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ORGANOSOLV PULPING OF DENDROCALAMUS STRICTUS AND EUCALYPTUS TERETICORNIS WITH AQUEOUS ETHANOL

S.V. Singh, S.S. Bhandari and S.P. Singh
Cellulose and Paper Branch,
Forest Research Institute,
Dehradun-248 006

Abstract

The results on ethanol-water pulping of bamboo (*D. Strictus*) and eucalyptus (*E. tereticornis*) are reported. Effect of Sodium xylene sulphonate and dodecylbenzene sulphonate sodium salt as additives in pulping was examined. Pulping of bamboo resulted in chemical pulps (yield 43-44%); whereas eucalyptus gave semi-chemical pulps (yield 57-58%). The strength properties of ethanol-water pulp of bamboo (Ewb) were as follows: tensile index 38.26 N.m/g, tear index 9.81 mN.m^2/g, burst index 2.02 KPam^2/g. Addition of sodium xylene sulphonate (1.0%) improved the strength properties of Ewb pulps (tensile index by about 5%, tear index by about 30% and burst index by about 15%). However, tensile index and burst index of ethanol-water-sodium xylene sulphonate pulp (Ewbx) were lower than that of bamboo kraft pulp (kpb) of equivalent yield, by about 20% and 37% respectively; whereas tear index was slightly higher (4.0%). The strength properties of eucalyptus ethanol-water pulp (Ewe) were : tensile index 38.12, tear index 3.46 and burst index 1.45.Addition of sodium xylene sulphonate (1.0%) did not exhibit any influence on strength properties. Ewe pulp was equivalent to eucalyptus kraft pulp (KPe) of same yield in respect of tensile index, whereas tear index, and burst index were lower than Kpe pulp. Addition of dodecylbenzene sulphonate sodium salt as additive did not exhibit any influence on either type of pulp. Ewbx pulp gave best results in respect of strength properties.

Introduction

The industry would like to reduce both stream and air pollution, since abatement costs make up a large part of production costs. In these points of view, researches are being carried out all over the world to develop pollution free pulping process. Studies reported on pulping via sodium xylene sulphonate, aqueous ethanol ketone-ammonia mixture, ethanolamine, peracetic acid, oxygen alkali, etc. could be cited as a few examples of the efforts in this direction.

Ethanol-water pulping of softwoods and hardwoods has been reported by Kleinert[1]. His kinetic studies revealed that aqueous ethanol is a powerful delignifying agent. Bulk delignification takes place in two distinct phases of pseudo first order. Delignification rates of hardwoods are considerably higher than those of soft-woods. Retention of lignin is strongly dependent on pH of the cooking liquor. After distilling off the alcohol from Ew black liquor a major fraction of the solubilized lignin separates as a quasi-molten phase. It is claimed that continuous Ew pulping with recovery is technically feasible. Pulping of rice straw by ethanol-water-ethanoldiamine has been reported by Guha et. al.[2] Pereira et. al.[3] have studied the kinetics of ethanol-water pulping and pulp properties of Eucalyptus globulus Lab. They have reported that ethanol-water pulps have low energy requirements on beating. However, strength properties are lower than those of kraft pulps and are comparable to bisulphite pulps.

The present paper describes the results of the investigations carried out on pulping of bamboo (*D. strictus*) and eucalyptus (*E. tereticornis*) with aqueous ethanol alone and with aqueous ethanol containing sodium xylene sulphonate and dodecylbenzene sulphonate sodium salt as pulping aids. The pulps thus produced were evaluated for strength properties and compared with corresponding kraft pulps of equivalent yield.

Results and Discussion

Bamboo pulps

Pulping of bamboo (*D. strictus*) with ethanol–water mixture (1:1 by volume) gave chemical pulp (Ewb) of 44.2% yield. The strength properties of standard handsheets of Ewb pulp (250±25 ml C.S.F.) were as follows (Table 1) : tensile index 38.26 N.m/g, tear index 9.81 mN.m^2/g and burst index 2.02 KPa.m^2/g.

