SIMULTANEOUS PRODUCTION OF WOOD PULP AND THE
CONVERSION OF THE NONCELLULOSIC CONSTITUENTS
OF WOOD INTO ALCOHOLS, OILS, AND RESINS

February 1940

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
Madison, Wisconsin
In Cooperation with the University of Wisconsin
SIMULTANEOUS PRODUCTION OF WOOD PULP AND
THE CONVERSION OF THE NONCELLULOSIC CONSTITUENTS
OF WOOD INTO ALCOHOLS, OILS, AND RESINS

By
ELWIN E. HARRIS, Chemist
and
E. C. SHERRARD, Principal Chemist

In an earlier paper it was shown that lignin that has been freed of cellulosic material can be hydrogenated in a water suspension to produce methanol, several derivatives of propyl cyclohexane, and a high-boiling resin. When wood in the form of chips or sawdust was subjected to hydrogenation, the lignin was similarly hydrogenated with the production of oils and resins and some of the hemicellulosic material converted into alcohols, leaving the cellulosic material as a pulp. Because acidic substances were liberated from wood which inhibited the reactivity of the catalyst, it was desirable to add sufficient alkali to keep the solution alkaline at all times. Alkali corresponding to 8 to 10 percent of the weight of the wood was usually used.

At higher pressures of hydrogen large amounts of hydrogen were taken up and pulp, methanol, propyl alcohol, propyl cyclohexane derivatives, and a resin were obtained. It was found that it was possible to obtain sufficient pulping by controlling the extent of the hydrogenation through the use of lower pressures. The pulping solution, which normally becomes dark brown from the action of alkali on the lignin, remained light colored. Most of the lignin may be obtained from this liquor, upon acidification, as a low-melting, resin-like material that darkens on exposure to air. Methyl and propyl alcohols are recoverable from the liquor by distillation.

1Application for U. S. patent covering this process has been made.
2Presented before the Cellulose Division, American Chemical Society, Boston, Mass., September, 1939, by E. E. Harris.
3A general description of this process was presented before the Engineers' Club of Birmingham, Ala., February 12, 1940 by C. P. Winslow.
Experimental

Thirty grams of air-dried wood chips were placed in a 600 cc. hydrogenation bomb, 300 cc. of a solution containing sodium hydroxide and 0.05 gram of Raney nickel catalyst were added. The bomb was closed and hydrogen pumped in to give the desired starting pressure. The bomb was heated until hydrogen was no longer absorbed, after which it was allowed to cool. The bomb was then opened and the contents filtered to recover the pulp. Compounds boiling below 100° C., consisting of methanol and propyl alcohol, were removed from the filtrate by distillation. The remaining filtrate was acidified, throwing out an oily resin. Several propyl cyclohexane derivatives were obtained by distillation of this resin. The acidified filtrate remaining after removal of the resinous material was evaporated and a residue obtained. Table 1 gives the conditions for the various experiments and the yields of products obtained.

The pulp obtained without further treatment was about the color of newsprint paper. It was quite free from shives and easily bleached by a mild treatment with chlorine.
Table 1.—Hydrogenation of wood in aqueous alkaline solution

<table>
<thead>
<tr>
<th>Kind of wood</th>
<th>Weight of sample</th>
<th>Water:Alkali</th>
<th>Initial hydrogen pressure</th>
<th>Temperature</th>
<th>Time</th>
<th>Yield of products (Percent of original wood)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grams Co. Grams Lbs. per sq.in.</td>
<td>°C.</td>
<td>Hours</td>
<td>Pulp</td>
<td>Methanol</td>
<td>Propyl alcohol</td>
</tr>
<tr>
<td>Aspen</td>
<td>30 300 3</td>
<td>1,000</td>
<td>170</td>
<td>3</td>
<td>44</td>
<td>3</td>
</tr>
<tr>
<td>Aspen</td>
<td>30 300 2-1/2</td>
<td>3,000</td>
<td>180</td>
<td>4</td>
<td>40</td>
<td>5.1</td>
</tr>
<tr>
<td>Maple</td>
<td>30 300 3</td>
<td>3,000</td>
<td>175</td>
<td>4</td>
<td>45</td>
<td>4.9</td>
</tr>
<tr>
<td>Slash pine</td>
<td>30 300 4-1/2</td>
<td>1,000</td>
<td>175</td>
<td>1-1/2</td>
<td>44</td>
<td>2-1/2</td>
</tr>
<tr>
<td>Aspen</td>
<td>30 300 3</td>
<td>3,000</td>
<td>200</td>
<td>12</td>
<td>None</td>
<td>4.6</td>
</tr>
<tr>
<td>Red gum</td>
<td>30 300 3</td>
<td>1,000</td>
<td>175</td>
<td>3</td>
<td>42</td>
<td>3</td>
</tr>
</tbody>
</table>

1 Determination not made.

RI218