
INDUSTRY PROFILE #17

GLUCOSE FROM CASSAVA STARCH

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INDUSTRY PROFILES

Introduction

This Industry Profile is one of a series briefly describing small or medium-sized industries. The Profiles provide basic information for starting manufacturing plants in developing nations. Specifically, they provide general plant descriptions, financial, and technical factors for their operation, and sources of information and expertise. The series is intended to be useful in determining whether the industries described warrant further inquiry either to rule out or to decide upon investment. The underlying assumption of these Profiles is that the individual making use of them already has some knowledge and experience in industrial development.

Dollar values are listed only for machinery and equipment costs, and are primarily based on equipment in the United States. The price does not include shipping costs or import-export taxes, which must be considered and will vary greatly from country to country. No other investment costs are included (such as land value, building rental, labor, etc.) as those prices also vary. These items are mentioned to provide the investor with a general checklist of

**considerations for
setting up a business.**

IMPORTANT

**These profiles should not be substituted for feasibility studies. Before an investment is made in
a plant, a feasibility study should be conducted. This may require skilled economic and
engineering expertise. The following illustrates the range of questions to which answers must
be obtained:**

*** What is the extent of the present demand for the product, and how is it now being
satisfied?**

*** Will the estimated price and quality of the product make it competitive?**

*** What is the marketing and distribution plan and to whom will the product be sold?**

*** How will the plant be financed?**

*** Has a realistic time schedule for construction, equipment, delivery, obtaining materials and supplies, training of personnel, and the start-up time for the plant
been developed?**

*** How are needed materials and supplies to be procured and machinery and equipment to be maintained and repaired?**

*** Are trained personnel available?**

*** Do adequate transportation, storage, power, communication, fuel, water, and other facilities exist?**

*** What management controls for design, production, quality control, and other factors have been included?**

*** Will the industry complement or interfere with development plans for the area?**

*** What social, cultural, environmental, and technological considerations must be addressed regarding manufacture and use of this product?**

**Fully documented information responding to these and many other questions should be
determined before proceeding with implementation of an industrial project.**

Equipment Suppliers, Engineering Companies

**The services of professional engineers are desirable in the design of industrial plants even though
the proposed plant may be small. A correct design is one that provides the greatest economy in
the investment of funds and establishes the basis of operation that will be most profitable in the
beginning and will also be capable of expansion without expensive alteration.**

Professional engineers who specialize in industrial design can be found be referring to the published cards in various engineering magazines. They may also be reached through their national organizations.

Manufacturers of industrial equipment employ engineers familiar with the design and installation of their specialized products. These manufacturers are usually willing to give prospective customers the benefit of technical advice by those engineers in determining the suitability of their equipment in any proposed project.

VITA

Volunteers in Technical Assistance (VITA) is a private, non-profit, volunteer organization engaged in international development. Through its varied activities and services, VITA fosters self-sufficiency by promoting increased economic productivity. Supported by a volunteer roster of over 5,000 experts in a wide variety of fields, VITA is able to provide high quality technical information to requesters. This information is increasingly conveyed through low-cost advanced communication technologies, including terrestrial packet radio and low-earth-orbiting satellite.

VITA also implements both long- and short-term projects to promote enterprise development and transfer technology.

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PRODUCT DESCRIPTION

The Product

The product is clear, colorless, glucose syrup, extracted from dried cassava starch or cassava chips. It is sold in drums or tank wagons.

Glucose, also called dextrose, was first manufactured in France early in the 19th century as a sweetener to replace sucrose (table sugar) which had become scarce in wartime. The variety of its uses has since grown enormously. Today, glucose is valued in almost all industrial countries for its unique properties. In candies (sweets) and preserves it provides "body" (desired density and flow characteristics) and controls crystallization. In canning, it provides body to the syrup without too much sweetness.

The Facility

A small plant can operate 250 days a year on a three-shift continuous basis and produce about 2,500 tons of glucose syrup. The degree of conversion of the starch to glucose depends on customer needs. The plant supplies a small market and can be expanded, if market conditions allow, to take advantage of economies of scale.

The plant should be accessible by good roads and should be near a good supply of cooking water. Access to a municipal sewer system is also recommended. Disposal of spent carbon and fiber tailings from the starch screen are the major solid-waste problems. Additional environmental issues concern disposal of effluent from housekeeping water and gases from the boiler flue and the convertor. However, the wastes pose very little health hazard when added to the environment.

