Effect of Steam Pressure during Blowing on the Pulp Strength in Jute Pulping

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ABSTRACT

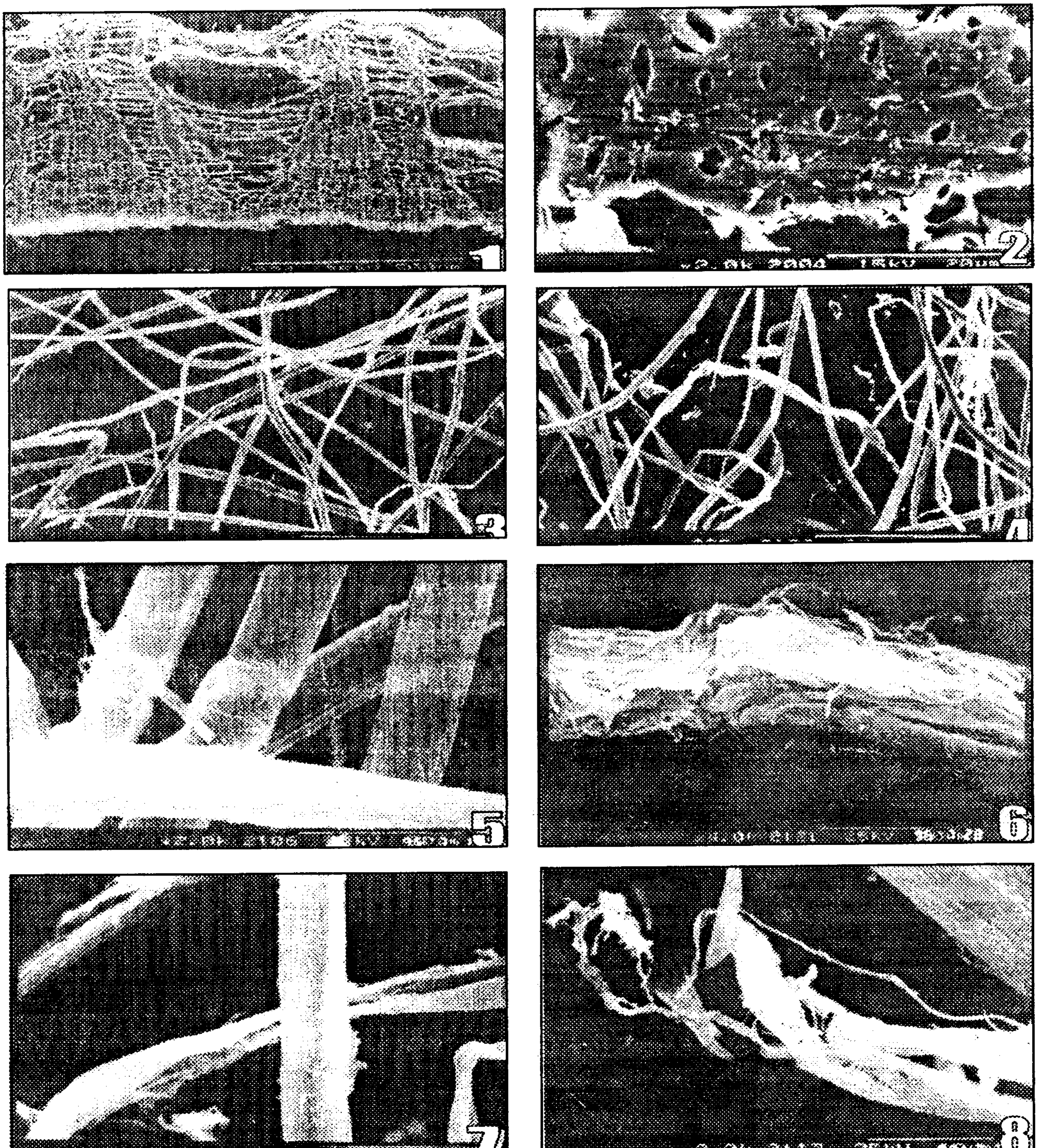
The cooked mass from the batch digesters in India is normally discharged at elevated pressures. The advantages of discharge of the cooked mass at high pressure are easy removal of pulp from the digester, liberation of individual fibres from the cooked chips and easy handling of liberated fibres in the later stages of fibreline operations. It was noticed in the late eighties of last century that the pulp mass left behind in the digester during the normal discharge has improved strength properties. The differences experienced between two such pulps have lead to the analysis of the reasons for such behaviour. Similar experiments were conducted in CPPRI pilot plant on jute pulping. The results indicated that variations in discharge pressures have significant influence on the morphology of the jute fibres and on the strength of fibres as indicated by the intrinsic viscosity. The scanning electron microscopic observations on the individual fibres of high pressure blow pulps have revealed severe physical damage.

