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FEASIBILITY REPORT

(PROJECT FEASIBILITY REPORT)

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SORBITOL FROM MAIZE STARCH



IDENTIFICATION & EVALUATION DIVISION FOR HI-TECH PROJECTS

ENGINEERS INDIA RESEARCH INSTITUTE

EIRI CONSULTANTS & ENGINEERS

* REGD. OFFICE *
4449, NAI SARAK, MAIN ROAD,
NEAR CHANDNI CHOWK,
DELHI - 11 00 06. (INDIA)
(BETWEEN MARWARI KATRA AND ROSHAN PURA),
PH : 91-11-23918117, 23916431, 45120361, 64727385, 23947058
E-Mail : eiriprojects@gmail.com, eiribooks@yahoo.com
Web: www.eiriindia.org, www.eiribooksandprojectreports.com

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SORBITOL FROM MAIZE STARCH
[EIRI/DFR/7637] (J.C.: 9843)

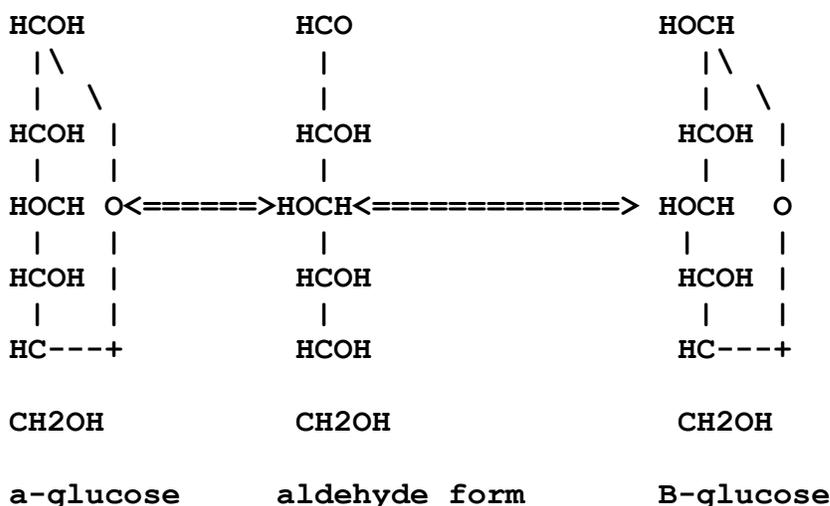
INTRODUCTION

D-Sorbitol, $\text{CH}_2\text{OH}(\text{CHOH})_4\text{CH}_2\text{OH}$ (D-glucitol, L-gulitol), is a hexahydric alcohol with a 6-carbon atom straight-chain that contains six hydroxyl groups, and has a molecular weight of 182.17. It exists as a white, odorless, crystalline solid. Because of a negative heat of solution, sorbitol has a cooling effect when tasted. The hexitol has about two-thirds the sweetness of sugar.

Sorbitol was first isolated by the French chemist Joseph Boussingault in 1872 from the fresh juice of mountain ash berries. It has since been found in many natural products such as edible fruits (apples, plums, peaches, cherries, etc.), berries of mountain ash, hawthorn and *Sorbus domestica*, tobacco, algae, and red seaweed. In spite of its wide occurrence, natural materials are not a good commercial source of sorbitol, and it is made synthetically. The content of sorbitol in grapes is insignificant and advantage is taken of this situation by using a sorbitol assay of grape wines as a means of detecting adulteration with other fruit wines or apple cider.



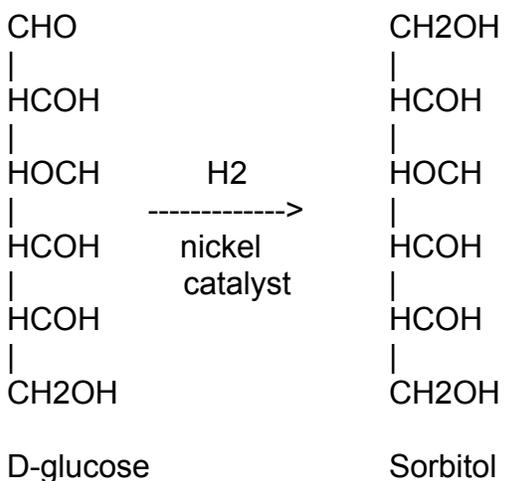
This sugar alcohol has been synthesized by the reduction of D-glucose, D-fructose, L-glucose and D-mannose. The most important commercial processes are the electrolytic and high pressure hydrogenation of D-glucose (dextrose), although the electrolytic method is gradually fading out of the picture. For reference purposes, the relationship of the ring formula of a hexose to the open aldehyde form is presented below:



The cyclic and open aldehyde structure are related to each other as tautomeric compounds. If a small amount of aldehyde configuration is removed by a chemical reaction, a fresh amount forms to restore equilibrium.



Both batch and continuous catalytic hydrogenation processes are employed. Corn sugar is the most common source of glucose, but hydrolyzed starch may also be used. The catalyst is nickel on diatomaceous earth. The reaction is run at 140°C and 125 atmospheres. Sorbitol solution is purified by ion-exchange resins and filtered through a bed of activated carbon. Sorbitol is sold as a 70% solution, and as a crystallized product in both powder and pellet form. The reaction can be shown in a simplified manner:





A variety of synthetic routes to sorbitol have been studied in the laboratory as follows:

1. Chemical reduction of glucose by means of sodium amalgam.
2. Chemical reduction of glucose by cyclohexanol or tetrahydrofurfuryl alcohol in the presence of Raney nickel.
3. Reduction of D-fructose or L-sorbose.
4. Hydrolysis and hydrogenation of sucrose.
5. Hydrogenation of invert sugar.
6. Hydrogenation of hydrolyzed lactose.
7. Reduction of the t and s-lactone of D-gluconic acid.



USES AND APPLICATIONS

Hexitols and their derivatives are used in many diverse field including foods, pharmaceuticals and cosmetics, textile and plymers. Aquous solution (sorbitol) are hygroscopic and are used as humectants, softeners and plasticizers in many different types of formulations, the hydgroscopicity of sorbitol solution is less than than that of glycerol but greater than sugar solutions. In crystalline form sorbitol does not absorb moisture greatly below the level of 70% relative humidity. Above this level, sorbitol is deliquescent and will dissolve in absorbed water. The uses of sorbitol are in the following fields.

FOOD :- Sorbitol imparts body and texture as well as some sweetness to frozen desserts Sorbitol is used in forzen desserts for diabetics where its slow rate of absorpion, followed by conversion to fructose in the liver results in a prolonged, slow supply of fructose, considered to be of advantage to the diabetic. For frozen diary desserts and mixes, FDA regulation permit sorbitol to be used as a nutritive sweetener at level not to exceed good manufacturing practice, defined as 17%. In the manufacture of sugar less chewing gum, both mannitol and crystalline sorbitol provide the water soluble solids. In some instances, a 70% aqueous solution of sorbitol is used in this application to provide the proper plasticity. Sorbitol resists fermentation to acids by microorganism in the mouth and therefore is believed not to contribute to the incidence of dental caries.

In artiffically sweetened canned fruit, addition of subtle syrup provide body. Sarbitol has property of reducing the undesirable aftertaste of saccharin. It sequesters metol ions in canned soft drinks and a sequesters iron and copper ions in wines.



Thereby preventing cloudiness from compounds of these metals. In candy manufacture sorbitol is used in conjunction with sugar to increase shelf life. It is used in making fudge, candy cream centers, soft and grained, marshmallows and in other types of candy where softness depends upon the type of crystalline structure. The function of sorbitol in this application is in retarding the solidification of sugar often associated with stoniness in such candy. In butter creams, an additional benefit is involved in flavor improvement by its sequestering action on trace metals. Sorbitol may be used in diabetic chocolates. Sorbitol is used as a humectant and softener in shredded coconut having a decided advantage over the invert sugar often used, since darkening of the product does not occur. A small quantity of sorbitol as the 70% aqueous solution added to peanut butter has been shown to reduce dryness and crumbliness and improve spreadability.

PHARMACEUTICALS

Sorbitol finds uses as body agent in pharmaceutical syrup and elixirs. The uses of sorbitol in cough syrup reduce the tendency of bottle cap to stick due to crystallization of sugar present. Uses of sorbitol enable preparation of troches with different degrees of hardness of direct compression sorbitol is used in enema solution manufacture of vitamin C starts with the conversion of sorbitol to L-sorbose.

Sorbitol and xylitol have been used for parenteral nutrition following severe injury, burns or surgery.

COSMETICS

It is widely used in cosmetic applications both as a humectant in which it retards the loss of water from o/w type creams, and as an emollient spreadability and lubricity of the emulsion are enhanced by aqueous sorbitol solution. Sorbitol is useful in both brushless and lather type shaving creams as humectant and plasticizers.



