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Effect of Optical Aging on Yellowness Characteristics of Soda Paper Made from Bagasse

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This research has been launched to study effect of optical aging of soda papers from bagasse on yellowness properties using chelating agent and metallic ions. Paper samples were prepared in Pars paper plant while chelating agents in different concentrations were used to neutralize metallic ions. They were exposed to the metallic ions after being dried well. For accelerated aging examinations, wavelength range of 300-400 nm was used in 0, 10, 20, 30, 40 and 50 h intervals. Yellowness of the papers was eventually evaluated based on TAPPI standard. The results demonstrated that increasing concentration of the chelating agent will decrease yellowness of the samples significantly, whereas their yellowness was increased significantly by extending the aging time. The most pronounced effect on increasing the yellowness was related to Fe^{2+} ion while the least pronounced effect was related to Zn^{2+} and Cu^{2+} ions.

Key Words: Optical aging, Soda papers, Bagasse, Yellowness.

INTRODUCTION

Bagasse is currently known as a resource of lignocelluloses materials with significantly high industrial capabilities which needs deeper investigations to find the ideal conditions in different industrial processes[1]. Backgrounds of this research indicate that soda is the most common process to cook bagasse[2]. Many techniques have been considered to decrease damaging effect of the ions one of which is using chelating agents such as EDTA[3]. Qiu *et al.*[4] have taken into considered using DTPA for decreasing peroxide decomposition due to manganese ion. Effect of metallic ions including Mn^{2+} on decomposition of hydrogen peroxide using DTPA, as stabilizer agent, has been studied. Results of this research have proved the pulp containing Mn^{2+}, with addition of DTPA more efficient that the same pulp without Mn^{2+} addition.

Saint and Deven[5] have focused on using yellowness inhibitors of mechanical pulps. By it, kinetic insolubility and stability of 2-benzotriazole as well as yellowness restraint of the mechanical pulps have been evaluated by studying changes in type and density of the inhibitors and concentration of the salt. Castro *et al.*[6] studied effect of aging on oxidation of ink polymer chains. They have reported that existing vegetable oils in offset printing inks incurs more oxidation and much difficulty in deinking procedure of old prints, which can reduce brightness of the deinked pulp as well.

The aim of this research is to study effect of optical aging of soda papers made from bagasse by chelating agent and metallic ions.

EXPERIMENTAL

Samples of soda paper were procured from Pars paper plant. They were saturated with EDTA as the chelating agent in three levels of 0, 0.5 and 1 % for neutralizing metallic ions. The samples were saturated again with solutions containing metallic ions of Fe^{2+}, Fe^{3+}, Cu^{2+} and Zn^{2+} after being dried.

The resultant samples were dried by mild fan blowing kept out of moisture and direct light. A simulated apparatus was employed in order to launch hastened optical aging examinations. The output waves had a wavelength range between 300 and 400 nm. Optical treatments were accomplished in 0, 10, 20, 30, 40 and 50 h intervals.

Measurement of yellowness characteristics of the papers was done according to TAPPI standard of T524 Ω-94[7] using a technobite micro apparatuses. Statistical analysis was run by SPSS software (ver. 11.5). Multi-domain Duncan test was used for comparing the average values earned.

RESULTS AND DISCUSSION

Table-1 summarized the results of changes in yellowness on different times, EDTA concentrations and metallic ions.

Table-2 listed the results of multidirectional variance analysis in studying variable factors (metallic ions, time, concentration of EDTA) on yellowness content of the paper samples. All these factors incurred significant effects on the yellowness with each of them being able to change yellowness content significantly.

