CONCENTRATION OF FRUIT JUICES

CONCENTRATUL DIN SUCURI DE FRUCTE

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Abstract: *The fruits are much appreciated for thei high content of vitamins and essential microelements, substances that have stimulating and restful effect upon human body. Preserving them like natural pasteurized juices or better concentrated juices, is the way the human body receives the essential substances, especially during the winter season, which assure its metabiological and physiological equilibru. Starting from this reason, modern technologies and also good practices are used during processing in order to obtain this kind of finished products without chemical or microbiological risk of contamination on.*

Rezumat: *Fructele sunt foarte apreciate pentru conținutul lor în vitamine şi microelemente esențiale, substanțe care au efect benefic asupra organismului uman. Prin conservarea lor ca suc pasteurizat sau suc concentrat, le putem consuma, mai ales în timpul iernii, asigurând astfel un echilibru metabolic şi fiziologic. Pornind de la acest motiv, se folosesc în prezent tehnologii moderne de prelucrarea fructelor prin care se obțin produse naturale, necontaminate chimic sau microbiologic.*

Concentration is a method largely used in the juice conservation, well purified and filtered that will reduce their volume by 5-6 times what diminishes considerably the packing and transport costs etc.

The modern installations may make the juice concentration by 7 times at most the initial concentration. In these conditions juices with soluble dry substance of about 10^0 refractometric may be concentrated up to 70^0 refractometric, a concentration where the activity of microorganisms is inhibited.

Nowadays there is the tendency to give up the advanced concentration of juices that need a big energy consumption and influence negatively the product quality achieving a concentration up to $40 - 45^0$ refractometric, applying the following as a supplementary conservation procedure: chemical conservation, aseptic conservation and packing.

Concentration may be made by several methods: evaporation, freezing, reverse osmosis and ultra filtration.

For the apple juice by evaporating 10, 20 or 30 % form the juice they may obtain in the flavor concentrate 60, 85 or 90 % from the flavor substances of juice.

As for other fruits the percentage of juice evaporated is 20 % for raspberries, blackberries, strawberries; 25 % for sour cherries; 20-30 % for black currants and bilberries.

The recuperation of flavors from the fruit juices bases on their solubility in water and their volatility.

Concentration is made for a contents of dry substance of 30-50 (65) % the technical procedures used in the concentration technology being thermal concentration, criocentration (with phase change) and reverse osmosis (without phase change).

According to the process continuity, concentration may be discontinuous or continuous and according to work pressure - normal or low - vacuum.

Concentration by reverse osmosis

Osmosis is a physical phenomenon that insures the turgescence of live cells and allows the exchange of substances by means of the semi-permeable membranes (plasmallema, tonoplast). Osmosis is a reversible phenomenon.

If upon the concentrated solution they exercise from the exterior a pressure superior to the osmotic pressure, the water from the concentrated solution goes in the diluted solution and a phenomenon of reverse osmosis takes place.

This concentration procedure is used frequently to obtain the concentrated citric juices.

Crioconcentration is the concentration method with a phase change that modifies in a more reduced proportion the chemical or organoleptic nature of the products transformed.

The principle of the procedure is the partial freezing of the water from product and the separation of the ice crystals from the concentrated product. The watery solutions frozen at temperatures the lower the more concentrated (the phenomenon of colligation).

The separation of crystals triggers by inclusion or adhesion a part of the concentrate too. A good separation is made only by centrifugation, pressing, washing-purification or by combination of these procedures. The cooling may be direct or indirect, preferring the former one that consumes less energy. In spite of al these, most of the installations from the food industry use the indirect cooling, being equipped with devices to remove the isolating ice layer deposited on the cooling elements. They concentrate through this procedure especially the orange juice and certain wines, in apparata called crystallizers, the latent warmth of solidification being taken over by a tambour. Inside it the cooling agent circulates, and on the outside the ice crystals are formed that are removed by scraping. The most known crioconcentrators are the installations: Linde-Krause, Votator and Daubron.

At the centrifugal systems, they pursue the formation of spherical crystals, uniform and big enough that do not adhere to the cooling device. The thermal-concentration consists in the evaporation of the water from the fruit juice by continuous boiling being the most spread procedure of concentration at world level. It may be achieved by three temperature stages (10-25^{0}C, 40-100^{0}C, 115-130^{0}C).

Among the thermal-concentration installations we mention:

-evaporator with a warming coat

-plate evaporator (eg. Installation Paravap)

-mechanically made film evaporator (eg. installations Rotofilm, Centritherm)

- concentration installations with double effect (eg. Manzini, Lang, Rossi-Catelli)

- triple effect installations (eg Wiegand, Unipektin, Stork, Luwa).

The concentration with simple effect is made in vacuum concentrators. Its functioning is discontinuous. The steam evacuated is condensed by means of a barometrical column in the barometrical condenser. The concentration with multiple effect is made in installations with two or three stages where the steam come from the first stage serves to warm the following stage(s). The energetic effectiveness is clearly superior and the water consumption is reduced. The product goes through the concentration stages, arriving to the concentration wanted in the final stage that has also the lowest temperature.

