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Surface active materials as an additive in nssc pulping of populus deltoids

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ABSTRACT

Over the past few decades, several chemicals were identified by the researchers, which can improve pulp yield, when used as pulp additives. Beside the different pulping additives i.e. AQ, PS, NaBH-4 and etc., surfactants using has led to considerable results in pulping process. In this study, using of two surfactants was considered in NSSC pulping of poplar. Results showed a decrease in yield amount from 81.2 to 78.8with an increase in cooking time from 60 to 90 for the conventional pulping (without additives). In addition, for modified pulping, using of these two surfactants not only didn't improve the yield amount, but also it was diminished in comparison to control (less than %1); on the other hand, application of two both surfactants decreased the amount of lignin in soluble, too. Evaluation of handsheets indicated the negative effect of both surfactants application on the amount of breaking length and tear strength. But for RCT and CMT strength, a different trend was observed; In the contrary to PEG 1500 (code 8) application of the effect of ELA-7 enhanced value. Finally, surfactant application has caused to increase caliper and bulk value which is consistent with the enhancement of air resistance amount.

INTRODUCTION

The paper industry worldwide is facing scarcity of cellulosic fibers and this limitation is an issue for all countries even fiber deficient nations[6]; therefore, over the past few decades, several chemicals were identified by the researchers, which can improve pulp yield, when used as pulp additives[2]. Beside the different pulping additives i.e. A.Q, PS, NaBH-4 and etc., surfactants using has led to considerable results in pulping process[7]. The motivation of using surfactants is the problem behind extractives, which can decline penetration of cooking liquor to the lumen. In this case, useof surfactants results in a more uniformcook with lower kappa number,lower screen rejects, lower pulp resincontent, and higher black liquor residualactive alkali content[14].

Application of surfactants as pulping additives in hardwoods pulping have been studied; Dugiralla (2000) observed that the addition of 0.1% surfactant to Kraft pulping liquor (on oven dry wood) re-

sulted in a more uniform cook with a significant decrease in kappa number; moreover it led to an increase of about 0.5 to 1% in the yield value at a constant kappa number. Guo et al. (2002) indicated that the use of PEG in hardwood Kraft pulping improved the delignification rate, selectivity, and yield value. Mishra et al. (2007) used some non-ionic surfactants in the pulping of bamboo and hardwood mixture. This approach resulted in reduction of extractives, kappa number, COD, TSS, and screen reject. In addition, the brightness of the unbleached pulps improved. Santiago et al. (2007) showed that the application of an alcoholic surface-active material in pulping of eucalyptus globules improved the pulp viscosity in a constant kappa number without any effect in pulp yield in comparison with conventional pulp. In this study,application of beneficial surfactants was evaluated in the pulping of Populous Deltoideswhich asone of most fast-growing species with huge annual production because of having valuable fibers in papermaking terms and less lignin amount compared to other hardwoods[7, 3]. In addition, NSSC pulp is the most common semi chemical pulping with the yield of about 75% and considerable stiffness that is appropriate for Fluting production[10].

MAREIALS AND METHODS

PopulusDeltoidessample logs were prepared from ShastKalateh forest in Gorgan city, in Iran and transported to cutting part of pulp and paper laboratory in Gorgan University. In next step, mentioned logs were cut to appropriate size and then cheeped using the round saw. Acceptable chips in size (length, width and thickness)were separated by sieves and then moisture content (%MS)were measured according to T 412 om-94 of TAPPI test standard method. Final step before pulping was analysis of ash, lignin and acetone-soluble extractives based on TAPPI test methods.

The suitable chips were pulped in 6-cylindric digester with 150 gr of mentioned chips based OD weight. Control NSSC pulping factors were L/W: 5/1, cooking Temperature: 170^{0}C, Chemical dosage: %12 Na_2SO_3 + %2 Na_2CO_3–as buffer- based on OD fiber weight and time at maximum temperature: 60, 75 and 90 minutes. Besides, in modified cooking, 0.5 and 1 percent of two kind of surfactant i.e. PEG 1500 and ELA-7 were added to white liquor of NSSC pulping. Yield (both accept and reject) and residual lignin were measured. Two representative nonionic surfactants were used: lauryl alcohol ethoxylated with 7 moles of ethylene oxide per mole of alcohol (ELA-7) and poly ethylene glycol 1500 (PEG 1500). These chemicals were prepared by Iranian KimiagaranEmrooz Co. After cooking, pulps were fully washed by cold water on a 20 mesh screen and collected on a 200 mesh screen. Accept yield and rejects were determined. Standard handsheets (60 g/m2) were made according to T205 om-88 from both control and modified pulps. In order to evaluate the probable effect of surfactant addition on paper properties, breakinglength (BL), tear, $RCT_{(N)}$ and $CMT_{(N)}$as strength characteristics along with physical ones i.e. thickness and bulk were measured according to TAPPI standard test methods. Statistical analysis wascarried out using SPSS software and comparison of means was done based on completely randomized design.

