkali charge rate	50%/30%/20%	50%/30%/20%	50%/30%/20%
H-Factor	635	649	2070

The results of control pulping are given in Table 2. How was expected, Kraft control got the highest screened yield with 53.4% average. Intrinsic viscosity was 1231 cm^3/g . The higher effective alkali charge for Soda control 1 decrease the screened yield for 47.5%. Soda control 2 has got 2% more yield than Soda control 1, but the viscosity was 205 cm^3/g less. Probably the higher alkaline charge attack more hemicelluloses decreasing the yield and increasing the viscosity.

Table 2: Control pulping results.

Sample	Rep. #	H-Factor	EA, %	Kappa	Brightness, %ISO	Screened	Yield, % Reject	Total	Visc, cm ³ /g	EAR, g/L
Kraft Control	1	635	20.0	18.1	-	53.5	0.1	53.6	1230	9.4
	2	634	20.0	17.7	-	53.2	0.1	53.3	1233	8.6
	Avg	635	20.0	17.9	35.5	53.4	0.1	53.5	1231	9.0
Soda Control 1	1	665	56.0	17.9	-	47.7	0.0	47.7	1062	42.4
	2	633	56.0	18.1	-	47.2	0.0	47.2	1072	42.4
	Avg	649	56.0	18.0	35.5	47.5	0.0	47.5	1067	42.4
Soda Control 2	1	2072	25.0	18.3	-	49.7	0.1	49.8	871	11.8
	2	2068	25.0	17.9	-	49.2	0.1	49.3	853	13.3
	Avg	2070	25.0	18.1	33.4	49.5	0.1	49.6	862	12.6

Soda pulping with additives

To compare soda with additives pulping was used only Soda control 2, which will call just Soda control. The results were compared with Kraft control too.

Soda pulping with Anthraquinone (Soda AQ)

Anthraquinone was tested until a limit of yield growing. The results are given in Table 3.

Table 3: Soda anthraquinone pulping results.

Sample	H-Factor	EA, %	Kappa	Brightness, %ISO	Screened	Yield, % Reject	Total	Visc, cm ³ /g	EAR, g/L
Kraft Control	635	20.0	17.9	35.5	53.4	0.1	53.5	1231	9.0
Soda Control	2070	25.0	18.1	33.4	49.5	0.1	49.6	862	12.6
Soda AQ 0.015%	2064	22.5	18.2	32.5	50.2	0.1	50.2	967	9.2
Soda AQ 0.03%	2011	21.5	18.2	30.2	52.1	0.2	52.2	953	7.7
Soda AQ 0.06%	2028	20.5	18.0	31.2	52.7	0.2	52.9	1026	6.9
Soda AQ 0.12%	2088	19.0	17.9	29.8	53.7	0.3	54.0	1023	4.9
Soda AQ 0.24%	2053	18.3	18.5	28.9	54.5	0.5	55.0	1039	3.5
Soda AQ 0.36%	2037	18.3	17.9	29.1	54.7	0.3	55.0	1034	3.8
Soda AQ 0.48%	2032	17.5	17.9	29.7	53.7	0.4	54.0	1005	4.7

The yield for Soda with 0.12% AQ dosage was higher than Kraft control, 0.3% more. The highest yield was for 0.36% AQ dosage.

Soda AQ 0.36% could give until 5.2% more screened yield compared to Soda control and 1.3% more compared to Kraft control. As shown in Table 3, the yield increases with the AQ dosage until 0.36% and decrease for 0.48%.

The reject content also increase with AQ dosage, because the reduction of alkaline charge. Soda AQ 0.48% has used 2.5% less alkali than Kraft control. The effective alkali residual decrease with the alkaline charge, but continuous at acceptable values for Lo-Solids pulping.

The AQ addition increase viscosity, but was not enough to surpass Kraft control viscosity.

Soda pulping with Surfactant (Surfac.)

The average results for surfactant pulping are given in Table 4.

Table 4: Soda Surfac. pulping results.

Sample	H-Factor	EA,%	Kappa	Brightness, %ISO	Yield, %		Total	Visc, cm ³ /g	EAR, g/L
					Screened	Reject			
Kraft Control	635	20.0	17.9	35.5	53.4	0.1	53.5	1231	9.0
Soda Control	2070	25.0	18.1	33.4	49.5	0.1	49.6	862	12.6
Soda Surfac 0.003%	2011	25.0	18.5	35.0	49.0	0.1	49.1	935	12.5
Soda Surfac 0.006%	2041	25.0	18.0	33.8	49.8	0.1	49.8	913	13.2
Soda Surfac 0.012%	2003	25.0	17.8	35.0	50.3	0.1	50.3	902	11.2
Soda Surfac 0.024%	2094	24.0	17.9	33.4	50.8	0.1	50.9	902	10.7
Soda Surfac 0.060%	2031	24.0	18.1	34.9	51.6	0.0	51.6	897	10.5
Soda Surfac 0.120%	1988	24.0	18.3	34.1	49.9	0.0	49.9	919	11.4

The surfactant addition gave a small screened yield gain compared with Soda control, 2.1% more. But was not enough to surpass Kraft control. The alkaline charge for Soda Surfac. 0.12% was 1% smaller compared with Soda control. Decrease from 25% to 24%.

The viscosity increase compared with Soda control and does not show any relation with surfactant dosage. The reject content keeps constant.

Soda pulping with Anthraquinone and Surfactant (AQS)

The surfactant has dispersant action and can increase the wood chips impregnation, that complements the chemistry action of anthraquinone of protect carbohydrates and remove lignin. The results for Soda AQS pulping are given in Table 5.

Table 5: Soda AQS pulping results.

Sample	H-Factor	EA,%	Kappa	Brightness, %ISO	Yield, %		Total	Visc, cm ³ /g	EAR, g/L
					Screened	Reject			
Kraft control	635	20.0	17.9	35.5	53.4	0.1	53.5	1231	9.0
Soda control	2070	25.0	18.1	33.4	49.5	0.1	49.6	862	12.6
Soda AQS 0.06%	2022	21.5	18.1	31.5	52.4	0.2	52.6	1005	7.1
Soda AQS 0.12%	2040	20.5	18.2	32.1	52.4	0.4	52.8	996	6.4
Soda AQS 0.24%	2013	19.5	17.5	28.9	53.9	0.2	54.1	1031	3.4
Soda AQS 0.36%	2050	19.0	18.5	28.1	54.0	0.4	54.4	1077	3.8
Soda AQS 0.48%	-	18.5	18.5	28.4	54.2	0.4	54.6	1050	3.8

The highest yield was for 0.48% AQS dosage, 0.8% more than Kraft control. The surfactant content at AQS mix was not enough to avoid rejects. As shown in Table 5, the higher dosage produces 0.4% of rejects.

The alkaline charge and effective alkali residual decrease with the addition of AQS dosage. The Soda AQS 0.48% alkali was 1.5% lower than Kraft control. The higher viscosity was 1077 cm³/g for Soda AQS 0.36%, but lower than Kraft control.

CONCLUSIONS

1. The anthraquinone addition increase Soda pulping screened yield and for some dosages was higher than Kraft control yield. But increase the rejects content for the same kappa number. The same happened with AQS mix.
2. Surfactant addition did not show good results for screened yield, but keeps low the reject content. The surfactant dosage for AQS mix can be increased for change the rejects into screened yield.
3. Some anthraquinone dosages decrease a lot the alkali charge and effective alkali residual, mainly for AQS pulping. So it is possible decrease the H-factor when increase the AQ dosage, making the viscosity higher.
4. Any additive could produce Soda pulp with higher viscosity than Kraft control.

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