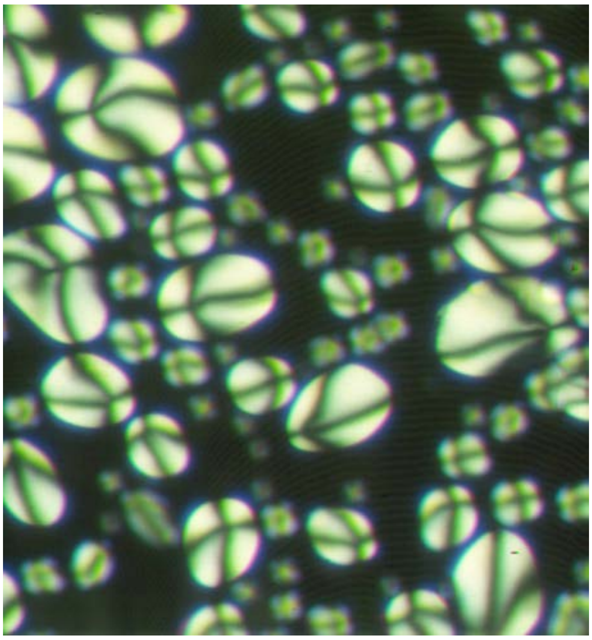
International
Starch
Institute

Starch for Foods and Pharmaceuticals TM23-3e

Modern starch process should comply with specifications of food and pharmaceutical starches.

Such starches have to be pure and with low microbial count.

The means to keep these specifications are sanitary operation and avoiding recontamination.



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Raw Material

Careful handling of raw materials is of special importance in case of potatoes, cassava, sweet potatoes and other tubers.

Every single blow damages cells, with starch losses and a dead spot on the tuber as a result. It is therefore of utmost importance to handle the tubers during transport as carefully as possible with the techniques and equipment available.

Unfavorable storage conditions cause starch losses and, in the worst case, dead and smashed tubers, which are disruptive for a sanitary process. Supplies of bad raw material have to be rejected.

Use of Sulfur.

In corn wet milling sulfur dioxide is used for steeping, but also in tuber wet milling sulfur dioxide is used.

The tuber cell juice is rich in sugar and protein. When opening the cells the juice is instantly exposed to air and reacts with the oxygen, forming colored components, which may adhere to the starch.

Sulfur dioxide gas or sodium-bisulfite-solution therefore has to be added - both generally recognized as safe (GRAS)[1]. A considerable reduction potential of the sulfur compounds prevents discoloration. Sufficient sulfur has to be added to maintain the juice and pulp light yellow.

[1] CFR - Code of Federal Regulations Title 21. PART 182 -- SUBSTANCES GENERALLY RECOGNIZED AS SAFE. Subpart D--Chemical Preservatives. Sec. 182.3862 Sulfur dioxide and Sec. 182.3739 Sodium bisulfite.

Four kg sodium-bisulfite-solution (38% $NaHSO_3$) has an effect equivalent to 1 kg of sulfur dioxide (SO_2) gas. Only food grade chemicals are used. The gas has a strong smell. The gas container has to be kept warm in order to maintain a constant pressure. In the container, the gas is in liquid form, and it evaporates in step with consumption. The evaporation cools the liquid and the gas pressure falls. The gas may be dissolved in water before use or added directly into the process stream. The sulfite solution is easier to handle and to meter accurately and constantly over time.

Discoloration by air is only partly reversible and the action of the sulfur is primarily to prevent color formation and has only a lesser bleaching effect.

Sulfur also retards bacterial growth. Potato juice, and especially diluted juice, is an excellent substrate for most microbes colonizing the interior walls of pipes and machines. The growth of the colonies is favored by a low speed of flow. The colonies form lumps or films, which may break away and clog up nozzles or just alter flow resistance, so that original design values can no longer be sustained.

The sulfur is added:

1) After the raspers or rasp pumps
2) To the concentration stage inlet
3) To the crude starch slurry before refining

Enough sulfur is added to keep the juice and pulp light in color and, as a rule of thumb, 2/3rd is added during extraction and 1/3rd in the refining station.

The dosage depends on actual conditions, but typical figures are 250 - 500 g sulfur dioxide gas per ton of potatoes, equivalent to 1-2 kg of sodium-bisulfite solution (38%) per ton of potatoes. This dosage only leaves a few ppm

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residual SO_2 in the starch (Re.: ISI 20-1e Determination of Sulfur Dioxide in Starch)[2].

Cooling

The lower the water consumption, the more pumps are involved in the process and the more heat is generated. To retard bacterial growth refrigerator temperatures are ideal.

In spite of a low temperature in the incoming process water the process conditions soon reach room temperature because of the pump energy introduced. These factors greatly favor microbial growth conditions.

In the effluent of concentrated fruit juice, cooling during extraction is a must because in hot juice microbes that break down protein and a bad smell may take control.