The aggregates with thermal-compression reuse the steam exhausted, compressing it up to the technological parameters necessary to reintroduce it in the retrace. They achieve an economy of the steam consumed. The procedure is most effectively used in combination with the multiple efect.

The installations with multiple efect may function both directly and in inverse current.

The method the most used on industrial level is the concentration by evaporation, the installations used being of the type Alfa–Laval, Schmidt, Manzini with double and triple effect to reduce consumption of utilities and the ultra fast concentration to insure the maintenance of the product quality.

Due to the fact that the volume of juice submitted to concentration decreases once with concentration, the more stages the installations has, the more concentrated the final product will be.

In our country the most spread concentration installation, used especially to obtain concentrated musts is the installation of the type IMUC , with double or triple effect and compression .

The concentration installation of the type IMUC is a continuous installation with double effect that meets the requirements of modern concentration techniques. The circulation diagram: inverse current. It is used generally for the concentration of products with high viscosity and heat sensitive.

The concentration installation IMUC has the following advantages:

- concentrates effectively the products with high viscosity

- the difference of temperature between the thermal agent and product may be easily controlled so the quantity of heat transferred by surface unit is high

- the total coefficient of transfer is high: 1850-1900 W/mpK.

- the duration of contact of product with the hot surface is very short, several seconds, so despite the entire recirculation, the total time of concentration is reduced

- continuous process completely automated.

Concentration installation with triple effect and thermal-compression of the type IMUC

The concentration diagram applied in the installation with triple effect and thermal-compression has its use in the case of high debits that by the economy of thermal agent and cooling water covers the plus of investments.
The particularities of these installations are: the pellicle multitubular evaporator with descendant pellicle achieved by free flow; the circulation of fluids is in parallel current, the thermal-compression is used in the first effect.

The functioning of the installation is automated and comprises:

- the product feeding in each evaporation body, with water in the mixing condenser and obviously, the heat carrier feeding. The feeding is made by means of the pneumatic valves.

- adjustment and the registration of the concentration degree of the finite product by means of the electronic refractometer

- electronic registration of the important work temperatures

- security devices: for a minimum and maximum level of product, by the vacuum in installation or the degree of concentration

- pneumatic regulators with proportional and integral action

- centralized switchboard.

The installation of concentration with triple effect also has other advantages such as: insures the maximum of economy of hear carrier due to the functioning in triple effect with thermal-compression, a reduced consumption of water, the cooling of product up to 7^0C, simple functioning and exploitation.

Among the modern installations of concentration of the grapes must produced by companies from EU, we mention the installation Concentramatic, produced by the company DEFRANCESCHI – the must is concentrated by water evaporation under vacuum at 20 degrees Celsius. The sugar losses in the evaporated water are very small, more than that the organolpetic features and the particular flavors are not altered due to the low temperatures to which the process takes place.

Another company producing such installations is represented by DELLA TOFFOLA – the concentration installation has a system of two or more effects and the concentration is made by means of steam.

The vacuum evaporator, ideal for must concentration in a system with low temperature under vacuum, has an output of 30 lt/h.

In USA, in the opinion of specialists from the company APV ANHYDRO, Towanda, NY, the most used concentration installations are the ones with triple effect or even quadruple with thermal-compressor being preferred the evaporators with descendant film.

In essence, the installation is made of a plate heat exchanger and with separating cyclone. By means of a pump, the liquid comes into the plate exchanger where a rapid heating takes place followed by the evaporation of a part in the water contained.

The biphasic fluid (mixture liquid-steam) from the plate heat exchanger passes into a separation cyclone that work under vacuum the separation of the two phases taking place: the liquid concentrated and the water steam.

The plate installations achieve a high heat transfer due to the big temperature difference between product and thermal agent on one side and on the other side due to the optimum construction of plates that favor the formation of rotatory currents on the corrugated surface of these.

Due to the high temperature during concentration they may also insure the sterilization of the finite product Consequently, if before concentration the installation was washed and disinfected correctly, the concentrate may be packed directly in septic conditions insuring a good conservation.

Most of the concentration installations are equipped with flavor recuperators.

The degree of concentration of the flavor substances is expressed by a ration having at nominator the quantity of fresh juice from which they obtain 1 kg of flavor concentrate. This is between 1/60 and 1/200 the most encountered being of 1/100 depending on product and the flavor recuperation installation.

The most encountered flavor recuperation procedures are either partial condensation or distillation. Compared to the first procedure, distillation insures a better flavor recuperation, but it has the disadvantage of the high cost of the steam used in the functioning of the distillation columns. This is why the company APV ANHYDRO, Towanda, NY proceeded to the combination of these procedures by incorporation of a distillation column in the concentration installation. The method present son one hand the advantage of diminished functioning costs due to the use of the same steam source both for the functioning of the distillation column and of the evaporator; on the other hand it has an obvious easiness in exploitation.

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