GENERAL EVALUATION

The process is relatively simple and its principles are widely understood. The market demand is stable at levels depending on local economic development.

Economic Outlook

Profitability depends on market factors, which, in turn, are heavily influenced by the agricultural and trade policies of the country. Transport costs are not usually a major factor.

Manufacturing Equipment Flexibility

The same equipment can be used to produce a crude, solid form of dextrose ("cast sugar") by acquiring aluminum pans in which the evaporator product is allowed to crystallize. After grinding, this product is suitable as a reducing agent for tanning. Making cast sugar requires more acid to be added to the convertor supply and slowing the rate of starch breakdown.

Knowledge Base

A chemist experienced in the food industry, particularly related to sweets, preserves, and canning, is needed to explain the uses of this product to potential customers. A chemical engineer is needed to perform or supervise analytical process control as well as oversee mechanical operations. It is strongly recommended that a professional engineer with experience in the production of glucose from starch be retained, at least when the plant is in the planning stage.

Quality Control

The product meets established standards. Syrup has a reducing-sugar content equivalent to 30% to 40% glucose by dry weight ("dextrose equivalent [DE]" = 30 to 40), and contains 80% to 82% dissolved materials by weight. Cast sugar requires a DE of 90.

Quality is assured by having the right laboratory instruments and

the plant personnel to use them correctly. For the small plant, amounts of chemicals are measured by volume or weight. For larger production, bags or barrels of some materials may be counted. Acidity of the convertor supply is checked by titration. Acid addition and product dry substance are monitored hourly. The product is neutralized by adding sodium carbonate solution and the end-point is checked with a pH meter. The needed amount of activated carbon is weighed according to the volume of the treatment tank.

The concentration of dry substance is measured with a torsion tube density controller. Batch quality testing involves determining reducing sugars (DE) by copper reduction, dry substance by refractometry, color by spectrophotometry, and taste, appearance, and odor by direct inspection.

Constraints and Limitations

Cassava is most likely to be grown only in moderate or tropical climates. Economical motor transport is limited to about 400 km. If long-distance rail transport lowers the temperature to 5 degrees C or less, the tank car may need to be reheated to speed unloading; this, in turn, can lead to unacceptable color changes.

MARKET ASPECTS

Users

Glucose syrup in used for hard candies and preserves, and for

making medicinal syrups, canning syrups, and table syrups. It can be used in manufacturing table syrups to adjust their viscosity or consistency. There are now better products for supplemental addition to milk for infant feeding, but glucose syrup remains an inexpensive substitute.

Suppliers

The raw material is dried cassava flour or chips. Cassava is grown in Africa, Central and South America (especially Brazil), India, and Indonesia, mostly for use as a boiled vegetable. Malaysia has a cassava-processing plant. Manufacturing chemicals, all common in trade, are hydrochloric acid, powdered activated carbon, and sodium carbonate (soda ash).

Sales Channels and Methods

Sales are by direct contact with those manufacturers who are prospective users. Some of then may already use syrups prepared from other sources. Good technical service is required to adapt the users' present formulation to the new product. Once a use pattern has been established, brokers may help to sell the product in drum lots. Sales to individuals are promoted by mass advertising and the usual channels for food specialties.

Geographic Extent of Market

The plant should be located where cassava is grown or is readily available at low cost. If the water content of the cassava chips

significantly increases their shipping weight, it is best that the plant be located near the source of the raw material. The product is stable and is readily transported in bulk, as well as in drums and bottles. High bulk-transport costs can limit the size of the market area, The 400-km limit on motor transport can also control the size of the market area.

Competition

Glucose syrup is well known, and competitive syrups are available worldwide. Syrups are manufactured from various materials in such tropical and semitropical countries as Australia, Brazil, colombia, Guatemala, Kenya, Mexico, Morocco, New Zealand, Pakistan, and Venezuela. In most of these, maize is the raw material. Some broken rice is processed in Pakistan. Some wheat is used in Australia and New Zealand.

Market Capacity

As a guideline, consider that U.S. annual usage of glucose syrups amounts to 9 kg per capita, of which 60% replaces sucrose in the canning of foods. At half this per-capita consumption, the plant described here would supply a population of 1/2 to 1 million people.

