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THE EFFECT OF BLEACHING ON THE DEGREE OF POLYMERISATION OF JUTE CELLULOSE

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Jute fibre was bleached with 0.7% sodium chlorite solution at pH 4. The effect of time, temperature of bleaching etc. on jute cellulose was investigated. In general bleaching affects degree of polymerisation of jute cellulose. The degree of polymerisation of cellulose obtained by bleaching jute was determined by viscosity measurements of the solution of nitro derivatives of the cellulose in each case. It was observed that least change in D.P. of cellulose from completely bleached jute takes place when bleaching is done within a temperature range of 65°C and 70°C. The time required for complete bleaching at this temperature is about 80 min.

The strength of cellulosic fibres is known to be dependent on the degree of polymerisation of the cellulose polymer. In jute the cellulosic component is separated from the noncellulosic part by bleaching. A 0.7% sodium chlorite[1] solution at pH 4 has been shown to have the best bleaching effect on jute. In order to retain the strength of the cellulose obtained from jute it is important that the bleaching be carried out under conditions where the least change in degree of polymerisation takes place. Although considerable work[2,3] has been carried out on the bleaching of jute by sodium chlorite no attention on this aspect of the bleaching operation seems to have been given. The present work was undertaken with a view to finding out the conditions of bleaching, such as time, temperature, fibre to bleaching liquor ratio etc., such that there is least change in the degree of polymerisation of the cellulosic component.

Experimental

The sample under investigation was of *Corchorus olitorius* type. The plant was sown at the end of April and reaped by the end of September. It was immersed under water for 15 days and the fibre was separated from the sticks and dried in the sun. The fibre was about 275 cm to 300 cm in length. It was arbitrarily cut into three parts—50 cm from the bottom end, 50 cm from the top, the remainder being considered as middle fraction. The middle fraction was chosen for the present investigation. This was reduced to small pieces, about 1 inch in length. The fibre was dewaxed and dried at room temperature in air and preserved in a bottle for subsequent bleaching operation. The jute fibres were mixed thoroughly and the homogeneous part of the fibre was bleached. The presence of lignin was tested by spot test.[4] The bleached jute fibre was dried in air at room temperature and then dried in an oven for 3 hr at 50°C. The bone-dry cellulose was nitrated by mixed acid method. The nitrocellulose was freed from acid for stabilization.[5] Nitrocellulose was dissolved in pure ethyl acetate and the viscosity of the solution was measured by a modified "Ubbelohde" type of viscometer at 30°C. The nitrogen content of the nitrocellulose was estimated by Devarda's method.

Results and Discussion

It was observed that bleaching with 0.7% $NaClO_2$ at pH 4 at low temperatures is slower than that at higher temperatures. Time required for complete bleaching at various temperatures are given in Table 1, the presence of lignin being tested by spot test in each case.

TABLE 1.—CHANGE OF TIME OF BLEACHING WITH TEMPERATURE.

Temp of bleaching (°C)	60	65	70	75	80
Time of complete bleaching (min)	150	100	60	55	45

The fibre was bleached at various temperatures. The sample was nitrated under identical and reproducible condition. Percentage of nitrogen was estimated. Intrinsic viscosity, $[\eta]$ of the nitro derivatives was found out by plotting η_{sp}/C vs C in each case, C being the concentration in per 100 ml of the solution. It was known that intrinsic viscosity of cellulose nitrate changes with its nitrogen content. The values were, therefore, corrected for theoretical trisubstitution by the method of Lindsley and Frank.[6]

Nitrogen content (%N), intrinsic viscosity, $[\eta]$ and intrinsic viscosity corrected, $[\eta]$ corrected, are given in Table 2.

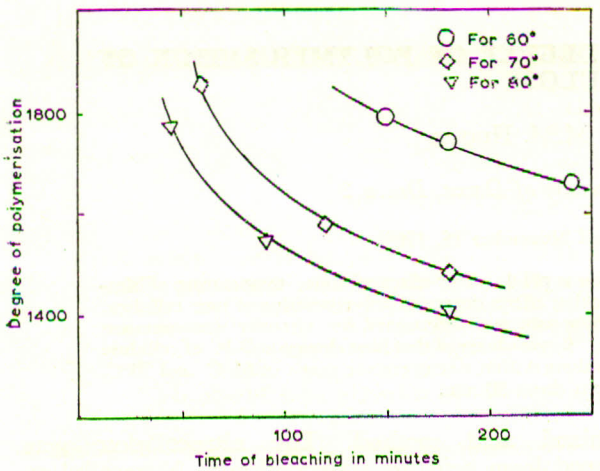

Fig. 1.

TABLE 2.

Time of bleaching (min)	Temp °C	Nitrogen content %	[η] (from graph)	[η] corrected
150	60	13.1	16.0	22.3
180	60	13.2	16.0	21.7
240	60	13.2	15.4	20.7
100	65	12.8	15.2	23.2
60	70	13.1	16.5	23.1
120	70	13.1	14.0	19.6
180	70	13.5	15.0	18.4
45	80	12.8	14.3	21.9
90	80	13.1	13.7	19.3
90	80	12.8	12.4	19.1
180	80	13.2	13.0	17.6

The nature of the change in the degree of polymerisation with time at various temperatures is shown in Fig. 1. It was observed that the change in D.P. with time at higher temperatures is higher than that at lower temperature and the nature of change in D.P. are similar, the D.P. being calculated from the relation,[7] D.P.$=80.5[\eta]$ So it is possible to find out the temperature range in which the minimum change in D.P. takes place during the delignification of jute fibre when bleaching is complete. To find such conditions a curve

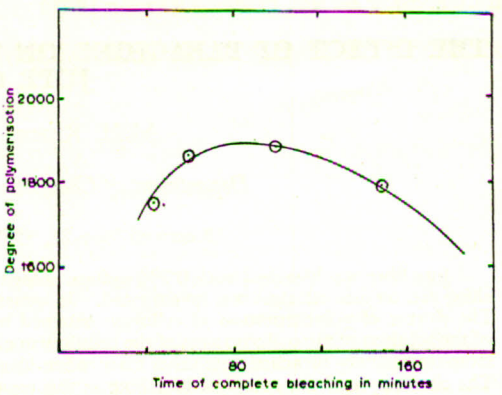

Fig. 2.

was drawn by plotting (Fig. 2) intrinsic viscosity corrected against time of complete bleaching in minutes at various temperatures, the data being taken from Table 2.

However, from the study of the curve given in Fig. 2, it is seen that the least change takes place at that temperature where time required for complete bleaching is about 80 min. The temperature lies between 65°C to 70°C.

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