TEXTILES

Sorbitol sequesters iron and copper ions in strongly alkaline textile bleaching or scouring solution. In composition for comparing permanent wash and wear properties on cotton fabrics, sorbitol is a scavenger for unreacted formaldehyde and is a plasticizer in soil resistant and soil clear finishes.

POLYMERS

In combination with various metal salts sorbitol is used as a stabilizer against heat and light in PVC resins and with a phenolic anti-oxidant, as a stabilizer in uncured styrene-butadiene rubber compounding. Heat sealable films are prepared from a dispersion of sorbitol and starch in water. Incorporation of sorbitol in collagen film greatly restricts their permeability to carbon dioxide.

Recommendation:-

Central Foods Technological Research Institute, Mysore (CFTRI) recommends use of Sorbitol in Bakery products. The odverse effects of artificial sweetness on dough used for making biscuits and sweet breads can be over come by adding sorbitol. CFTRI has reported satisfactory result after using 10%, 30% Sorbitol along with artificial sweeteners used in place of sugar during dough preparation.

B.I.S. SPECIFICATION

IS- 4750 - (1977) - Sorbitol Food Grade

IS- 3987 - (1983) - Sorbitol solution (70%) for Cosmetic industry.

For more Information contact at:

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg,

New Delhi-110 002

91 11 23238821,23233375,23239402

91 23238821, 23239399 (Fax)

sales@bis.org.intandards Institution.



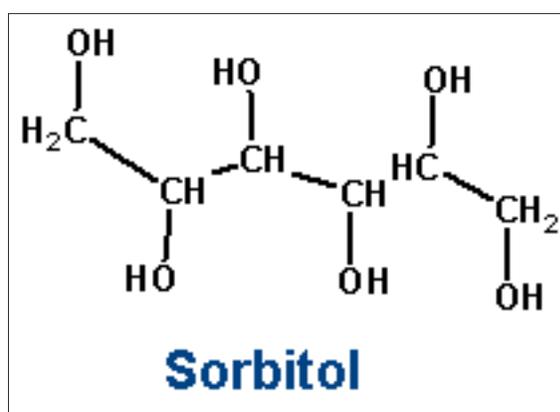
Sr.No.	Sales Outlets Address	Telephone No/Fax/e-mail
01.	Director (Sales) Manak Bhawan, 9, Bahadur Shah Zafar Marg New Delhi-110 002	91-11- 23238821,23233375,23239402 91-23238821, 23239399(Fax)
02.	Western Regional Office Manakalaya, Plot No. E-9, MIDC, Road No. 8, Behind Telephone Exchange, Andheri (East), Mumbai-400 093	Phone 022-28329295 Fax 28374231 Email: saleswro@bis.org.in
03.	Eastern Regional Office 5, Chowringhee Approach P.O. Princep Street, Kolkata-700 012	033-232053243 91-33-23377459(Fax) ero@bis.org.in
04.	Northern Regional Office SCO 335-336, Sector 34-A Chandigarh-160 022	91-0172 2665512 91-0172 2602025 (Fax) 910172-2609285, 2664750,2624136(PBX) nro@bis.org.in
05.	Southern Regional Office C.I.T. Campus, IV Cross Road Chennai-600 013	91-044-22542315, 22541584,22541470 91-044-22541087 (Fax) sro@bis.org.in

NOTE :- The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.



MARKET POSITION OF SORBITOL INDUSTRY

Sorbitol, a hexavalent sugar alcohol is a common constituent in many edible fruits. Although known since many decades, it could not find any commercial application, as its extraction from fruits was very expensive.



Sorbitol was first isolated from the juice of mountain ash berry in 1872 by the French chemist, Joseph Bovsingavit. However, both the small yield and the high price of the finished product did not offer any inducement for the industry to employ sorbitol. Its importance was recognised later only after the large scale economical manufacture of sorbitol from the commercially available glucose became possible by catalytic reductions with hydrogen. During the last few decades, numerous industrial uses of sorbitol were established in Europe, USA, Japan and elsewhere in the world, to make it one of the important industrial chemicals, with innumerable applications in a large number of industrial processes. The versatile and unique properties of sorbitol came to be known to the Indian industry only during the last two to three decades. Even today, the indigenous industries are not yet familiar with the varied and versatile properties of sorbitol and its applications in industrial processes.



Properties

Commercially, sorbitol is generally marketed in the form of 70% solution, as a clear colorless or faint yellow syrupy liquid, with a sweet cooling taste. It is chemically classified as a polyhydric alcohol. Being a hexavalent alcohol, it is closely related chemically to the bivalent glycol, ethylene glycol and glycerol. However, unlike glycols and glycerol, sorbitol occurs as a white solid substance. In an aqueous solution of 70% w/w strength, sorbitol has many common properties of glycols and glycerol, which make sorbitol a good substitute. Sorbitol is chemically inert and therefore compatible with many chemical substances, which makes it useful in cosmetic and pharmaceutical formulations and minimise the dangers of any side reactions. Sorbitol liquid (70%) hardly reacts to fluctuations in environmental humidity. This makes sorbitol liquid a good humectants (water stabilizer). A good humectant should stabilize the water content, i.e. not respond to moisture fluctuations of the environment to any considerable degree and must, therefore, not be too hygroscopic. While glycols and glycerol belong to the highly hygroscopic group of substances, sorbitol liquid 70% is only moderately hygroscopic. Therefore, optimum softening and flexibility effects in a product may be obtained with sorbitol liquid along or in combination with glycols, glycerol and other humectants. As a humectant plasticizer sorbitol is now increasingly used either alone or in combination with glycerol in the gelatin capsule industry, printing ink formulations, cosmetic emulsions and tobacco processing. Sorbitol is non-volatile with steam, contrary to glycerol and other polyalcohols. This makes the use of sorbitol economical. For example, during the roasting process of tobacco, the water polyalcohols mixture is to be heated with steam and the lower polyhydric alcohols (like glycerol) are lost by evaporation with the consequent loss of active substances. Also, at normal temperatures, the nonvolatile character of sorbitol has a beneficial effect, especially in products with large surfaces. Such is the case during the storage of cut tobacco, paper, foils, bottle capsules and others. The lower alcohols in the place of sorbitol will gradually evaporate and thus the products may lose flexibility, whereas with sorbitol liquid, this risk is eliminated with advantage. The non-volatile nature of sorbitol liquid also makes it useful either alone or in combination with glycerol, in textile dressing, dyeing and printing.

To summarise, the principal advantages which sorbitol exhibits over other polyols are:

w Sorbitol gives up water very slowly to dry atmosphere w Sorbitol takes up water very slowly from a humid atmosphere Sorbitol liquid does not, like the lower alcohols, destroy foam. For this unique property, sorbitol liquid is particularly of value for the formulations of products, where a high grade foaming capacity is the essential mark of quality, such as shaving creams, shaving soaps and other cosmetic preparations. In addition, sorbitol liquid does not promote electrical charging. It has considerable anti-static activity. This antistatic activity provides certain advantages in textile finishing and paper processing.

The relatively non-toxicity of sorbitol, further, is a distinctive advantage, when compared to the toxicity exhibited by ethylene glycol in internal use. This non-toxicity has made possible the extensive use of sorbitol in oral pharmaceutical formulations and edible gelatin capsules. For the same reason, the Food and Drug Administration permits the use of sorbitol in the manufacture of wrapping papers for foodstuffs. Dermatologically, also, sorbitol is innocuous and, therefore, can safely be incorporated in cosmetic and dental formulations. Sorbitol powder is preferred in the preparation of sorbitol based esters and polyethers.

Applications

In general, hexitols and their derivatives particularly Sorbitol, are used in diverse industries, viz. pharmaceuticals, cosmetics, toothpastes, cigarettes, foods, textiles, adhesives, confectionery, printing ink, etc. One of the major uses of sorbitol is as a humectant and conditioning agent. Many products under day-to-day atmospheric changes require the addition of a humectant to assist them to retain their freshness, softness and flexibility and to maintain ideal manufacturing conditions.



Confectionery

In candy manufacture, sorbitol is used together with sugar to increase shelf life. The function of sorbitol is to retard the solidification of sugar often associated with staleness in candy. It also helps to improve softness, taste and texture. In butter creams additional benefit is enhanced flavour. Sorbitol may be used in diabetic chocolates. Sorbitol is used as humectant and softener in shredded coconut, its decided advantage over invert sugar being that the darkening of the product does not occur. Sorbitol 70% added to peanut butter has been shown to reduce dryness and crumbliness and improve spreadability.

