Production of Gossypol from Cottonseed Gums.

Preliminary Cost Study

S. P. KOLTUN, K. M. DECOSSAS, JOSEPH POMINSKI, W. A. PONS JR., and E. L. PATTON, Southern Regional Research Laboratory, New Orleans, Louisiana

The five million tons of cottonseed produced annually in the United States and 16 million tons produced in the world contain approximately 60 million pounds and 200 million pounds of gossypol, respectively.

"Gums" produced commercially in one oil mill by water-washing contain approximately 5% gossypol and are a potential source of 200,000 lbs. of gossypol annually. These gums are currently added back to the hexane-wet meal in order to increase the capacity of the desolventizer, reduce meal dustiness, increase ease of pelleting and pellet output, raise fat content and increase protein solubility and nutritive value of meal. Additional premiums are realized for the meal. Additional premiums are realized for the stock might be substituted for the gums.

Using this process, the Southern Utilization Research and Development Division produced large quantities of pure gossypol, which have been made available for nutritional investigations of the physiology of gossypol in the feeding of swine and poultry, for research on improving process methods for seed and oil, for use as a standard analytical reagent (4), and for numerous other uses.

At this time there are no uses for gossypol to justify commercial production, but research is currently under way to develop uses for the compound as a chemical intermediate. Because of the great reactivity of its phenolic, carbonyl, methyl, and isopropyl groups, gossypol has great potential as a starting material for the synthesis of a number of organic compounds of unique structure.

A chemical balance and complete flow diagram for the production and purification of gossypol-acetic acid and its conversion to gossypol is shown in Figures 1 and 2.

Plant Investment

This cost study is based on the construction and operation of a hypothetical continuous plant with a capacity for extracting gossypol from cottonseed gums at a rate of 81,000 lbs. annually.

Estimated total plant investment costs for the various types of plants for producing either crude gossypol-acetic acid, pure gossypol-acetic acid, or pure gossypol are shown in Table I.

A material balance was prepared, based on pilot-plant and laboratory-scale runs. By applying the flow rates and yields obtained from the material balance to the known gumm output of a direct solvent-extraction plant, it became apparent that, with a continuous process, the rate of production of gossypol would be extremely low. Therefore it was decided to perform Phase No. 1, conversion to gossypol-acetic acid, concurrently with the operation of the mill, storing the crude material for purification at a later time. During periods of shut-down, which were assumed to total somewhat less than a month, Phases Nos. 2 and 3, purification of the gossypol-acetic acid and conversion to gossypol, respectively, would be accomplished. The flow rates were so adjusted that all of the crude acid produced and stored from Phase No. 1 could be converted to gossypol in the period of time allotted. In an effort to reduce costs, equipment from Phase No. 1 was used in Phase No. 2 if capacity permitted.

Investment costs for equipment were for the most part compiled from costs furnished by equipment manufacturers. Stainless steel equipment would be used in most cases on account of the corrosive nature of some of the chemicals.

The total physical-plant costs were derived by the addition of installed equipment cost, process piping, instrumentation, auxiliary facilities, and buildings, which were calculated by applying percentages to purchased equipment costs (1, 2, 3, 7). Engineering and construction costs and contingencies, each assumed to be 25% of the total physical-plant costs, were added to the total physical-plant costs, to obtain the total plant cost. One total-plant cost for the entire process

<table>
<thead>
<tr>
<th>Phase No.</th>
<th>Description</th>
<th>Cost (S/lb.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conversion to gossypol-acetic acid</td>
<td>108.9 73.5 31.9 62.1</td>
</tr>
<tr>
<td>2</td>
<td>Purification of gossypol-acetic acid and conversion to gossypol</td>
<td>108.6 63.0 38.7 69.4</td>
</tr>
<tr>
<td>3</td>
<td>Total manufacturing costs</td>
<td>555.0 309.0 263.3 380.7</td>
</tr>
</tbody>
</table>

*One of the laboratories of the Southern Utilization Research and Development Division, Agricultural Research Service, United States Department of Agriculture.*
Fig. 1. Phase I. Flow sheet for recovery of gossypol-acetic acid from cottonseed gums.