Effect of addition of sodium xylene sulphonate and dodecylbenzene sulphonate sodium salt as cooking aids was examined at equivalent yield. It was found that addition of 1.0% (on p.d. raw material) of these additives gave pulps of equivalent yield (43--44%). The strength properties of ethanol–water–sodium xylene sulphonate pulp of bambo (Ewbx) were: Tensile index 40.12, tear index 12.90 and burst index 2.31, whereas these values for ethanol–water–dodecylbenzene–sulphonate sodium salt pulp (EwbD) were as follows : 36.56, 11.63 and 2.04 respectively. These data indicate that Ewbx pulp was slightly superior to Ewb and EwbD pulps. It is surmised that addition of sodiumxylene sulphonate has perhaps helped in stabilization of carbohydrates during the process of delignification (at equivalent yield level), as a result of which an improvement in strength properties is observed. On the other hand, it could be seen that dodecylbenzene sulphonate sodium salt did not exhibit any improvement in strength properties over EWb pulp, as such it was not an effective additive. A comparison of EWbx pulp with bamboo kraft pulp (KPb) of equivalent yield (44.4%) indicated that the tensile index and burst index of EWbx pulp were lower by about 20% and 37%, respectively, whereas the tear index was slightly higher (4%) than that of Kpb pulp (Table 1).

TABLE - I

Strength properties of EWb, Ewbx, EwbD and KPb pulps at 43–44%yield and at 250 ± 25 ml C. S. F.

Pulp type	Tensile index N.m/g	Tear index mn.m²/g	Burst index KPa. m²/9
Ewb	38.26	9.81	2.02
Ewbx	40.12	12.90	2.31
EwbD	36.56	11.63	2.04
KPb	50.00	12.26	3.69

Eucalyptus pulps

Ethanol-water pulping of eucalyptus (*E. tereticornis*) gave semi-chemical pulp (EWe) of 58% yield. The strength properties of standard hand sheets of EWe pulp (250 ± 25 ml C.S.F.) were as follows: tensile index 38.12 N.m/g, tear index 3.46 mN.m²/g and burst index 1.45 KPa. m²/g (Table 2). Addition of 1.0% sodium xylene sulphonate gave semi-chemical pulp (EWex) of almost equivalent yield (57.0%) having tensile index 38.08, tear index 3.29 and burst index 1.53. The strength properties of pulp obtained with the additon of dodecyl-benzene sulphonate sodium salt (i.e. EWeD pulp) were similar to that of EWeX pulp. The data in Table 2 indicate that there was practically little effect of these additives on strength properties of eucalyptus pulp thus obtained.

TABLE - II

Pulp type	Tensile index N.m/g	Tear index $mN.m^2/g$	Burst index $KPa.m^2/g$
Ewe*	38.12	3.46	1.45
Ewex*	38.08	3.29	1.53
EweD*	35.13	3.25	1.50
KPe**	41.47	7.50	2.42

* Pulp yield 57–58%

** Pulp yield 52.3%

A comparison of EWe, EWex and EWeD pulps with eucalyptus kraft pulp (KPe) of 52.3% yield indicated that tensile index is of the same order as that of KPe pulp; the tear index and burst index are, however, lower than KPe pulp, (Table 2)

Bleaching of bamboo/eucalyptus pulps

A few preliminary experiments on bleaching of EWbX and EWeX pulps were carried out by employing CEHH sequence. It was found that bamboo EWbx pulp could be bleached to 73% brightness, whereas eucalyptus EWeX pulp was found difficult to bleach to 70% brightness. Further experiments on (i) mechanism of delignificatin in presence of sodiumxylene-sulphonate and (ii) bleaching of pulps are in progress and the results will be reported later on.

Conclusion

Bamboo could be easily pulped by ethanol–water mixture 50:50 (by volume) to yield chemical pulp (43–44% yield), whereas eucalyptus gave semi-chemical pulp 57–58% yield. Addition of sodiumxylene sulphonate (1.0%) improved the strength properties of ethanol-water pulp of bamboo. Addition of dodecylbenzene sulphonate sodium salt did not show any effect on strength properties. Rate of delignification of bamboo is faster than that of eucalyptus.

EXPERIMENTAL

Pulping

Pulping was carried out in a stationary digester under the following conditions :

Ethanol–water.	1 : 1 (by vol.)
Material liquor ratio.	1 : 3.5
Temperature.	170°C
Time to Max. temp.	1:0 hour
Time at Max. temp.	4.0 hours
Additive	0.0--1.0%

Pulp evaluation

Screened pulp yield of chemical pulps from bamboo was determined as usual. In case of eucalyptus, the cooked material was first refined in a 12 inch Sprout Waldron Refiner before screening. Standard handsheets were prepared after beating the pulp in Lampen mill to a freeness of 250 + 25ml C.S.F. and dried according to standard procedure. The strength properties were determined according to ISO standard DP 5270 after Conditioning the sheets at 65 ± 2% RH and 27 ± 1°C.

References

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