Textiles

Sorbitol functions in textile applications basically as a dispensing agent, humectants bodying agent and sequestering agent. In printing, a paste of 2% to 3% sorbitol solution 70% (on the weight of the gum in the dye paste) prevents levering of the paste, improves brightness and intensity of colour, assists penetration, prevents bleeding and promotes leveling.

In textile sizing, sorbitol acts as a humectant and especially in winter it preserves the film of adhesive from becoming dry and maintains its plasticity. In finishing, it gives a soft feel, good drape and proven dimension stability to the fabric.

Tobacco

The moisture content of cigarettes is very important, and change in moisture content, due to change in humidity, is minimised if sorbitol is used as conditioner. Also sorbitol is non-volatile and hence there is no danger of losing the conditioner during drying and other pressing operations. Sorbitol is compatible with various ingredients used in tobacco mixture. Because of its sweetness and cooling taste, sorbitol contributes to the flavour of chewing tobacco besides conditioning the product.



Table 1 Typical Specifications of sorbitol (70%)	
Particulars	Non-Crystallising Sorbitol
Description	A clear colourless viscous liquid.
Taste	Mild sweet
Specific gravity at 25°C	1.285 Min
Refractive index at 20°C	1.455-1.465
Reducing sugar	solution as per specified test in I.P. NLT 12.8-ml of 0.05 M sodium thiosulphate solution should be consumed as per specified test in I.P.
Optical rotation	+1.5 to +3.5 (as per specified test in I.P.)
Clarity & color	Clear & colourless
Arsenic	NMT 2-ppm
Heavy metals	NMT 10-ppm
Chloride	NMT 50-ppm
Sulphate	NMT 125-ppm
Nickel	NMT 1-ppm
Sulphated ash	NMT 0.1% w/w
Solid matter	68% to 72% w/w
Polyols	NLT 62% w/w as D-Glucitol
NMT: not more than; NLT: not less than	

Adhesives

Sorbitol is the ideal answer since it neither loses nor absorbs any appreciable quantity of water, unlike conventional humectants like glycerine or ethylene glycol. Sorbitol increases the viscosity of the glue composition so that more water is needed, resulting in greater economy. Sorbitol functions as a moisture conditioning agent and its non-volatility ensures non-cracking labels and envelopes with minimum of curling.

Pharmaceuticals

Sorbitol finds use as a bodying agent in pharmaceutical syrups and elixirs. The use of sorbitol in cough syrups reduces the tendency of the bottle caps to stick due to the crystallisation of the sugar present. Sorbitol is a good humectant and plasticiser and these properties make it useful in emulsion ointments, non-fat soluble ointments and gelatine capsules. Ointments, creams and pastes will show satisfactory spreading capacity with sorbitol as adjuvant. Aqueous sorbitol solutions are not subjected to fermentative decomposition, and that is why sorbitol finds increasing use in the preparation of dental formulations for buckle cavity.

Cosmetics

Sorbitol is widely used in cosmetics, both as a humectant to retard loss of water from oil in water (O/W) type of creams and as an emollient. Sorbitol solution 70% has proved a useful additive for improving the aesthetic appeal of glycerine carbolic soap by imparting better transparency. Generally speaking, sorbitol solution 70% can replace other humectants, by weight where the humectants percentage is less than 10%.

Toothpaste

Sorbitol effectively replaces glycerine and sugar in toothpastes imparting the required degree of plasticity and sweetness, humectant and plasticizing properties of sorbitol.

Skin cream and cream foundation

Sorbitol replaces glycerine as humectants and conditioning agent and helps to reduce the greasiness as well as the particle size of the dispersion.



Emulsion

Sorbitol retards the loss of water by evaporation from oil-in-water emulsion and is more effective than glycerine of the same concentration when this is less than 10%.

Foods

Sorbitol imparts to frozen desserts, body and texture, as well as some sweetness. Sorbitol is used in frozen desserts for diabetics because it is slowly absorbed from the intestine and is metabolised as fructose. In the manufacture of sugarless chewing gum, sorbitol provides water soluble solids; further a 70 per cent solution of sorbitol resists fermentation of acids by micro-organisms in mouth and therefore it is believed not to contribute to the incidence of dental caries. In artificially sweetened canned fruits, the undesirable aftertaste of saccharine is avoided by use of sorbitol. In low-caloric soft drinks, sorbitol finds use as a bodying agent, in addition to its use as a sequestering agent in canned soft drinks.

Diabetic diets

Extensive research has led to the adoption of sorbitol to substitute sugar as sweetening agent in diabetic diets.



LIST OF MANUFACTURERS OF SORBITOL

Vijaya Enterprises

Address: No. 227, 2nd Floor, Udyogkshetra,
Industrial Estate, Mulund Goregaon Link Road,
Mulund West, Mumbai, Maharashtra - 400 080, India
Phone: +(91)-(22)-25623903 / 25623905
Fax: +(91)-(22)-25919012
Mobile: +(91)-9821011480
Website: www.vijayaent.com/

Devson Impex Private Limited (Head Office)

Address: Gr 24, T V Industrial Estate,
248 Worli Road, S.k Ahire Marg, Mumbai,
Maharashtra - 400 030, India
Phone: +(91)-(22)-24953501 / 61119222
Fax: +(91)-(22)-24939740 / 61119292
Mobile: +(91)-9323853501
Website: www.devson.in/gluconates-ascorbates.html

Food And Biotech Engineers India Private Limited

Address: Chaprola Road, Prithla, Tehsil- Palwal,
District - Faridabad, Faridabad, Haryana - 121 102, India
Phone: +(91)-(1275)-262157 / 262158
Fax: +(91)-(1275)-262259
Mobile: +(91)-9312069945
Website: www.dairyfoodtech.com/

A. B. Enterprises

Address: No. 202, Shradanand Building - 272/ 274,
Samuel Street, Mumbai, Maharashtra - 400 003, India
Phone: +(91)-(22)-23435097 / 66312586
Fax: +(91)-(22)-23435097
Mobile: +(91)-9869434794 / 9892424605
Website: www.abenterprisesindia.com/chemicals.html



MANUFACTURE OF SORBITOL FROM MAIZE STARCH

Sorbitol can be manufactured from maize starch by simultaneous hydrolysis and hydrogenation using a nickel catalyst and pressures of approximately 100 atmospheres. The presence of certain metallic salts e.g. magnesium, nickel or calcium chloride improves the efficiency of the conversion and can be accomplished by two steps.

1. Conversion of Maize starch into liquid glucose/Dextrose on hydrolysis.
2. Conversion of Dextrose/liquid glucose into sorbitol on hydrogenation under high pressure.

Conversion of Maize Starch into liquid glucose:-

The raw materials required for the manufacture of glucose are starch and mineral acid; Amylolytic enzymes may also be used for starch hydrolysis. The conversion of starch to glucose takes place through a series of steps in which carbohydrates of progressively decreasing complexity-soluble starch, dextrans like amylo dextrin, erythro dextrin and achro-dextrin, maltose and dextrose-are formed. The composition of the hydrolysate is determined largely by the concentration and temperature of the acid used for catalysing the hydrolysis. For the manufacture of glucose a starch suspension in water containing 35-40% starch is mixed with sufficient hydrochloric acid to give a concentration of 0.012 to 0.02N acid in the final mixture and heated in an autoclave to a temperature of 140-160. The product is held at this temperature for 15-20 minutes. The reaction mixture is tested with iodine and if not starch is present, as indicated by the colour test the pressure is released and the liquid transferred to a neutralizing tank. The acid is neutralized with soda ash. Proteins, fats, fatty acids, and colloidal material are coagulated by adjusting the pH to 4-3. The mixture is passed through a filter press, the filtrate is decolourised by activated carbon and the clear filtrate concentrated in a triple effect evaporator. Treatment with activated carbon is repeated and the liquid further concentrated in a vacuum pan. The concentrated syrup (40-45~ Be) is quickly cooled and transferred to storage silos. The product obtained contains 43% dextrose on dry basis. Glucose is prepared also by enzymic conversion of starch or by a combination of acid conversion, neutralisation and enzymic conversions (U.S. Patent 2,201,609 of 1940)



RAW MATERIALS

The principal raw materials required for the manufacture of glucose is starch. Excepting glucose and foods Ltd. who purchase their requirement of maize starch, other factories utilize upto 20% of their any productions of maize starch. Maize was being imported from U.S.A. for making starch but the price of maize was reported to be somewhat higher than that of imported starch. Efforts have been made to use indigencous tapioca starch as the raw material. In fact Kamla Sugar Mills Ltd. have attempted to utilize only tapioca starch for the manufacture of dextrose.

