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Delignification of Sisal wood by pulping with organic acids

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Abstract: Sisal wood was subjected to organic acid pulping catalyzed by strong acids like HCl. The selective condition for pulping is 80%, 0.2% catalyst (HCl), S/L 1:12.5 for 120 min, formic acid, giving residues impurities but the α-cellulose and klason lignin in Sisal wood.

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INTRODUCTION

Wood due to high content of α-cellulose, good pulp yield and its fast growth is an important raw material for the pulp industries in the world[1]. The sulphate process is employed for pulping, but it is inconvenient due to environmental hazard and production of lignin (not recoverable for chemical uses) make the search for alternative strategies of wood processing attractive[2]. Lignocellulosic materials (LCM) are renewable resource with great potential as alternative raw material for the chemical industry. An efficient fractionation of LCM should allow the separation of their polymeric components (cellulose, hemicellulose and lignin) which could be separately processed to useful and economically competitive end product, according to the Biomass refining[3].

Among the up-scaleable future pulping processes, pulping with organic acids seems to offer the greatest versatility and potential. Organosolv pulping options are considered to be an energy-efficient approach to the production of pulps with a wide spectrum of use. In general, these studies have reported high specification for delignification of wood in the various acid media applied. No extremely satisfactory organic system has yet been found and so far none of the system can delignify all the wood species to produce a commercial pulp with low residual lignin content without seriously degrading the cellulose. Organosolv pulping processes may be preferred over chemical pulping processes due to their low investment cost[4] friendly prospect problem. Recovery of solvent aldehyde and, lignin and low operating temperature and pressure[5]. No work is yet known to the another on organosolv pulping this particular raw material. This paper describe pulping of Sisal wood, using, and formic acid. The main objective of this study is to establish the proper working condition is by a organosolv pulping[6].

MATERIALS AND METHODS

Sisal wood were dried in an oven at 105°C, chipped disintegrated to a particle size of 0.315 – 1.00 mm and the homogenized and stored in a desiccators. It was than extracted with alcohol benzene to the extraction level was analyzed[13]**.** The extracted sample was then subjected to analysis of its α - cellulose[14]**,** Klason lignin**[15]** and holo cellulose content[16]**.** All the parameters measured were measured on the basis of initial dry weight of the raw materials utilized in that particular set of experiments. Moreover, unlike conventional chemical processes, organosolv processes allow the selective separation and recovery of cellulose, hemicellulose and lignin which can be converted by chemical and bio technological means into a variety of chemicals.

The delignification of 10gm samples were carried out in 250ml round bottom flasks under reflux condition, at 110^0C under constant volume conditions using liquors containing formic acid, water and HCl in different sets of experiment with different proportions.

The experiments was carried out using three different condition for delignification media. The different concentration of HCl utilized by weight as a catalyst in the delignifying liquor were using different S/L ratio of 1: 10, 1: 12.5 and 1: 15gm per gram, to establish the optimum delignification conditions. (The pulping them used in each case was 2 hrs or 120min, which was established after series of experiments).

RESULTS AND DISCUSSION

The proximate chemical analysis of Sisal wood used in the present study has been listed in Table 1, which shows the value of α – cellulose and lignin in raw materials are 60% and 25% on higher side and other ash while extractive content are also lower side. All this value shows that this raw material is

worth in investigation for paper industry. 80% formic acid, 0.2% catalysts HCl solid/liquor ratio of 1:12.5 and time is 120'minutes was suitable for pulping of Sisal wood, have earlier established somewhat lower S/L ratio of 1:10 for Eucalyptus wood higher provide ratio has provide superior in respect to delignification of Sisal wood probably due to the bulky ratios of this raw material.

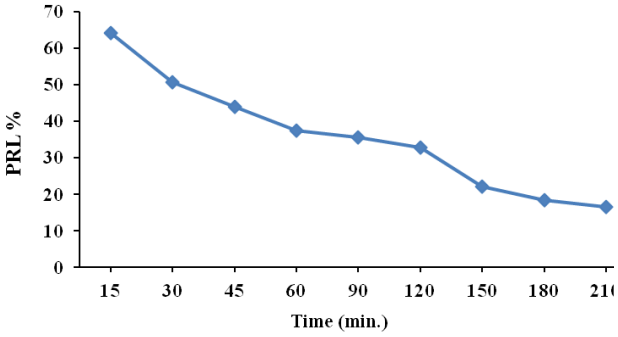
Table 1: Proximate chemical composition of Sisal wood.

Ash	1.15
Holo cellulose	9.15
α-cellulose	50.5
Klason lignin	24.05
Pentosan	9.60
Hemicellulose	
Alcohol –benzene extractive	6.42

Table 2: Establishing of conditions for pulping Sisal wood with formic acid.