RESULTS AND DISCUSSION

Control pulp

Investigation of chemical components showed that PopulusDeltoides included %26.8, %0.8 and %1.29 of lignin, ash content and acetone-soluble extractives, respectively; thus, it comprised about %71 of carbohydrates. The results showed that the effect of cooking time on yield and amount, residual lignin and ach contentof control pulp was significant; so that with an increase in cooking time from 60 to 90, a decrease was observed in yield amount from 81.2 to 78.8. As a matter of fact, along with time enhancement, more amount of carbohydrate get in soluble and the pulp yield was declined. The results of control pulping are summarized in TABLE 1:

Surfactants addition

In next step, results of the mentioned additives utilization were considered(see TABLE 2). Two points should be mentioned: in the one hand, using

TABLE 1 : The results of control pulping

Code	Cooking time	Total Yield	Accept	reject	Lignin amount
1	60	81.2	71.3	0.23	20
2	75	78.8	68.3	1.27	17.8
3	90	78.8	67.8	0.73	18.4

TABLE 2 : The results of modified pulping

Pulp	Code	Dosage (as OD fiber)	Cooking Time (min)	Yield (%)	Accept (%)	Reject (%)	Residual Lignin (%)
PEG 1500	4	0.5	60	80.6	73.1	0.5	18.4
	5		75	79.2	69.3	0.24	17.7
	6		90	78.3	70.8	0.16	17.7
	7	1	60	80.6	71.7	0.33	18.6
	8		75	79.4	72.2	0.24	18
	9		90	78.2	70	0.17	16
ELA-7	10	0.5	60	78.9	69	0.51	16.7
	11		75	77.6	70.2	0.22	18.4
	12		90	79.2	70	0.41	17.3
	13	1	60	78.6	67	2.85	15.5
	14		75	78.9	62	6.14	15.6
	15		90	78.3	69.3	0.33	16.5

of these two surfactantsnot onlydidn't improve the yield amount, but also it was diminished in comparison to control (less than %1);on the other hand, application of two both surfactants decreased the amount of lignin in soluble, too;so that obviously residual lignin amount was decreased due to surfactant addition about 0.7% in pulp 6 compared to pulp 3 and about 1.6% in pulp 4 related to pulp 1; moreover, there is a similar trend among the other treatments, too. This is because of probable synergic effect of surfactants on lignin solution which has been rooted owing to higher selectivity of these additives[14, 8].

In this step, the efficacy of the surfactants on paper properties both mechanical and physical was considered. Not all 15 mentioned pulps weren't tested in properties terms; in fact 3 treatments were selected regarding to yield amount of control and modified pulp in TABLE 2 and 3. Thus,the pulp with code 2 was selected as representative of control samples to prepare handsheets. The reason behind the selection was better lignin solution and less yield decrease related to thepulp 1 and 3; meanwhile, no significant difference was observed between the yield and residual lignin of two dosages of both surfactants; therefore, pulp with code 8 and 11 were chosen in cases of PEG 1500 and ELA-7, respectively.

Handsheets valuation

Strength properties

The results of surfactants usage on mechanical properties were illustrated in TABLE 3:

As indicated in the TABLE 3, application of surfactant caused to decrease the amount of B.K and Tear. Two reasonswould be brought up: first, less amount of carbohydrate in treated pulps compared to control; besides, it could be resulted from debonding influence of surfactants[14]; actually, surface active materials can act as a debonding agent and reduce strength properties value.

In the contrary to PEG 1500 (code 8)application of the effect of ELA-7 enhanced RCT and CMT value. As a matter of fact, an increase in lignin amount would be replied in these two parameters (REF); the more lignin amount in the pulp, the more stiffness in pulp that is presented in RCT and CMT values (REF).

Physical properties

Afterwards, the effect of surfactant addition was considered on physical properties of handsheets. As

TABLE 3 : The valuation of strength properties

Code	B.L (KM)	Tear	CMT(N)	RCT(N)
2	4.74	70.96	57	61
8	2.876	65.64	52	57.7
11	3.766	65.83	59.7	66

TABLE 4 : The valuation of physical properties

Code	Caliper(mm)	Bulk	Air Resistance
2	0.126	2.03	18.5
8	0.136	2.07	60.3
11	0.136	2.09	28.7

shown in TABLE 4, effect of surfactant application has caused to increase caliper and bulk value; it's probably been resulted from negative effect of surfactant on fiber bonding[14]. Asseen in the TABLE 4, air resistance value has been increased in treated samples compared to control.Although, it's accepted that porosity and air permanence aren't same[1], but also it could be contended that perhaps debonding effect of surfactant has affected the paper air resistance which is consistent with the trend of bulk change.

CONCLUSION

The two surfactants used in this study had different effects on pulp properties that are consistent with the different HLB values and different hydrophobic character of the surfactants.

ELA-7 usage significantly decreased B.L and tear which have been affected by fiber bonding; In addition, both treated samples have less lignin amount in comparison to the control which is consistent with the CMT and RCT enhancement.

With an increase in time at temperature, an decrease would be found in yield amount either for control or modified samples, but at the same retention time, treated samples had less lignin amount and similar yield.

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