The manufacturing process employed in India is the same as that in use in other countries. Maize starch is suspended in water and cooked after adding hydrochloric acid, in a converter under a pressure of 30 lbs/inch. For 15 minutes the hydrolysis is interrupted when a test sample of the hydrolysate fails to give a blue coluration with codine. The pressure is released and the charge run into a wooden vat, where it is neutralised with a solution of soda ash and the reaction adjusted to the Iso electric point to coagulate colloidal impurotoes. The liquor is filtered decolorized with activated carbon and filtered again. The filtrate (20oBe) is concentrated to 30-32 Be under vacuum , when all inorganic salts other than sodium chloride precipitate out. The syrup is treated with activated carbon, filtered, and concentrated to 45 Be.

Convesrsion of Liquid Glucose/Dextrose into Sorbitol:-

The catalytic hydrogenation of dextrose yield sorbitol Dextrose is dissolved in worm distilled water until, 50% solution is obtained. The final solution contains small amounts of inorganic salts which could poison the catalyst during hydrgenation. These impurities are removed by passing, the solution through a catonic anionic exchange system.

In the batch process, catalyst is prepared Just prior to hydrogenation by treatment of Raney nickel, which is an aluminum-nickel alloy containing about 50% nickel by wt. The catalyst is activated by dissolving aluminium from the matric via treatment with warm (6p°C) 25% caustic soda. Aluminium is dissolved from the matrix and treatment with deionized water removis the sodium aluminate which is formed. Catalyst is fed in slurry from to a hydrogenation reactor by the use of nitrogen under pressure. A typical concentration of catalyst is 2% nickel (based on glucose).

After catalyst and deionized dextrose solution are charged into the pressure auto clave/reactor the hyrogen flow is started and hydrogenation takes place at about 1000 ps ig and upto 3 hr of time During the reaction the process temperature in controlled below 150°C.

Upon completion of reaction auto clave/pressure is reduced by venting hydrogen to a gas holder, but sufficient pressure is maintained to move reaction products out of the auto clave/reactor crude sorbitol solution is then passed through two filter system for romoval of catalyst. Since the catalyst is pyrophonic it is recycled to the auto claves without coming in contact with air.



The freshly made sorbitol solution is purified by passage through a three stage deionization system that contain a cationic, anionic and mixed bed column Metallic cations (Such as nickel) are removed in the first stage, and gluconate anions are absorbed in the second. Further treatment may be given with activated carbon to remove trace organic impurities.

Deionized solution contain about 50% sorbitol commercial sorbitol of 70% concentration is the result of evaporation at 45- 50oC under a low pressure of 50 - 80 mm Hg crsystalline sorbitol is obtained by further concentration and crystallization and is sold in both pellet and powder form.



DETAIL OF ACID ENZYME HYDROLYSIS

Starch Make - Up Tank

In the acid - enzyme process starch, Hydrochloric acid and water are introduced into the starch make up tank in which hydrolysis of starch occurs with HCl and water content. The contents are well mixed.

Acid Hydrolysis

After perfect mixing operation in the starch make up tank, it is fed to convertor (Acid hydrolysis tank) add same neutralizing agent viz NaClO₃. Apply steam to convertor for heating. In this acid hydrolysis tank, temp and pressure control is well maintained. For minimum colour on the temp should be kept or low and the reaction time as short or possible by using higher acids concentration then desired 10 - 15%. D.E (Dextrose Equivalent) is achieved. At this permanent acid hydrolysis should be stopped.

The nitrogenous compounds, the major cause of colour formation are protein, peptides, and amino acids. The smaller molecular weight materials undergo a Maillard reaction but the bigger peptides, although less deleterious in this regard are subjected to be connected with form formation. Hydroxy methyl furfural (HMF) is also formed.

The stuff is then transferred to Filtration operation, where proteins and impurities are removed.



FILTRATION

So, after completion of the hydrolysis, the liquor is filtered and introduced into reaction vessel. Where it is treated with activated carbon active charcoal or ion-exchange resin to remove colour ash and other minor impurities. This acts as a decolorizer to remove the colour of starch. The purification of starch hydrolysates is significant from the point of view not only of decolorisation, but also of the removal of colorless contaminants in order to prevent discoloration at a later date during storage or use.

FILTRATION & EVAPORATION

The stuff after the reaction vessel is based length plate frame type. Filter press is transferred to evaporator (Flash Chamber) where the liquid slung of starch is evaporated to 60% solids.

Cooling :-

It is then transferred to a cooler where the stuff is cooled to 55°C and PH is adjusted between 4.4 - 5.0.

SACCHARIFICATION

Saccharification convertor

It is then transferred to saccharification convertor of in which saccharification process takes place. Preliminary liquefaction of the starch goes in a continuous steam, through a system of reaction tubes under pressure. An essential feature of the process is that the heating is carried out indirectly in a tube heaters.



In the saccharification convertor, temp is maintained as 55°C but not to exceed 58°C into this convertor, rhizotus nives glucosid enyme is introduced into the system which brings in the connection of starch moleull into dextrose lime.

For accomplishing crystalline glucose. The system is adapted to take account of the requirements to be wet such as make dialute starch suspensions, higher acidity and higher temperature, to produce this material. even when these factors are satisfactorily adjusted it is formed that a long reaction time is required and this is obtaines by first, reducing the through put of the plant and later by increasing the length of the reaction zone.

Time or 48 - 60 hours is taken for total sugar manufacture with DE (Detrose Equvalent) of 97.6 - 98. For solilified wether liquar from crystalised dextrosed DE 98.5 - 99.

The preliminary gelatinisation which is essential for effective hydrolysis can be carried out by heating a 30 - 40% by weight suspension of the starch in dialute acid under pressure until a DE value of 10 20 is attained.

It has been visulised that using 0.14% ozalic acid on weight of starch takes into consideration DE 10 - 13 to be at the optimum for liquifi9cation. To extensive thinning with acid leads to loss of efficiency in the saccharification step, but the above value has been proved to be optimum. The liquar is then adjusted to the optimum PH value for the particular enzyme

Preparation to be used. A pH range between 4.0-5.5 is usal but with the enzymes from pH lies between 4.4 and 4.8 and the batch is adjusted to pH 5.0 since it tends to fall during the reaction.



The liquor is then pumped to the conversion tank, the enzyme added after the temperature has been adjusted preparation to 55°C and maintained at that temperature for the rest of the dwell time. According to the amount of enzyme added this way range from 24 to 96 hours when a maximum conversion of 95-96 DE is attained. After completing the conversion the liquor is filtered and processed further by the normal process used in the straight acid conversions.

The resulting syrups having DE values of 96-97 can be used to produce crystalline Dextrose or dextrose monohydrate by well established method.

A process has been developed in the production of syrups of 35-50% DE an acidified starch slurry of 22° Be' is introduced by means of a metering pump into stream of the same solution that has been prehydrolysed at 124°C in the mixing chamber which results in a drop in temperature to 118°C. Here it is subjected to intensive mixing so that each individual starch particle is gelatinised and liquified in an extremely short time without coming into contact with the hot wall of the heater. Consequently, there is no lump formation, and the rise in viscosity is negligible. Some of the glucose syrup can be drawn off from the process from an early part of the heating zone. While the remainder passes the full length of the reaction tube and is processed for the manufacture of crystalline dextrose. The stream then passes through the heat exchanger for deactivation 3mm at 100°C.

The transformation for heat exchanger may be carried out by a circulation pump which handles 14 times the quantity supplied by the heat pump and in the heat exchanger the solution is heated to 124°C in turbulent flow with Reynolds numbers up to 800.

The solution leaves the circuit with a DE of 5-4 % and its temperature is raised to 144°C in the next exchanger. This is necessary to achieve the desired degree of conversion of 42% DE in the reactor. The liquified flows via an expansion valve, which maintains the pressure in the system.



DECOLORISATION & FILTRATION

It is then transferred decolorization unit using carbon filtration, accompanied by evaporate to Be 45-50° active carbon followed by filtration. The liquors can be refined by mixing with charcoal and passing through two stages of the reaction tube under controlled conditions of temperature and time, each stage being followed by a filter press.

As enunciated about, it has been observed that DE and the dextrose content of the liquor increases as the concentration of solids is reduced with a 20% potato starch suspension temperature at pH 1.2 and a conversion temperature of 160°C for 11 min, a DE of 95 % and a true dextrose content of 95 % on total dry solids are obtained. With maize starch at pH 1.5 for 19 minutes, the figures are DE 95%, true dextrose content 90% the further controlling the final DE are

- (1) Starch concentration.
- (2) pH
- (3) Conversion time.
- (4) Conversion temperature.

In the above system, therefore, (1) & (2) are controlled and (3) is held constant by control of the feed pumps and (4) is controlled by the deregulator.



