Continuous mercerising plants are used extensively for making viscose. Such a plant consists of a tank with a stirrer, to which cellulose sheets and alkali are fed. The pulp thus obtained is pumped out of the bottom of the apparatus to a homogenising tank and thence to a squeezing device. This leads to marked disintegration of the cellulose sheets, thus making all the fibres accessible to the alkali.

However, whereas in mercerising all the cellulose sheets in the presses are in the alkali solution for a specific period, in the continuous method different parts of the cellulose are treated with alkali solution for different times. After the cellulose sheet has been fed to the mercerising machine, it is rapidly wetted and breaks up into particles of different sizes. Intense stirring leads to rapid distribution of these particles in the pulp, together with which they enter the homogeniser. Some of the particles which have been distributed throughout the homogeniser enter the squeezing device.

Thus the duration of mercerising of certain particles consists of the time required to transport the pulp through the pipes and the residence time in the squeezing press, which is practically 1-2 min. In this case the particle undergoes little degradation. Other particles of the cellulose sheet which has entered the merceriser will be processed for different periods. The particles which were present in the apparatus for a considerable period may undergo marked depolymerisation.

After mercerisation, the alkali cellulose is a mixture of particles with different average degrees of polymerisation P. A previous report [1] analysed the work of a viscose plant from the viewpoint of scatter of the residence time of the in-process material in different parts of the plant. The authors showed that the residence time of the cellulose mass in the mercerising machines differs markedly. It was suggested that under specific conditions such scatter may lead to a marked increase in the content of high- and low-molecular fractions, which impedes the manufacture of high-grade viscose.

This paper deals with the effect of different mercerising times of cellulose on the fractional composition of alkali cellulose under differing mercerising conditions.

For simplicity we shall consider the mercerising tank and the homogenising tank as ideal mixing apparatuses, of which the charge and discharge are constant and equal. We shall neglect the rupture time of the sheet and assume that the cellulose feed is continuous. Hence the fraction of cellulose, of which the residence time in one apparatus \( \varphi_1 \) is not less than \( t \) sec, is [2]
\[
\varphi_1 = e^{-t/\tau},
\]
where \( \tau = V/\omega \) is the mean residence time of the cellulose in the apparatus in h; \( V \) is the working volume of the apparatus in m\(^3\); and \( \omega \) is the rate of feed of the pulp in m\(^3\)/h. The fraction of cellulose, of which the residence time in the two sequentially operating merceriser and homogeniser units of the same working volume \( \varphi_{1,2} \) is not less than \( t \) sec, will be
\[
\varphi_{1,2} = e^{-t/\tau} \left(1 + \frac{t}{\tau}\right).
\]

If the working volumes of the merceriser and homogeniser are both 6 m\(^3\) and the rate of feed of the pulp is 22 m\(^3\)/h, the overall mean mercerisation time of both cellulose fractions in \( 2 \tau = 32.7 \) min. This value is usually taken as the mercerisation time by plant engineers.

The fraction of cellulose of which the residence time in the mercerising machine is more than 16.4 min (Fig.1, curve 1) is 38%. The cellulose fraction of which the residence time in both plant units is more than the mean mercerisation time in one unit only is 74% (curve 2). Therefore, the mean time does not
Analysis of (1) and (2) and the data in Fig. 1 reveals that reduction of the mean mercerisation time by reducing the working volume or increasing the bath modulus increases the fraction of weakly mercerised cellulose and reduces the cellulose fraction which passes into the low-molecular fractions. An increase of the mean mercerisation time has the opposite effect. In fact, if the working volumes of the merceriser and homogeniser are both 15 m³, and the rate of feed of the pulp is 33 m³/h, the total mean mercerisation time is \(2 \tau = 55\) min and the scatter of the residence time of cellulose in the apparatus is greatly increased (see Fig. 1, curve 3). Thus, the scatter of the mercerisation time of the cellulose particles may actually be very considerable.

It was of interest to determine the scatter of the mean \(P\) of these cellulose particles. Using data of Lotarev and Bork [4] on the degradation of cellulose in pulp at 40°C, we constructed a graph of the distribution of the mean \(P\) values (Fig. 2). If curve 2 of Fig. 1 coincides with curve 1 of Fig. 2 after elimination of time, we get a graph (Fig. 3, curve 1) whose horizontal axis represents the overall fractions of cellulose \(\omega_0\), and the vertical axis the mean \(P\). After differentiation of the curve we found the distribution (in fractions) of the mean \(P\) of the cellulose parts (curve 2). The result shows that with the existing continuous process the distribution of the mean \(P\) is fairly narrow and cannot have a marked effect on the polydispersity of the final alkali cellulose.

The authors of [4, 5] have proposed intensifying the process by adding to the alkali various accelerators of cellulose degradation, for example, hydrogen peroxide (see Fig. 2, curve 2). Such degradation during mercerising gives very wide distribution of the mean \(P\) values of cellulose particles (Fig. 3, curves 3 and 4). Some of the cellulose particles undergo marked oxidative degradation, while others are only slightly depolymerised. According to the integral curve, the following ratios of cellulose particles with different mean \(P\) are observed:

<table>
<thead>
<tr>
<th>Mean (P)</th>
<th>&lt;400</th>
<th>&lt;700</th>
<th>700-800</th>
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</thead>
<tbody>
<tr>
<td>(\varphi_{1,2}), %</td>
<td>30</td>
<td>60</td>
<td>10</td>
</tr>
</tbody>
</table>

The use of oxidising agents and catalysts in continuous mercerising plants in order to reduce the ripening time, or combined mercerising and ripening time, is apparently counterindicated, because it may increase the polydispersity of alkali cellulose so markedly that the fibre quality is greatly impaired.