TABLE-2
MULTIDIRECTIONAL VARIANCE ANALYSIS FOR YELLOWNESS CONTENT OF PAPER SAMPLES IN VARIABLE TIMES, EDTA CONCENTRATION AND METALLIC IONS

Source of variation	Sum of squares	Degree of freedom	Averaged squares	F	Signature
Ion	9.144	3	3.048	365.658	0.000
EDTA	59.354	2	29.677	3560.246	0.000
Time	2667.535	5	533.507	64003.069	0.000
Ion-EDTA Interaction	10.739	6	1.790	214.730	0.000
Ion-Time Interaction	10.868	15	0.725	86.919	0.000
Time-EDTA Interaction	16.747	10	1.675	200.909	0.000
Ion-Time-EDTA Interaction	7.846	30	0.262	31.376	0.000
Error	1.200	144	0.008		
Total	2783.434	215			

TABLE-1
EFFECT OF SATURATING SODA PAPER SAMPLES WITH DIFFERENT CONCENTRATIONS OF EDTA ON YELLOWNESS OF THE RESULTANT PAPER AT VARIOUS TIMES

Used ion	EDTA (%)	Time (h)					
		0	10	20	30	40	50
Fe^{2+}	0.0	6.4	9.29	11.7	14.46	16.81	17.79
0.3	0.5	6.41	8.29	10.66	13.21	14.76	16.06
ppm	1.0	6.42	7.11	9.19	12.27	13.75	16.16
Fe^{3+}	0.0	6.35	8.83	11.36	13.59	15.37	16.83
1.0	0.5	6.43	7.9	10.53	12.37	14.17	15.97
ppm	1.0	6.3	7.23	9.85	11.25	12.89	14.69
Cu^{2+}	0.0	6.41	8.29	11.17	13.37	15.52	16.21
0.1	0.5	6.42	7.73	10.83	12.29	15.51	15.71
ppm	1.0	6.41	7.56	9.97	11.56	15.02	16.19
Zn^{2+}	0.0	6.35	7.83	10.85	13.12	15.35	16.47
1.0	0.5	6.29	7.21	10.11	12.39	14.79	15.76
ppm	1.0	6.41	7.49	9.78	11.66	13.86	16.02

An investigation on common effect (interaction) of the variable factors in Table-2 reveals that all possible interactions have been significant at 5 % level. Table-2 showed that the interactions of metallic ions-time, metallic ions-EDTA conc. and time-EDTA conc. have been absolutely significant, while extended times have raised yellowness for all metallic ions significantly. The growth in yellowness content exists even for samples saturated with Zn^{2+}.

TABLE-3
DUNCAN TEST RESULTS IN STUDYING THE EFFECT OF ION TYPE ON YELLOWNESS OF THE PAPER SAMPLES

Ion	Number	Subgroup		
		1	2	3
Zn^{2+}	54	11.2059		
Cu^{2+}	54	11.2172		
Fe^{3+}	54		11.4596	
Fe^{2+}	54			11.7078

Table-2 also showed that the most pronounced effect in raising the yellowness belongs to Fe^{2+} ion whereas the least pronounced effect is related to Zn^{2+} and Cu^{2+} ions, which are grouped together, with yellowness changes of other ions being significantly different.

Table-2 insists that the most and least dominant effects on yellowness content of the samples are associated with Fe^{2+} and Zn^{2+} ions, respectively. This trend is verified by Fig. 1 as well. According to Fig. 1 it can be argued that the effects of metallic ions in this study are generally in agreement with the results from investigations of other researchers[3,8] which can be summarized by the following relation:

$$Fe^{2+} > Fe^{3+} > Cu^{2+} > Zn^{2+}$$

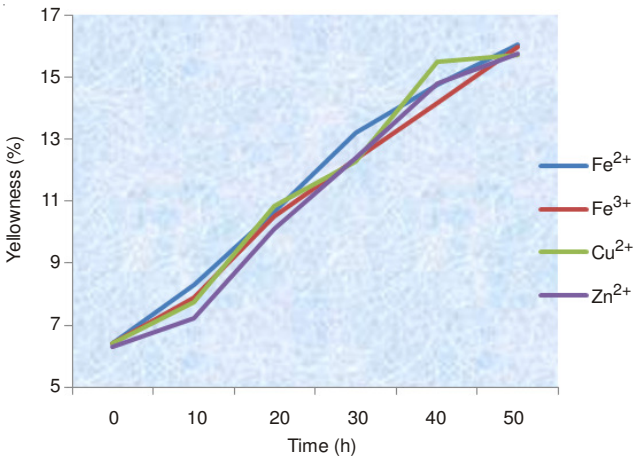

Fig. 1. General comparison of the effects imposed by various metallic ions on yellowness content in paper samples

Study on different levels of the chelating agent of EDTA in Table-4 indicates that the averaged effects of this material in reducing yellowness for all concentrations are classified in three distinctive groups.