ACTIVE CARBON TREATMENT AND FILTRATION

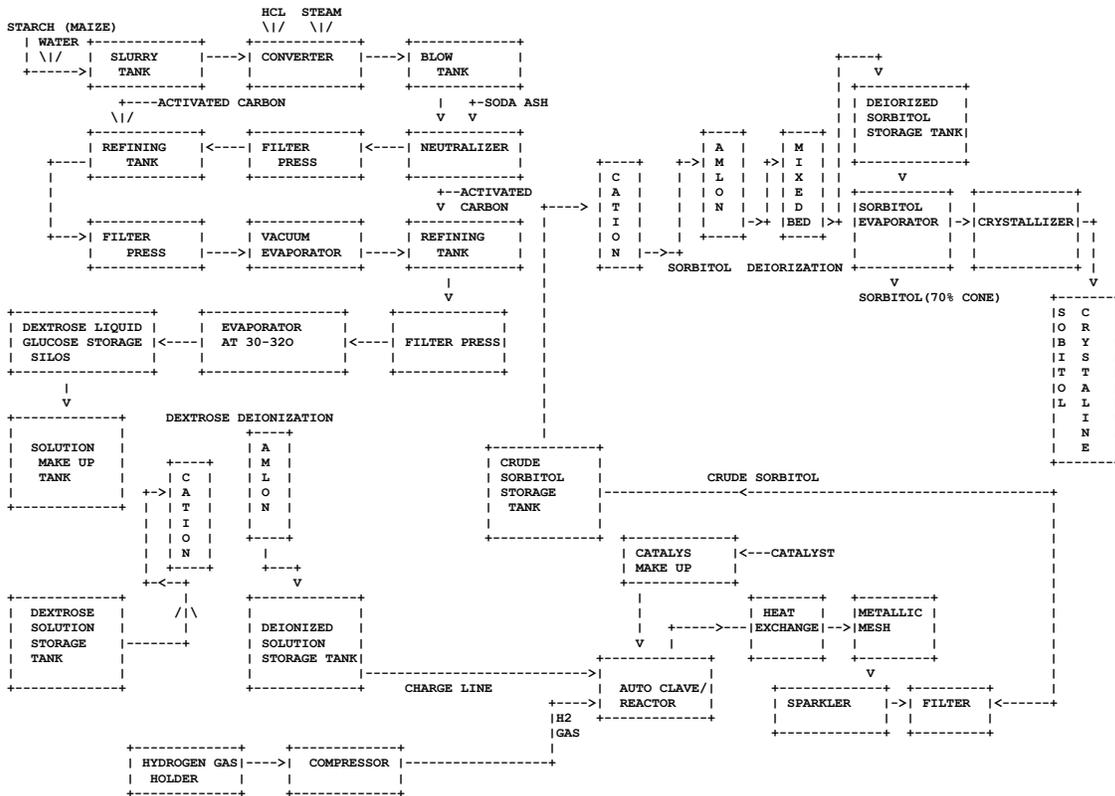
It is then classified and decolonized by treatment with tannic acid followed by active carbon (charcoal) treatment and filtration. In order to repress to a great extent the formation of gentiobiose and other condensation products which appear to be formed during the stages of the saccharification, and to remove traces of heavy metal salts.

FITER:-

The D-glucose syrup from the enzyme conversion is subjected to ultrafiltration at 20 psi. The pure saccharide is removed from the filtrate whilst the active enzymes are retained by the semi-permeable membrane and re-used.



PROCESS FLOW DIAGRAM FOR THE MANUFACTURE OF SORBITOL FROM MAIZE STARCH





SUPPLIERS OF PLANT AND MACHINERY

FILTER PRESS

Goyum Screw Press (Oil Expeller Division)
Address: Plot No. 324/2, Industrial Area A,
Ludhiana, Punjab - 141 003, India
Phone: +(91)-(161)-4633180 / 5084180
Fax: +(91)-(161)-2230380
Mobile: +(91)-9915065000 / 9814033180
Website: www.oilmillmachinery.com/filter-press.html

Vihar Engineering
Address: 9, Kembros Industrial Estate,
Sonapur Lane Behind Asian Paints,
Bhandup West, Mumbai, Maharashtra - 400 078, India
Phone: +(91)-(22)-25660821
Mobile: +(91)-9820778915 / 9819582526
Website: www.blenderandmixer.com/liquid-processing-equipment.html

Kumar Metal Industries Private Limited
Address: 101, Kakad Bhavan, 30th Road,
Opposite Gaiety, Galaxy Cinema, Bandra West,
Mumbai, Maharashtra - 400 050, India
Phone: +(91)-(22)-28458300 / 26441673
Fax: +(91)-(22)-28454346 / 28456263
Website: www.oilmillmachineries.com/oil-mill.html



HEAT EXCHANGER

Advance International - India
Address : 501-a, Hemkunt Chambers,
89, Nehru Place, New Delhi India
Phone(s) : 91-11-26234501 / 26234502
Mobile : +91-9313121478 / 9312355720
Fax(s) : 91-11-26234503
Website : www.advanceinternational.co.in

Balbinder Engineering - India
Address : Ingoriya Road, Nagda,
Madhya Pradesh India
Phone(s) : 91-7366-241128
Mobile : +91-9827233682 ,
Mr Dinesh 09907608131
Website : www.bansalfabricator.com

Technosol Engineers - India
Address : 212, Shakuntal Complex,
Waghodia Road, Vadodara, Gujarat India
Phone(s) : 91-265-2518510
Mobile : +91-9426503993 / 9173989693
Website : www.technosolengineers.in

Badrin Industries - India
Address : 65/1, Rukamani Street,
Krishnapiram Ambattur, Madras- 600053,
Chennai, Tamil Nadu India
Website : www.badrinindustries.com

Gmp Systech Eingeering Pvt . Ltd. - India
Address : E - 46 / 2 / 3 & 4,
Behind Garware Stadium,
Chikalthana Industrial Area,
AURANGABAD, Maharashtra India
Website : www.gmpsystech.com



VACUUM PAN EVAPORATORS

Noble Procetech Engineers

Address: 3, Gunjan Plaza, Ram Nagar,
Pathardee Road, Near Day Care School,
Nashik, Maharashtra - 422 009, India

Phone: +(91)-(253)-6612267 / 2372831

Mobile: +(91)-9822060464

Website: www.nobleprocetech.com/dosing-systems.html

Crystal Engineers

Address: No. 207, Indulal Complex,
L. B. Shastri Road, Navi Peth, Pune,
Maharashtra - 411 030, India

Phone: +(91)-(20)-24530532 / 6451404

Fax: +(91)-(20)-24530554

Mobile: +(91)-9822009549 / 9227733535

Kirti Enterprise

Address: Kavery, No. 20, Smart Industrial Area,
Near Gondal Road, Behind S. T. Workshop,
Rajkot, Gujarat - 360 004, India

Phone: +(91)-(281)-2365359 / 2365802

Fax: +(91)-(281)-2365802

Mobile: +(91)-9227607113

C.B.M. Engineering

Address: Radaur Road, Village Jorian,
Yamunanagar, Haryana - 135 001, India

Mobile: +(91)-9996925845 / 9996925847



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Geeta Food Engineering
Address: No. 12, Ground Floor,
Electronic Co - Operative Estate Ltd,
Pune - Satara Road, Pune,
Maharashtra - 411 024, India
Phone: +(91)-(20)-32313040 / 32314724
Mobile: +(91)-9326724704

Aromen Engineering Company Private Limited
Address: No. 167, Aromen Industrial Estate,
Kaliyapuram Road, Thirumalayampalayam Post,
Coimbatore, Tamil Nadu - 641 105, India
Phone: +(91)-(422)-2656495 / 2656496
Fax: +(91)-(422)-2656497
Mobile: +(91)-8144914481 / 8144914486
Website: www.sugarfab.net/sugar-boiling-equipment.html

BOILER

Kumar Metal Industries Private Limited
Address: 101, Kakad Bhavan, 30th Road,
Opp. Gaiety Galaxy Cinema, Bandra (West),
Thane - 400 050, India
Phone: +(91)-(22)-26441667 / 26441664 / 26441663
Fax: +(91)-(22)-26428136
Website: www.solvent-extraction-plant.com/oil-seed-plants.html

Milkon Heavy Engineering Company
Address: 1202/3/15/E, Chandrashil Appt.
Ghole Road, oppt. Surya Hotel,
Deccan Gymkhana, Pune - 411 004, India
Phone: +(91)-(20)-27120834
Fax: +(91)-(20)-27124629
Mobile: +(91)-9923085000 / 9860087875
Website: www.milkonheavyengineering.com/dairy-equipment.html