PRODUCTION AND PLANT REQUIREMENTS

Requirements Annual Output:

2,500 tons

Infrastructure, Utilities Small Plant

Land 1500 sq m

Building 400 sq m
Power 30 kW
Steam (electric boiler) 600 kg/h
Fuel (gas)
Water
cooling (from stream) 1400 cu m/d
boiler feed water 14 cu m
process, use condensate
from evaporated heater and: 6 cu m

Major Equipment & Machinery Small Plant

Tools & Machinery
converter tank
neutralization vat
evaporator
lift truck 2
rotary leaf filter

Support equipment & parts
Chemical lab instruments

Production tools & equipment
transportation equipment
furniture & fixtures

Materials & Supplies Small Plant

Raw Materials
cassava starch 1870 tons
hydrochloric acid 8 tons
sodium carbonate 2750 tons

Supplies
lubricants & hand tools
cutting tools & abrasives
maintenance & spare parts
office supplies

Packaging; for example:
Drums, 20 and 200 1
Bottles, 500 ml

Labor Small Plant

Skilled 3

Semiskilled 6
Unskilled 6

Indirect
general mechanic 1
supervisor (grad. foods 1
technician/industrial chemist)
sales representative 1

<FIGURE>

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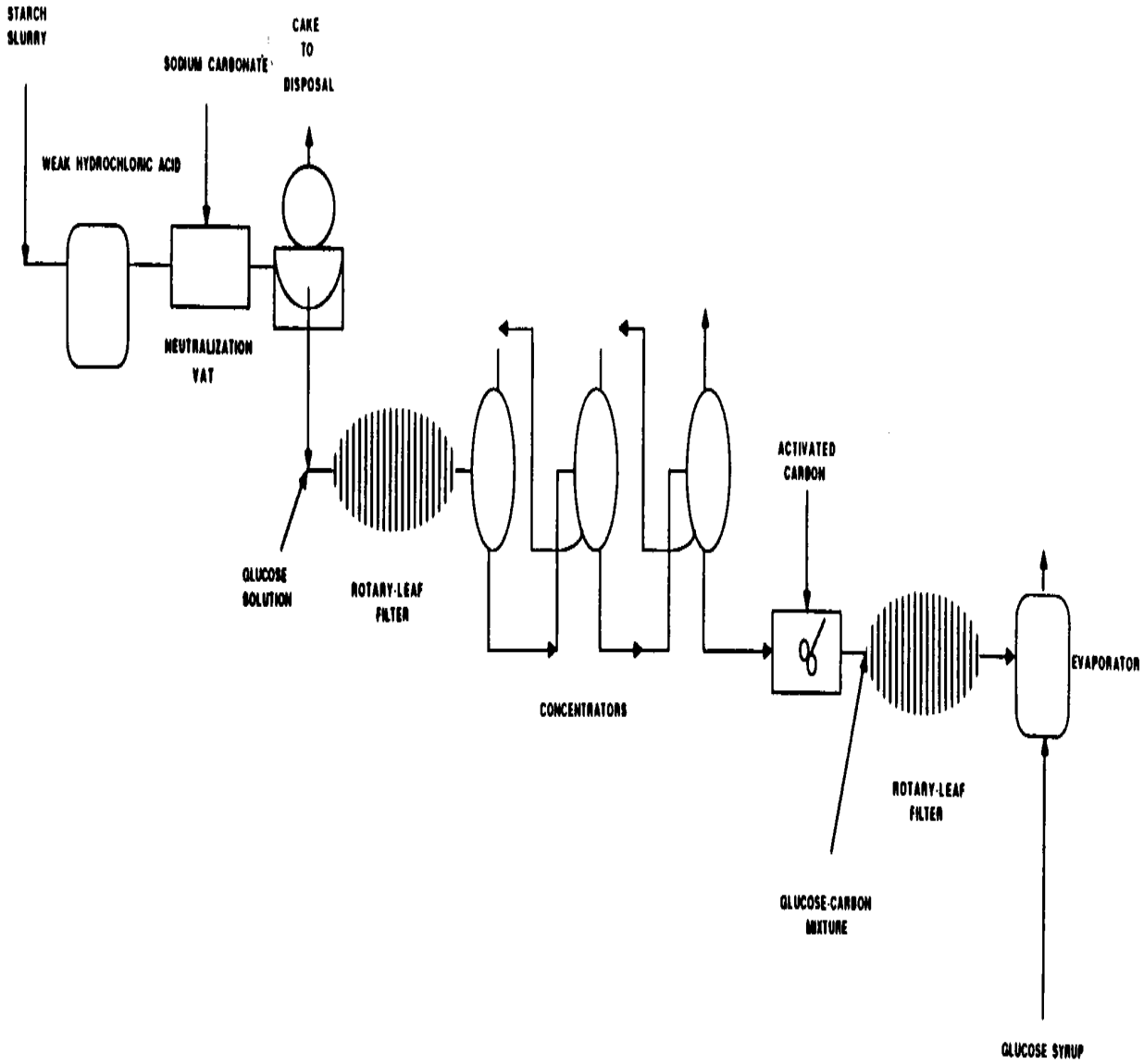

