Zeta Potential of few pulping and bleaching investigations

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ABSTRACT

The objective of this work was to determine the effect of various processing operations on zeta potential of fibre fines. The variables studied were pulping method and bleaching. The zeta potential of fines from different type of paper making pulps have been determined by an electrophoretic mobility technique. Difference in zeta potential indicated the behaviour of fibre separation in different pulping and bleaching processes.

Wood fibres, like many other particles, acquire a negative surface charge when suspended in water. The origin of the surface charge in wood fibres is generally believed to result from ionization of surface acidic groups (1,2). It is difficult to measure the surface charge of fibres or fines. The electrokinetic potential or zeta potential, produced by charged surfaces can be measured indirectly using streaming current, streaming potential, electroosmosis or micro-electrophoresis techniques (3). With microelectrophoresis, it is possible to measure electrophoretic mobilities within a colloidal system, from which zeta potential can be calculated.

Pulping and bleaching, cause some changes in the chemical composition of wood fibres, which also alters their surface (chemical) properties or in other words, electrokinetic properties.

The purpose of this preliminary work was to investigate the effect of pulping and bleaching on zeta potential of wood and agriresidue fibres.

Experimental :

Sulphate unbleached pu'p from Bamboo and Pine was made using laboratory digester. Both the pulps were bleached by CEHH sequence. The conditions have been given in Table-1.

Stage	Consistency	pH	Temp.	Time
Chlorination	2.5	Below 2	20-30° C	45 min.
Alkali Extractive	8%	11	70° C	3 hr.
Hypo (H_1)	8%	10	40° C	1.5 hr.
Hypo (H_2)	8%	9.5	35° C	1.5 hr.

To measure zeta potential, 0.1% consistency of pulp was maintained and was disintegrated for 10 minutes in laboratory disintegrator. The disintegrated pulp was screened using 200 mesh wire screen. The (—) 200 mesh fraction was used to measure zeta potential in a 3.0+ Zeta Meter System, using micro-electrophoresis technique.

In this instrument a high quality stereoscopic microscope is used to comfortably observe colloidal particles (of —200 mesh fraction of pulp) inside the chamber called an electrophoresis cell. Electrodes placed in each end of chamber are connected to a high voltage DC power supply which creates an electric field across the chamber. Charged colloidal

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particles move in the field and their velocity and-direction are related .to their zeta potential. Zeta Meter first measures the electrophoretic mobility of the particles which is expressed as micron/second per Volt/centimeter. The first term, micron per second is simply a velocity measurement, while the second is an expression of the electric field strength. Zeta potential (in millivolts) is calculated from the measured electrophoretic mobility using Helmholz smolu-chowski equation for spherical particles.

Results and Discussion :

Zeta potential of fines from unbleached bamboo and pine pulp at different levels of bleaching is given in Table-2 and 3 respectively.

Table-2 : Zeta Potential of Fines of Bamboo Bleached Chemical Pulp.

Sample	Kappa No.	Zeta Potential mV
Bamboo chlorinated pulp	—	(—) 8.9
Bamboo extracted pulp	8	(—) 10 2
Bamboo 1st stage hypo	4	(—) 8 0
Bamboo 2nd ,, ,,	1	(—) 5 4

Table 3 : Zeta Potential of Fines from Pine Blcached Chemical Pulps.

		mV
Pine Chlorinatcd Pulp	—	(—) 9.0
Pine Extracted ,,	9.2	(—) 12 6
Pine 1st stage hypo	5.4	(—) 9 0
Pine 2nd stage hypo	2.0	(—) 8.0

Zeta Potential of some cellulosic material and Isolated lignin fraction is given as reference (4) are listed in Table-4.

Table 4 : Zeta Potential of Reference Material.

Cotton Linter	(—)	7.6 mV.
Milled wood lignin	(—)	29.4 ,,
Klason Lignin	(—)	31.4 ,,
Chlorite Holocellulose	(—)	32 0 ,,

Both bamboo and pine pulps bleached at different stages gave comparable results showing similarity in their behaviour. Both extracted pulps gave higher zeta potential as compared to chlorinated and 1st stage hypo because of more phenolic nature of system.

All the pulps show that oxidation of carbohydrate has not taken place to a considerable extent as in case of ch'orite holocellulose which gives highest values of zeta potential (—32 0) because of more oxidation of of cellulose to carboxylic acid groups. This higher carboxylic content resulted to more negative zeta potential.

The zeta potential of fines from unbleached chemical pulps have also been determined as tabulated in Table 5.

Table 5 : Zeta Potential of Fines from Unbleached Chemical pulps

Pulp	Kappa No.	Zeta Potential (— mV)
Bamboo Sulphate	29	— 18 6
Pine Sulpha'e	28.4	— 17.1

In evaluating these results, it is necessary to consider the source of fines. In the case of an unbeaten pulp, the fines fraction represent the debris produced during the process of fibre separation, and it will depend on the mechanism by which fibre separation occurs. If the separation occurs in middle lamella the debris would be expected to be rich in lignin; thus higher zeta potential is anticipated. However if the fibre separation occurs at S_1-S_2 boundary, the debris will be a mixture of carbohydrate and lignin and average zeta potential could be lower.

The above speculation was again confirmed while analysing the zeta potential values of some other Agricultural waste pulps which has been depicted in Table-6.

Table 6 :

Pulp	Kappa No.	Zeta Potential —mV
Wheat Straw	19	— 13.4
Rice Straw	18	— 13.3
Bagasse	20	— 12.5

These agri-residue puips gave a softer cook even with soda pulping. Their fine fraction has come from the debris of different cell wall layers. Thus contain comparatively lesser amount of lignin resulting in lower zeta potential values as expected.

Conclusion :

Zeta potential measurement is a useful tool in detecting changes is surface properties occuring during pulping or bleaching. It indicates the chemical nature of fines fraction of pulp thereby helping in studies of fibre separation which could also be confirmed by Electron miscroscopic examination of these pulps.

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