Formic Acid Percent	70	0.2	120	1:12.5	53.69	35.94	11.55
	80				51.12	23.76	9.98
	90				45.98	19.98	12.39
Catalyst (HCl)	80	0.15	120	1:12.5	56.91	28.00	11.16
		0.20			52.12	24.76	9.98
		0.25			44.15	29.00	10.78
Solid/ Liquor Ratio	80	0.2	120	1: 10	51.81	28.44	8.11
				1: 12.5	51.12	24.76	9.98
				1: 15	49.67	27.00	9.51

Figure 1: Plot between PRL and time of Sisal wood with formic acid.

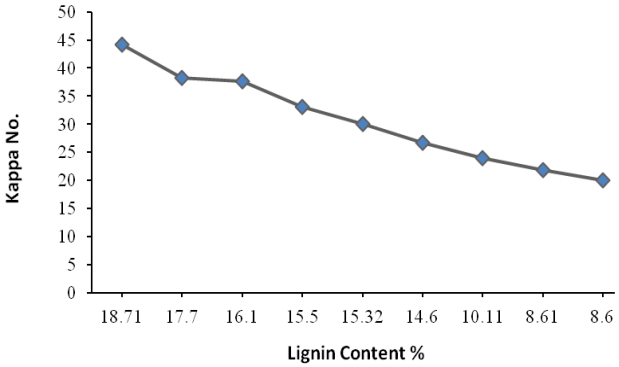


The kinetics of the delignification process under the established pulping condition was studied in detail by varying the time from 15 to 210 minutes and the relevant data presented in Table 3 it shows that bulk delignification of Sisal wood occurs in fractionates time of 120 minutes. This behavior has been further highlighted in figure 1 in which % of residual lignin (PRL) of the fractionated product has been plotted against time of digestion[7]. A sharp slope was observed upon fractionates upto the same delignification time, after which it all in a constant value in figure 2. The relationship between klason lignin and % yield of the finished product which shows the fast decreases in the yield from 69-49% with the proportional decreases of klason lignin from 24.05 to 9.98%. It is therefore, unformed and optimum delignification of this raw material has been achieved in 120minutes with consequent yield of 51.5°%. and also depicts the various characteristics like % yield, α-cellulose, klason lignin and Kappa no[8] of the different products experiments were performed in connection with establishing the condition of optimum of % acid, fractionates % catalyst and S/L ratio. It would be observed that bleachable grade pulps of kappa No.<30[9] were obtained from experiments, α-cellulose was 51% and klason lignin was rather on the lower side in raw materials.

Table 3: Kinetics studies of selected conditions for pulping Sisal wood with formic acid

Kinetic Studies of Established Operational Conditions	Acid (%)	HCl (%)	Time (min)	S/L Ratio	Yield (%)	Kappa No	Klason Lignin (%)	Residual Lignin (%)
Formic Acid	80	0.20	15	1:12.5	73.07	48.92	17.52	53.09
			30		64.51	41.62	15.62	41.72
			45		59.31	39.72	13.72	37.54
			60		57.57	37.98	11.92	28.41
			90		54.56	36.61	8.98	20.21
			120		51.12	23.76	9.98	16.89
			150		43.06	23.89	7.09	12.45

Figure 2: Plot between Kappa No. and lignin content Sisal wood with formic acid.



Operational variables studied in case of delignification of Sisal wood by formic was percentage of acid and HCl as catalyst and S/L ratios. The experiment was conducted at low temperature with the advantage of minimum cellulose and hemicellulose. Degradation and extraction of lignin in its most valuable form[10]**.** Table 2 depicts the three sets of experiment performed separately to establish optimum delignification condition in case of formic acid. The fraction time used in each case is 120min, established after a series value of formic acid concentration was the very effective parameters as regards the delignified yield and extracted formic lignin concentration of formic acid is increases, from 70 to 90%[11] drastically reduced the yield 51.12 to 45.98 (Table 2) in lower value of klason lignin and yield of the delignified product the concentration of 80% formic acid was selected and carried out in further experiments. The kappa No. of product is 23.5, which according to certain standards is bleachable the selection of catalyst is 0.2% and S/L ratio is 1:12.5 which is ideal for further experiments.

The kinetics of delignification of Sisal wood with formic acid was depicted under the established as shown in table 3. It could be observed that increase of time had a good effect on the yield of delignified product and eventually their klason lignin / kappa No. Moreover, it could also be seen in fig I that PRL is fractionated Sisal wood samples (table 3), gradually decrease with the increase of time of delignifications.

On observation during formic acid pulping was that dignified material was quite soft not dry it is wet but if it was allowed to dry then it returned to original state and was unsuitable for beating. It is a conventional process. The fractionation time is increase to 120 min. the value of yield, klason and kappa No is better however yield percentage is suitable for pulping.

CONCLUSION

This study concludes that Sisal wood may be delignified by fractionation with aliphatic organic acid like formic acid used are suitable for delignification. Formic acids gives better quality fractionated product with lower percent residual lignin (PRL).

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