Explanation of Diagram

Workflow begins with receipt of dried cassava starch or chips, if chips, a mill and dust collector should be added. The raw material is dumped into the slurry tanks with water to make a slurry of 30 percent dry substance. It is screened to remove the fibers and then pumped to a convertor supply lank. The chemical breakdown of starch to sugar takes place in the presence of weak acid. After the breakdown has proceeded to the desired stage, the acid is neutralized with soda ash (sodium carbonate). Impurities are then removed with activated charcoal in filter presses and the product is concentrated by evaporation as diagrammed.

The tanks and pipes are made of stainless steel and other materials in standard use for food processing. Filter presses can be made of wood or polypropylene.

REFERENCES

Unless otherwise stated, these addresses are in the United States.

Technical Manuals & Textbooks

Grace, M. R. (ed.), Cassava Processing, rev. ed. Plant production and protection papers, No. 3. Rome (Italy): Food and Agriculture Organization of the United Nations, 1977.

Equipment Suppliers

Anhydro Division of APV Crepaco, Inc., 120 John S. Pietsch Square, Attleboro Falls, Massachusetts 02763. Plate evaporators, heat exchanges.

Chemineer, Inc., P.O. Box 1123, Dayton, Ohio 45401. Agitators.

Dedert Corp., 20000 Governors Drive, Olympia Fields, Illinois 60461. Falling film evaporators.

Illinois Water Treatment Co., 4669 Shepherd Trail, Rockford, Illinois 61105. Ion exchange, chromatographic enrichment.

Mitsubishi Chemical Industries, Ltd., 5-2 Marunouchi 2-Chome, Chiyoda-ku, Tokyo 100; P.0 Box 245, Tokyo Central, Japan. Ion exchange, chromatographic enrichment.

Mixing Equipment Co., Inc., 138 Mt. Read Blvd., Rochester, New York 14603. Agitators.

Sparkler Filters, Inc., Box 19, Conroe, Texas 77305. Safety filters, leaf filters.

U.S. Filters Corporation, 12442 E. Putman St., Whittier, California 90602. Rotating leaf filters.

Financing and Engineering Companies

A.E. Staley Manufacturing Co., 2200 East Eldorado St. Decatur, Illinois 62525.

Cargill, Inc., P.O. Box 9300, Minneapolis, Minnesota 55440

CPC International, Inc., International Plaza, P.O. Box 8000, Englewood Cliffs, New Jersey 07632. (This company has the widest representation.)

Professional Services:

Intensa, S.A., Rio Panuco 82, Col. Cuauhtemoc, Mexico, D.F., Mexico.

Karl Kro/yer Genbrog, A/S, Dronningens Tvaergade 16, DK-1302 Copenhagen K, Denmark.

Mitsubishi Chemical Industries, Ltd., 5-2 Marunouchi 2-chome, Chiyoda-ku, Tokyo 100; P.0 Box 245, Tokyo Central, Japan.

Suomen Sokari Oy (Finnish Sugar Company), Kyllikenportti 2, SF-00240 Helsinki, Finland.

VITA Resources

VITA has a number of documents on file dealing with industrial processes. VITA also provides a variety of services to help set up processing plants, including locating used equipment, brokering, etc. Fees depend on service rendered.

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