INTRODUCTION

Pulp fibres are liberated by chemically dissolving the non-cellulose components (mainly lignin) from the raw material, which cements the fibres together. The aim of the chemical pulping is to liberate the fibres with minimum possible damage so that the degree of polymerization of the cellulose component is retained to its maximum possible extent. Kraft process normally removes the lignin more selectively from the raw material and the kraft fibres are the strongest ones in the chemical pulping processes. The unbleached kraft fibres are flexible and dark in colour. The chips come apart into individual fibres by shear forces when the delignification process reaches its optimal level, which happens during the discharging process of the pulp from the digester either by pressure or by pumping. A series of experiments based on 'hanging bucket' method in the late 1980s have shown that the fibres in chip mass retained inside the batch digester at the completion of the cook are stronger than the fibres blown from the digester. It indicates that the discharge conditions like pressure drop, heat, velocity, frictional forces and steam flashing are responsible for the loss of pulp strength. The experiments of Cyre et al (1989) on cold blow methods involving the addition of dilution liquor and pumping out the pulp mass from cooled and depressurized the digester at regulated flow have yielded a pulp with significantly higher pulp strengths. The adoption of cold blowing techniques has helped in improving the quality of pulp. Based on this background, the Institute has carried out experiments in its pilot plant to investigate the role of blow pressure on the strength and quality of jute pulp.

EXPERIMENTAL

The retted jute bast fibre was procured from West Bengal. The pulping optimisation was carried out in the laboratory using Kraft-Aq. The jute bast fibre was charged with Kraft liquor at 12% active alkali (as Na_2O) and added 0.05% anthraquinone and cooked in the $11 m^3$ digester in the pilot plant. The cooked mass was discharged from the digester at three different blow pressures viz 3.5, 4.0, 6.0 and 7.0 kg/cm^2. These pulps were then washed in the laboratory and screened using 'Serla' screen. The screened pulp was used to estimate the intrinsic viscosity CED based on Scan-C15:62 method. Small quantities of the pulps were dehydrated in alcohol series and transferred to pure xylene. The fibres in the pure xylene were freeze dried to obtain free fibres. These free fibres were spread on the stubs using double sided adhesive tape and coated with gold using sputter coater. Observations were made on these fibres in Hitachi S-2300 Scanning Electron Microscope and some of the images were collected on photomicrographs.



Figures 1-9 Jute bast fibres: 1. Cross section of jute bast; 2. Cross section of a bundle of Jute bast fibres; 3. Jute bast pulp fibres blown at 3.5 kg/cm^2 Pressure; 4. Jute bast pulp fibres blown at 6.0 kg/cm^2 pressure; 5. Jute bast pulp fibres blown at 3.5 kg/cm^2 pressure- Note the intact fibres; 6. Jute bast pulp fibres blown at 6 kg/cm^2 pressure- Note the cracking up of fibre along the length; 7, 8. Jute bast pulp fibres blown at 7.0 kg/cm^2 pressure- Note the fibres completely spilt along the length of the fibre and generation of cell wall debris.

RESULTS AND DISCUSSION

The pulp strength estimated by the intrinsic viscosity indicates that the jute pulps prepared in the pilot plant and blown at 3.5 kg/cm^2 pressure have maximum strength ie 1100cm^3/g viscosity compared to the jute pulps blown at higher blow pressures (Table 1). The pulps blown at 4.0 kg/cm^2 pressure have experienced minimum damage ie 1010 cm^2/g viscosity whereas viscosity of the jute pulp blown at 6.0 kg/cm^2 pressure dropped to 690cm^3/g. The jute pulp blown at 7.0 kg/cm^2/pressure was severely damaged and the intrinsic viscosity of the pulp dropped to 610cm^3/g.

Table 1. Effect of blow pressure on pulp strength

Sl. No.	Blow Pressure (kg/cm^2)	Intrinsic Viscosity of Pulp (cm^3/g)
1	7.0	610
2	6.0	690
3	4.0	1010
4	3.5	1100

The scanning electron microscopic observations on the jute bast cross sections (Fig. 1) show that the fibres are grouped into bundles and the fibres are thick walled with a narrow lumen (Fig. 2). The scanning electron microscopic observations indicate that the pulps blown from pilot digester at low blow pressures have yielded the intact fibres (Figs 3, 5). The observations on the jute pulps made in the pilot plant and blown at different pressures have revealed different degrees of physical damage to the fibres. The visual damage was clearly noticed in the pulp fibres blown at 6.0 kg/cm^2 pressure (Fig. 6). The fibres are completely split open along the length of the fibre in damaged fibres and the fibre wall is shattered into fibrils (Fig. 6-8). As the morphology of the softwood fibres (fibre tracheids) and the fibres from other sources like hardwoods, bast fibres and straws (libriform fibres) are compared the softwood fibres have wide lumen and porous whereas the libriform fibres from other fibre sources have fibres with narrow to very narrow lumen with either rudimentary pores or sometimes nonporous. During the discharge of pulps from batch digesters at higher pressures, the damage to softwood fibres will be relatively lower as the pressure within the tubular fibre can be released through the bigger pores connecting the lumen with outside. As the libriform fibres from bast pulp or hardwood pulp have minute or no pores, the pressure gradient will be very high between the fibre lumen and outside environment and such a closed tubular cylinder is bound to shatter. That is the reason why the jute bast fibres are severely damaged in higher blow pressures.

CONCLUSION

High pressure during the discharge of pulp from pulp severely affects the pulp viscosity. The fibre structure is severely damaged at high steam pressure blowing.

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