CIP - Cleaning In Place.

No matter how efficiently microbial activity is controlled, the interior of machines and pipes has to be cleaned regularly, - weekly or every second week.

Cleaning is carried out with caustic and hypochlorite as cleaning aids. Caustic is a powerful agent for removals of the protein build-up on interior walls and the hypochlorite - both generally recognized as safe (GRAS)[3] [4] is an efficient germ killer. Both work quicker when hot. Caustic has a strong gelling action on starch even at low temperatures. A good procedure is thus to CIP initially with hypochlorite and then - when most of the starch is flushed out along with the hypochlorite - a second CIP with caustic is carried out. The two can be used as a mixture. The temperature has to be kept below 45 ^{o}C in order to protect the plastic components in the equipment.

Caustic (Sodium hydroxide solution, 27-28% NaOH) is used in an optimal concentration of 1% NaOH. (10 ml of CIP-liquid is titrated with 0.1N HCL and percentage NaOH = ml HCL*0.04). Hypochlorite (Sodium hypochlorite solution - NaOCl, activity: 15% Cl) is used in a concentration of 200 ppm Cl[5].

The CIP-liquid also needs a certain time to act - not less than ½ hour. If the temperature rises faster, it is necessary to cool or CIP twice.

During CIP it is of utmost importance to keep pipes filled up. Tanks are most efficiently CIP'ed with rotating disc nozzles - and covered tanks are required.

If only a small pipe segment is incompletely cleaned, bacteria spread instantly and re-infect the installation immediately.

Drying.

Yeast, fungi and bacteria in the final starch are unavoidable, but their number has to be kept low. Low bacterial count is a quality property of particular importance to the food industry.

The measures utilized to keep the counts low are sulfuring, cooling and efficient CIP.

All measures used to produce good starch slurry are of no use if the starch is contami-

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2 http://starch.dk/isi/methods/20so2.htm

3 CFR - Code of Federal Regulations Title 21. PART 184 -- DIRECT FOOD SUBSTANCES AFFIRMED AS GENERALLY RECOGNIZED AS SAFE. Subpart B--Listing of Specific Substances Affirmed as GRAS.

4 CFR - Code of Federal Regulations Title 21. PART 178 -- INDIRECT FOOD ADDITIVES: ADJUVANTS, PRODUCTION AIDS, AND SANITIZERS. Subpart B--Substances Utilized To Control the Growth of Microorganisms.Sec. 178.1010 Sanitizing solutions.

5 FDA limit is 200 ppm determined as available chlorine.

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nated in the dryer. All surfaces of the dryer have to be heat insulated to avoid water condensation and the starch has to be properly cooled before deposit in the store.

The starch also has to be evenly dried. Even small amounts of moist and warm starch will cause the bacterial count to skyrocket.

STORAGE.

Metal storage silos for short-term storage have to be insulated with "Rockwool" and well cladded. Concrete and metal silos for long-term storage needs an inner wooden cladding and a ventilated space between the cladding and the silo wall.

WATER

The color or whiteness may be improved by removing iron and manganese from the process water. Oxides of iron and manganese (for. ex. rust) are dark colored components, which have to be removed in the water treatment plant.

FIBER-NUMBER.

Residual fibers also influence the color. The exact quantity of cellulose may be determined analytically.

The amount of colored impurities (brownish residuals of cork (skin tissues), fungi and fungi spores) can be determined by boiling away the starch in a weak acid and filtering (re. *ISI 08 Determination of Fiber in Starch as Fiber Number*[6]). By comparing the colored impurities retained on the filter with a color standard the test gives a fiber number, where 1 and below is good and 2 and above is bad. A fiber number above 2 is associated with visible reduction of whiteness.

Starch is among the purest of all agricultural products - actually, purity has become one of the most important competitive parameters. Starches for foods and pharmaceuticals are no exemption.

PEROXYACIDS

Good manufacturing practice, well-designed refining equipment, sanitary piping and welding plus CIP will do the job. Certain applications may need lower counts and peracetic acid has proved more successful than hydrogen peroxide for such purpose.

$$H_2O_2 + CH_3CO_2H \rightleftharpoons CH_3CO_3H + H_2O$$

Preparation of peracetic acid. Ingredients:

20 kg of glacial acetic
29 kg hydrogen peroxide 35-40%
0.5 kg of concentrated sulfuric acid

Mix ingredients gently. The mixture is left cold for at least 2 days and a maximum of 10 days before use. Keep small stock. Peroxyacetic acid is a highly reactive chemical and a dangerous explosion hazard. Excess acetic acid and hydrogen peroxide improves the stability.

Add 3 liters of mixture per ton of starch solids to purified starch slurry and wait one hour before dewatering and drying.

Peracetic acid (peroxyacetic acid or PAA), CH_3CO_3H is produced industrially by the autoxidation of acetaldehyde.

[6] http://starch.dk/isi/methods/08fib.htm

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