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Excel Plants & Equipment Pvt Ltd
Address: Gate No. 611, Mouje Kuruli,
Chakan M. I. D. C., Tal- Khed, Pune - 410 501
Phone: +(91)-(2135)-679717 / 32334808 / 679704
Mobile: +(91)-9822094773 / 8149223600
Website: www.excelplants.com/

South Asia Metal & Alloys
Address: Shop No. 9, Ground Floor,
Sonarika Building, No. 25 / C, Chandawadi,
C. P. Tank Road, Mumbai - 400 004, India
Phone: +(91)-(22)-66595840
Mobile: +(91)-9833447374
Website: www.inconel-monel-hastelloy.com/

REACTORS

Dipesh Engineering Works
Address: Sej Plaza, 1-3, 3rd Floor,
Junction Of S. V. Road & Marve Road,
Near Nutan High School, Malad West,
Mumbai, Maharashtra - 400 064, India
Phone: +(91)-(22)-40736736
Mobile: +(91)-9323931873
Website: www.jbpatelgroup.com/agitators.html

Raymer Engineering
Address: No. 20, Thakkar Industrial Estate,
3rd- Floor, Unit No. 7, Chapsi Bhimji Road,
Mazgaon, Mumbai, Maharashtra - 400 010, India
Phone: +(91)-(22)-23774333
Mobile: +(91)-9322262743 / 9220814009
Website: www.raymerengineering.com/ball-mill.html



PM Industries

Address: Gate No. 53,

Chikhali - Dehugaon Road,

A. P. Talawade, Pune,

Maharashtra - 412 114, India

Phone: +(91)-(20)-27690777 / 27690888

Fax: +(91)-(20)-27690777

Mobile: +(91)-9890609531

Website: www.pmindustriesindia.com/plough-shear-mixer.html

PUMPS & PUMPING EQUIPMENT

Advanced Technocracy Inc.

Address: Atico House No. 5309, Grain Market,

Near B. D. Senior Secondary School,

Ambala - 133 001, India

Phone: +(91)-(720)-6699349

Fax: +(91)-(171)-4007718

Mobile: +(91)-9996186555 / 9034949132

Website: www.electronicinstrumentsmanufacturer.com/scientific-instruments.html

Milkon Heavy Engineering Company

Address: 1202/3/15/E, Chandrashil Appt.

Ghole Road, oppt. Surya Hotel, Deccan Gymkhana,

Pune - 411 004, India

Phone: +(91)-(20)-27120834

Fax: +(91)-(20)-27124629

Mobile: +(91)-9923085000 / 9860087875

Website: www.milkonheavyengineering.com/water-treatment-consumables-equipment.html



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Fluidyne Instruments Pvt Ltd
Address: No-3, 1st Floor, Uday Building,
70-D Central Avenue Road
Next to Hotel Grand Central,
Near Chembur Station, Chembur (East),
Mumbai - 400 071, India
Phone: +(91)-(22)-25285345 / 25280073
Fax: +(91)-(22)-25280642
Mobile: +(91)-9821027547
Website: www.fluidyneindia.com/barrel-transfer-pump.html

Prosun Energy Private Ltd
Address: No. 195/2, R. M. T. Bungalow Road,
Sai Nagar, Industrial Estate Post,
Coimbatore - 641 021, India
Phone: +(91)-(422)-2673319
Mobile: +(91)-9894111935
Website: www.solarpowerplantsandlights.com/solar-pump.html

ION EXCHANGER

Potent Water Care Private Limited
Address: No. 32, C.S.C. - 12, G - 29,
D.D.A. Market, Sector - 3, Rohini,
New Delhi, Delhi - 110 085, India
Phone: +(91)-(11)-27512220 / 45682119
Mobile: +(91)-8750041561
Website: www.pswimmingpool.com/water-treatment-chemicals.html

Water Care Technology
Address: Shop No. 27, C. S. C. 12, G- 29,
D. D. A. Market, Sector - 3, Rohini,
Delhi - 110 085, India
Phone: +(91)-(875)-0041561
Mobile: +(91)-8750041561
Website: www.swimmingpoolexpertindia.com/water-treatment-chemicals.html



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Pool Tycoon

Address: Shop No. 32, C. S. C. 12, G - 29,

D. D. A. Market, Sector - 3, Rohini,

Delhi - 110 085, India

Mobile: +(91)-8750041561

Website: www.swimmingpoolequipments.com/ion-exchange-resins.html

Doctor H2O

Address: Shop No. 32, C. S. C. 12,

G - 29, D. D. A. Market, Sector - 3,

Rohini, Delhi - 110 085, India

Mobile: +(91)-8750041561

Website: www.swimmingpoolequipmentindia.com/sauna.html



SUPPLIERS OF RAW MATERIALS

MAIZE STARCH

Vijaya Enterprises

Address: No. 227, 2nd Floor, Udyogkshetra,
Industrial Estate, Mulund Goregaon Link Road,
Mulund West, Mumbai, Maharashtra - 400 080, India
Phone: +(91)-(22)-25623903 / 25623905
Fax: +(91)-(22)-25919012
Mobile: +(91)-9821011480
Website: www.vijayaent.com/

Vats International

Address: LD- 38, Pitampura,
Delhi, Delhi - 110 034, India
Phone: +(91)-(11)-27318917
Fax: +(91)-(11)-27311126
Mobile: +(91)-9810131850

Meru Chem Pvt. Ltd

Address: 313, ram Gopal Indl Estate,
R.p.road, Mulund West, Mumbai,
Maharashtra - 400 080, India
Phone: +(91)-(22)-25691517 / 25691516 / 65092506
Fax: +(91)-(22)-25691516
Mobile: +(91)-9223432507 / 9820196391
Website: www.chemical-supplier.net/other-chemicals.html



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Devson Impex Private Limited (Head Office)

Address: Gr 24, T V Industrial Estate,
248 Worli Road, S.k Ahire Marg, Mumbai,
Maharashtra - 400 030, India

Phone: +(91)-(22)-24953501 / 61119222

Fax: +(91)-(22)-24939740 / 61119292

Mobile: +(91)-9323853501

Website: www.devson.in/maize-starch-allied-products.html

NITROGEN GAS

Universal Industrial Plants Manufacturing Co.(P) Ltd.

Address: Okhla Industrial Area,
New Delhi, Delhi - 110 020, India

Phone: +(91)-(124)-4386250 / 6519863

Fax: +(91)-(124)-4386234

Mobile: +(91)-9810626301

Website: www.air-separation-plants.com/nitrogen-plant.html

Delhi Cryogenic Products

Address: A 4420 DLF, NCR,
New Delhi, Delhi, India

Phone: +(91)-(124)-6519870

Mobile: +(91)-9560771717

Website: www.delhicryo.com/lowpressure-cylinderfilling-oxygen-nitrogen-plants.html

Triveni Chemicals

Address: No. 135, Pancharatna Char Rasta,
G. I. D. C., Vapi, Gujarat - 396 195, India

Phone: +(91)-(260)-6618618

Fax: +(91)-(260)-6618624

Mobile: +(91)-9227788155

Website: www.trivenichemical.com/gas1.html



ACTIVATED CARBON

Air Care Equipments

Address: Dreams Aakruti, C - 102,
Plot No. 1, S. R. No. 52, Kalepadad,
Near Dhere Concrete Company, Hadapsar,
Pune, Maharashtra - 411 028, India
Mobile: +(91)-9823050371 / 9420174854
Website: www.aircareequipments.com/carbon-powder.html

Hindustan Produce Company

Address: No. 7, Clyde Row, Hastings,
Kolkata, West Bengal - 700 022, India
Phone: +(91)-(33)-22230828 / 22230110
Fax: +(91)-(33)-22230140
Mobile: +(91)-9831484682
Website: www.hindustanproduceco.com/petroleum-coke-graphite-powder-flakes-activated-carbon.html

Water Care Technology

Address: Shop No. 27, C. S. C. 12, G- 29,
D. D. A. Market, Sector - 3, Rohini,
New Delhi, Delhi - 110 085, India
Phone: +(91)-(875)-0041561
Mobile: +(91)-8750041561
Website: www.swimmingpoolexpertindia.com/water-treatment-chemicals.html

Chemicals & Associates

Address: No. 27, Ashoka Chambers 5 - B,
Rajendra Park, New Delhi, Delhi - 110 060, India
Phone: +(91)-(11)-47479797
Fax: +(91)-(11)-25755507
Mobile: +(91)-9311122878 / 8882555999
Website: www.chemicals99.com/filter-media.html



NICKEL CATALYSTS

Air Tech Engineers And Consultants
Address: AP-826, 1st Floor, G-Block,
11th Main Road, Annanagar, Chennai,
Tamil Nadu - 600 040, India
Phone: +(91)-(44)-26285409 / 65475532
Fax: +(91)-(44)-26285409
Mobile: +(91)-9840023793