TABLE-4
DUNCAN TEST RESULTS IN STUDYING THE EFFECT OF EDTA CONTENT ON YELLOWNESS OF THE PAPER SAMPLES

EDTA	Number	Subgroup		
		1	2	3
1	72	10.7933		
0.5	72		11.3279	
0	72			12.0717

Table-5 shows that each level of optical aging increases the yellowness content significantly, while each time duration has individually imposed considerable effect on raising the yellowness.

For studying and comparing effects of the 4 different ions, effect of each metallic ion at 0.5 % EDTA was evaluated on paper samples during aging procedure (Fig.1). It can be simply seen that the curve of Fe^{2+} is placed lower most.

The samples which were saturated by this ion were affected by aging operation to a great extent and experienced severe increase in their yellowness content. The samples which

were saturated with Zn^{2+} are located at lower place than other ions, which implies that this type of ion has increased yellowness less than all other ions.

TABLE-5
DUNCAN TEST RESULTS IN STUDYING THE EFFECT OF TIME VARIABLE ON YELLOWNESS OF THE PAPER SAMPLES

Time	Number	Subgroup					
		1	2	3	4	5	6
0	36	6.3833					
10	36		7.8967				
20	36			10.5000			
30	36				12.6283		
40	36					14.8167	
50	36						16.1608

Curves of Cu^{2+} and Fe^{3+} are almost similar. Ni *et al*.[9] have concluded that Fe^{2+} imposes much detrimental effect on the yellowness content due to formation of oxygen-bearing radicals. Mn^{2+}, Cu^{2+} and Fe^{3+} have shown almost similar trend while Al^{3+} has incurred the least pronounced effect.

Conclusion

Yellowness is the amount of difference between shining and whiteness which is expressed in terms of reflection as a measure of losing whiteness.

The following remarks were made by studying the results of this research:

(1) Yellowness of the samples has experienced significant decrease when concentration of the chelating agent is increased.

(2) Yellowness has been increased at longer aging times.

(3) The most remarkable effect in raising the yellowness content belongs to Fe^{2+} while the least pronounced effect is associated with Zn^{2+} and Cu^{2+}.

REFERENCES

1. A. Abdulkhani and S.A. Mirshokraie, *Iran. J. Nat. Res.*, **58**, 173 (2005).
2. B. Doherty and T. Rainey, in ed.: D. Hogarth, Bagasse Fractionation by the Soda Process, Proceedings of the Australian Society of Sugar Cane Technologists Mackay, Queensland, Australia, 2-5 May (2006) .
3. S.A. Mirshokraei, *Iran. J. Nat. Res.*, **58**, 405 (2005).
4. Z. Qiu, Y. Ni and S. Yang, *J. Wood Chem. Technol.*, **23**, 1 (2003).
5. K. Saint-Cyr, T.G.M. Van De Ven and G. Garnier, *J. Pulp Paper Sci.*, **28**, 78 (2002).
6. C. Castro, G.M. Dorris and C. Daneault, *J. Chromatogr.*, **969**, 313 (2002).
7. Tappi Standard, T 524. om-94, (1994).
8. B.H. Yoon, L.J. Wang and G.S. Kim, *J. Korea Tappi*, **37**, 8 (2005).
9. Y. Ni, A. Ghosh, Z. Li, C. Heinter and P. McGarry, *J. Pulp Paper Sci.*, **24**, 529 (1998).