Air-Tech Engineers
Address: No. 310, Gayatri Chambers,
R. C. Dutt Road, Alkapuri, Vadodara,
Gujarat - 390 007, India
Phone: +(91)-(265)-2313358
Fax: +(91)-(265)-2313358
Mobile: +(91)-9825306669 / 9898691189
Website: www.airtechengineers.net/nickel-catalyst.html

Air- N- Gas Process Technologies
Address: B - 8, Maruti Industrial Estate,
Phase - 1, G. I. D. C., Vatva, Ahmedabad,
Gujarat - 382 445, India
Phone: +(91)-(79)-40064451
Fax: +(91)-(79)-40064451
Mobile: +(91)-9879567526



CAUSTIC SODA

Triveni Chemicals

Address: No. 135, Pancharatna Char Rasta,
G. I. D. C., Vapi, Gujarat - 396 195, India

Phone: +(91)-(260)-6618618

Fax: +(91)-(260)-6618624

Mobile: +(91)-9227788155

Website: www.trivenichemical.com/chemicals-by-alphabet-c.html

B. K. Chemicals

Address: B - 2, Shrushti Apartment,
1st Floor, Near Century Enka, Colony No. 2,

Pune - Nasik Highway, Bhosari, Pune,
Maharashtra - 411039, India

Phone: +(91)-(20)-27111941

Mobile: +(91)-9371020040 / 9881418345 / 9422012096

Website: www.bkchemicals.in/industrial-chemicals-powder.html

A. B. Enterprises

Address: No. 202, Shradanand Building - 272/274,
Samuel Street, Mumbai, Maharashtra - 400 003, India

Phone: +(91)-(22)-23435097 / 66312586

Fax: +(91)-(22)-23435097

Mobile: +(91)-9869434794 / 9892424605

Website: www.abenterprisesindia.com/industrial-chemicals.html



SORBITOL FROM MAIZE STARCH [EIRI/DFR/1194] J.C. 9843
J.C. 9843

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PLANT ECONOMICS

Rated Plant capacity = 66.00 MT./day
= 19800.00 MT./annum
SORBITOL FROM MAIZE STARCH

Basis

No. of working days = 25 days/month
= 300 days/annum

No. of shifts = 3 per day

One shift = 8 hours

MAIZE STARCH PROCESSING = 60MT
PER DAY, (9000 MT/ANNUM)
SORBITOL PRODUCE = 66 MT/DAY
(19800 MT/ANNUM)

Currency - Rs.



SORBITOL FROM MAIZE STARCH [EIRI/DFR/1194] J.C. 9843
J.C. 9843

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LAND & BUILDING

1. Land Area reqd. 8000 sq.mt. @ Rs. 6000/- sq.mt.	Rs.	4,80,00,000.00
2. Builtup Area - Main Processing Unit Bldg. 3000 sq.mt. @ Rs. 9000/- sq.mt.	Rs.	2,70,00,000.00
3. Raw Material Storage 500 sq.mtrs. @ Rs.10000/- sq. mt.	Rs.	50,00,000.00
4. Finished product store Room 300 sq.mt. @ Rs. 9000/- sq.mt.	Rs.	27,00,000.00
5. Administartive Building 100 sq.mt. @ Rs.15000/- sq.mt.	Rs.	15,00,000.00
6. Labortory 100 sq.mt. @ Rs.15000/- sq. mt.	Rs.	15,00,000.00
7. Generator's Room 100 sq.mt. @ Rs. 9000/- sq.mt.	Rs.	9,00,000.00
8. Boiler Room 100 sq.mt. @ Rs. 9000/- sq.mt.	Rs.	9,00,000.00
9. Security 50 sq.mt. @ Rs. 9000/- sq.mt.	Rs.	4,50,000.00
10. Maintenance 50 sq.mt. @ Rs. 9000/- sq.mt.	Rs.	4,50,000.00
11. Fire Station 100 sq.mt. @ Rs. 9000/- sq.mt.	Rs.	9,00,000.00
12. Parking Area 100 sq.mt. @ Rs. 9000/- sq.mt.	Rs.	9,00,000.00
13. Boundary Wall with Gate	Rs.	50,00,000.00

	TOTAL	Rs. 9,52,00,000.00



SORBITOL FROM MAIZE STARCH [EIRI/DFR/1194] J.C. 9843
J.C. 9843

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PLANT & MACHINERY

1. Slurry tank complete with agitator & motor, Cap:10 MT	1 No.	Rs.	30,00,000.00
2. Coverter (Auto clave) made of manganese, Bronze pressure 30 psi for Hydrolysis of maize starch Cap: 12 MT	1 No.	Rs.	50,00,000.00
3. Filter press Cap: 2 ton/hr.	4 No.	Rs.	20,00,000.00
4. Vacuum pan Evaporator with Vacuum pumps & other accessories Cap:4ton/hr	3 No.	Rs.	25,00,000.00
5. High pressure Reactor/Auto clave of 100 psi with necessary arrange made of mild steel with - S.S. lining Cap: 12 MT	1 No.	Rs.	50,00,000.00
6. Heat Hxchanger with SS coil & other accessories.	1 No.	Rs.	15,50,000.00
7. Cation/Anion Exchange unit	4 No.	Rs.	18,00,000.00
8. Hydrogen gas Holder with accessories	1 No.	Rs.	15,00,000.00
9. Hydrogen gas compressor	1 No.	Rs.	8,75,000.00
10. Crystallizer	4 No.	Rs.	20,00,000.00
11. Storage Tanks for Refining Cap:10 MT	6 No.	Rs.	50,00,000.00
12. Dextrose Solution storage tank Cap: 7 MT.	6 No.	Rs.	50,00,000.00
13. Crude Sorbitol Storage Tnak Cap: 8 MT	6 No.	Rs.	60,00,000.00



SORBITOL FROM MAIZE STARCH [EIRI/DFR/1194] J.C. 9843
J.C. 9843

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14. Deionized solution storage tanks Cap: 8 MT.	6 No.	Rs.	60,00,000.00
15. Measuring and control equipments		Rs.	5,00,000.00
16. Flow Indicator level indicator pre- ssure indicator indicator for steam air Hydrogen temperature etc.		Rs.	5,00,000.00
17. Misc pipe fittings valves, centrifugal pumps etc.		Rs.	25,00,000.00
18. Lab Testing Equipments		Rs.	10,00,000.00
19. Boier 3 ton/h		Rs.	60,00,000.00
20. Automatic Packaging machine		Rs.	15,00,000.00
	TOTAL	Rs.	5,92,25,000.00



SORBITOL FROM MAIZE STARCH [EIRI/DFR/1194] J.C. 9843
J.C. 9843

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OTHER FIXED ASSETS

1. Office equipment, furniture plus other equipment & accessories	Rs.	10,00,000.00
2. Installation costs for water, electricity, fuel etc.	Rs.	20,00,000.00
3. Pre-operative & preliminary expenses	Rs.	5,50,000.00
4. Consultancy/Technical know how	Rs.	6,00,000.00
5. Misc	Rs.	2,00,000.00
6. Computer, Printer, Software etc.	Rs.	5,00,000.00
7. Generator Set	Rs.	25,00,000.00

TOTAL	Rs.	73,50,000.00



SORBITOL FROM MAIZE STARCH [EIRI/DFR/1194] J.C. 9843
J.C. 9843

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FIXED CAPITAL

1. LAND & BUILDING	Rs.	9,52,00,000.00
2. PLANT & MACHINERY	Rs.	5,92,25,000.00
3. OTHER FIXED ASSETS	Rs.	73,50,000.00

TOTAL	Rs.	16,17,75,000.00



SORBITOL FROM MAIZE STARCH [EIRI/DFR/1194] J.C. 9843
J.C. 9843

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WORKING CAPITAL REQUIREMENT/MONTH

RAW MATERIALS

1. Maize Starch 1500 MT @ Rs. 22,000/- MT.	Rs.	3,30,00,000.00
2. Hydrogen Gas 2,33,640 m3 @ Rs. 8/-m3	Rs.	18,69,120.00
3. Nickel catalyst 1876 kgs @ Rs. 400/- kgs	Rs.	7,50,400.00
4. Activated Carbon 20,430 kgs @ Rs. 45/- kgs.	Rs.	9,19,350.00
5. Misc chemicals Viz.soda ash, hydro- chloric acid caustic soda etc.	Rs.	5,00,000.00
6. Nitrogen Gas 6400 m3 @ Rs.12/-m3	Rs.	76,800.00
7. Packaging materials (L.S.)	Rs.	8,50,000.00

TOTAL	Rs.	3,79,65,670.00



SORBITOL FROM MAIZE STARCH [EIRI/DFR/1194] J.C. 9843
J.C. 9843

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SALARY & WAGES / MONTH

1. Manager cum Technologist	1 No.	Rs.	1,00,000.00
2. Maintenance Engineers	3 No.	Rs.	75,000.00
3. Shift Supervisor	3 No.	Rs.	60,000.00
4. Chemist	1 No.	Rs.	20,000.00
5. Skilled Workers	5 No.	Rs.	60,000.00
6. Semi skilled worker	4 No.	Rs.	34,000.00
7. Unskilled worker	8 No.	Rs.	64,000.00
8. Marketing personnel	2 No.	Rs.	30,000.00
9. Accountant	1 No.	Rs.	12,500.00
10. Clerk/Typist	1 No.	Rs.	8,500.00
11. Peon/Chowkidar	3 No.	Rs.	21,600.00
12. Computer Operator	1 No.	Rs.	10,000.00

	TOTAL	Rs.	4,95,600.00

Plus perks @ 33% p.a.		Rs.	1,63,548.00

	TOTAL	Rs.	6,59,148.00



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UTILITIES AND OVERHEADS

1. Power Consumption of 50000 Kwatt hrs @ Rs. 7.00 per Kwatt hr.	Rs.	3,50,000.00
2. Water Consumption of 4000 KLs @ Rs. 4.00 per KL	Rs.	16,000.00
3. Conveyance & Transportation etc.	Rs.	4,00,000.00
4. Insurance Professional fees	Rs.	25,000.00
5. Publicity & Sales Promotion	Rs.	6,00,000.00
6. Repairs & maintenance	Rs.	2,00,000.00
7. Telegraphic Expenses	Rs.	50,000.00
8. Miscellaneous	Rs.	2,50,000.00
9. Fuel L.D.O. for Boiler 48000 liter	Rs.	20,00,000.00
10. Administrative Expenses Viz. Stationery postage, telephone Bills etc.	Rs.	4,00,000.00

	TOTAL	Rs. 42,91,000.00

Total load is 92 Kwatts



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TOTAL WORKING CAPITAL/MONTH

1. RAW MATERIAL	Rs.	3,79,65,670.00
2. SALARY & WAGES	Rs.	6,59,148.00
3. UTILITIES & OVERHEADS	Rs.	42,91,000.00

	TOTAL	Rs. 4,29,15,818.00

1. WORKING CAPITAL FOR 2 MONTHS	Rs.	8,58,31,636.00
2. MARGIN MONEY FOR W/C LOAN	Rs.	2,14,57,909.00

COST OF PROJECT

TOTAL FIXED CAPITAL	Rs.	16,17,75,000.00
MARGIN MONEY	Rs.	2,14,57,909.00

	TOTAL	Rs. 18,32,32,909.00



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TOTAL CAPITAL INVESTMENT

TOTAL FIXED CAPITAL	Rs.16,17,75,000.00
TOTAL WORKING CAPITAL FOR 2 MONTHS	Rs. 8,58,31,636.00

TOTAL	Rs.24,76,06,636.00



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COST OF PRODUCTION/ANNUM

1. Working Capital for 1 year	Rs.51,49,89,816.00
2. Interest @ 13.50% on T.C.I	Rs. 3,34,26,895.86
3. Depreciation @ 10.00% on buildings	Rs. 47,20,000.00
4. Depreciation @ 20.00% on Plant and Machinery	Rs. 1,18,45,000.00
5. Depreciation @ 20.00% on office equipment & furnitures	Rs. 2,00,000.00

TOTAL	Rs.56,51,81,711.87



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TURN OVER/ANNUM

1. By sale of Sorbitol 19800 MT @ Rs. 35000/- ton.	Rs.69,30,00,000.00
TOTAL	Rs.69,30,00,000.00

$$\begin{aligned}\text{PROFIT} &= \text{RECEIPTS} - \text{COST OF PRODUCTION} \\ &= 69,30,00,000.00 - 56,51,81,711.87 \\ &= 12,78,18,288.13\end{aligned}$$

$$\begin{aligned}\text{PROFIT SALES RATIO} &= \text{Profit} / \text{Sales} \times 100 \\ &= \frac{12,78,18,288.13}{69,30,00,000.00} \times 100 \\ &= 18.44 \%\end{aligned}$$

$$\begin{aligned}\text{RATE OF RETURN} &= \text{Operating profit} / \text{T.C.I} \times 100 \\ &= \frac{12,78,18,288.13}{24,76,06,636.00} \times 100 \\ &= 51.62 \%\end{aligned}$$



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BREAK EVEN POINT (B.E.P)

Fixed Costs of the plant are as under -

1. Interests	Rs. 3,34,26,895.86
2. Depreciation	Rs. 1,67,65,000.00
3. 40.00% of salaries	Rs. 31,63,910.40
4. 40.00% of overheads	Rs. 2,05,96,800.00
TOTAL	Rs. 7,39,52,606.27

$$\begin{aligned} \text{B.E.P.} &= \frac{\text{FIXED COSTS}}{\text{FIXED COSTS} + \text{PROFIT}} \times 100 \\ &= \frac{7,39,52,606.27}{7,39,52,606.27 + 12,78,18,288.13} \times 100 \\ &= 36.65 \% \end{aligned}$$

LAND MAN RATIO = Total land / Manpower

$$8000 : 33 :: 242 : 1$$



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RESOURCES FOR FINANCE

1. Term loans from Financial institutions
(65.00 % of fixed capital)
at @13.50% p.a rate of interest Rs. 10,51,53,750.01

2. Bank loans for 3 months
(65.00 % of working capital)
at @ 13.50% p.a rate of interest Rs. 5,57,90,563.40

3. Self raised capital from even
funds & loans from close ones to
meet the margin money needs at a
@ 13.50% p.a rate of interest Rs. 8,66,62,322.61

TOTAL Rs. 24,76,06,636.00



We hope **Detailed Feasibility Report** in your possession at the time, must have conveyed you the elementary idea on process data, market and economics. We feel you must have now taken a decision to finalize your project plan for ultimate implementation in a successful manner. Before you go ahead, we suggest you to take our **MARKET SURVEY CUM DETAILED TECHNO ECONOMIC FEASIBILITY REPORT**.

"EIRI" offer you **MARKET SURVEY CUM DETAILED TECHNO ECONOMIC FEASIBILITY REPORT** on this project.

Brief contents of MARKET SURVEY CUM DETAILED TECHNO ECONOMIC FEASIBILITY REPORT are as under :

- Introduction
- Properties
- BIS (Bureau of Indian Standard) Specifications & Requirements
- Uses & Applications
- Present Indian Market Position
- Expected Future Demand
- Export & Import Statistics Data
- Names and Addresses of Existing Units (Present Manufactures)
- List of Plant & Machineries
- Miscellaneous Items and Accessories
- Instruments, Laboratory Equipments and Accessories
- Electrification, Electric Load and Water
- Maintenance, Suppliers/Manufacturers of Plant and Machineries
- Process of Manufacture with formulae if applicable
- Flow Sheet Diagram
- List of Raw Materials
- Availability of Raw Materials
- Requirement of Staff & Labour
- Personnel Management
- Skilled & Unskilled Labour
- Requirement of Land Area
- Built up Area
- Plant Layout.

along with financial details as under:

Summary of Capital Cost of Project
Land & Side Development Exp.
Buildings
Plant & Machineries
Misc. Fixed Assets
Technical Know how Fees & Exp.
Preliminary Expenses
Pre-operative Expenses
Provision for Contingencies

below mentioned financial statements (Annexure) will be for 5 to 10 Years

- Annexure :: Cost of Project and Means of Finance
- Annexure :: Output, Profitability and Cash Flow Chart
- Annexure :: Assessment of Working Capital requirements



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Annexure ::	Sources of Finance
Annexure ::	Balance Sheets
Annexure ::	Break-Even Analysis and profitability analysis.
Annexure ::	Quantitative Details-Output/Sales/Stocks
Annexure ::	Sales Realisation
Annexure ::	Raw Material Cost
Annexure ::	Other Raw Material Cost
Annexure ::	Packing Material Cost
Annexure ::	Consumables, Store etc.,
Annexure ::	Employees Expenses
Annexure ::	Fuel Expenses
Annexure ::	Power/Electricity Expenses
Annexure ::	Repairs & Maintenance Exp.
Annexure ::	Other Mfg. Expenses
Annexure ::	Administration Expenses
Annexure ::	Selling Expenses
Annexure ::	Depreciation Charges - Profitability
Annexure ::	Depreciation Charges
Annexure ::	Interest and Repayment - Term Loans
Annexure ::	Tax on Profit
Annexure ::	Assumptions for Profitability workings
Annexure ::	Assessment of Working Capital

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