STUDIES CONCERNING THE USES OF ION EXCHANGERS IN FOOD INDUSTRY

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Abstract: The based on ion exchange extend fast in the chemistry and technology of food products owing to special advantages tehnical-economic on which they realize. In this study are adduced the applications to the ion exchangers in some technologies from food industry (sugar, milk, juices, fats technology and in oenology). So the separation and the batching of bases and acids, of cations and anions from the food products it realizes highly easy using adequate ionic resins, chelates resins its resins with exchange selective ability and nanomaterials.

Keywords: ion exchange, adsorption, ionic resins, nanomaterials, food products.

1. INTRODUCTION

Ion exchangers are insoluble substances in water and organic resolver, in structure to which stands active ionogenic groups able to diffuse ions in electrolyte solutions with which wine in contact. After ions nature which are changed, it exists base exchangers or cationites, anion exchangers or anionites and amphoteric exchangers. After their natural state, ion exchangers are liquids or solid substatances liquid. Ionites are organic products with acid character (liquid cationites) or with basic character (Anionities liquid).

Solid ionites are natural or synthetic products, organic or inorganic nature with finely porous structure able to imbibe watery, with liquids sundries and with electrolyte solutions until a certain specifical bloating degree. Owing to solutions broadcast of electrolytes in micropores of solid ionites is possible the ion exchange realization within of those micropores, to solid-liquid interface, in « the exchange points » of macromolecules of ionite in which are found the ionogenic groups of those molecules. The ion exchange process are realized in two successive stages: adsorption of aquated ions from the electrolyte solution to surface ion exchanger and the ion exchange reaction until the exchange poise establishment.

2. THE APPLICATIONS OF ION EXCHANGERS IN THE CHEMISTRY AND TECHNOLOGY OF JUICES

The microbiological stabilization of juices through ion exchange constitute now a sure process, efficient, and much more economic than others the based on processes enlargement of different chemical substances (Ex: sulphur dioxide, sorbic acid, alkaline sorbates, diethyl ester etc.), maintain in atmosphere the inert gases or to low temperatures, the sterilization etc. The fermentation process of juices is can braked through removing the cationites fractionally. The cationic resins strong acid under form HR retain, from the juices, so inorganic cations as well as organic cations needed development of the microorganisms.

Through the treatment with the resins under form HR takes place enlargement of treaty juice acidity. Exceeding the acidity report value/content of sugars, which it entails the gracious taste of juice, after the treatment with the resins under form HR is needed a treatment later with with an anionic resin strong basic (Under form ROH) for the restraint of the excess of acidity and the reestablishment optimum value acidity report /content of sugars.
Removing the cationites until limit under which not yet is the possible the development ferments, realizes a perfect stability of juices with the intact maitain of sensorial and nutritival properties

The diminution of the content of ions K, Ca, Mg, Fe etc. does not realize themselves to the prejudice of juice qualities, contrary with which happens in the process prevention case of of the process of fermented through chemical substances enlargements, which in addition to fact as confers juices a disagreeable taste, are and toxic.
For successful the treatments through ion exchange applied juices for chemical and microbiological stabilization, is needed knowledge of components which contributes to specific flavour of those products, to avoid their detention on ionic resins.[2,6,5,8,12]

3. THE APPLICATIONS OF ION EXCHANGERS IN THE SUGAR TECHNOLOGY

Through ion exchange can recover the sugar from molasses, , concomitantly with the saving to some components valuable from sugars as glutamic acid and betaine. In the offing of those realizations did some purge tries of sirups from beet sugar with help ion exchangers existing in that weather: clays, natural zeolites, green earth, synthetic permutites and carbons sulphonated. In 1901 did tries [2] of purge with clays. with the aim of the substitution of the ions K^+ and, Na^+ from juices with ions Ca^{2+} from structure aluminum silicates contained in respective clays. In 1903 experimented the zeolites [3] and after 1905 used, in same aim, synthesized permutites after the process Gans .

3.1 The purification of diffusion juices

Diffusion juices, obtained after extraction with the water of sugar from the sugar beet, is an impure solution, with a heaved content of anorganic and organic compounds, of colour from open black to brown, opalescence, which spume easily. The efficient crystallization of sugar depends in a decisive mode removal of this solutions. The advanced purification of diffusion juices can been realizing through the the combinations specific stages of remake of diffusion juice (predefecation, defecation, decomposition of reducatant substances, sulphitation, the discolouration etc.). In this sense, through the successive crossing of diffusion juices across successive layers of cationite anionite obtained discolouration of solution, the content reduction of calcium salts and a purity of over 97%. [12,8]But temporally purification on cationic resin, it is possible partial hydrolysis of sugar, favoured of catalysis acid, producing reverse sugar.For the losses avoidance in sugar, reversed the separation cycle, electing the sequence anionite cationite. So, at first they are removed acids components of diffusion juice, next cations.

The final purity of diffusion juice is augmented through the the combinations separation through sorption on ion exchangers with a chemical pretreatment. For instance, through the earlier defecation of diffusion juice and its passage across ionites, are eliminated about 96% from the impurity minerals, 60% from the organic impurities, reverse sugar being very reduced (under 0,5%). Similarly realizes and purge of green syrup, getting an increase of yield in sugar of 1 % (Related the quantity of beet processed).[6]

3.2 The recovery of some aminoacids from diffusion juice

To the crossing of diffusion juice across the the layer of anionite, are keeped acids components, among which and the aminoacids (glutamic acid, asparagic acid etc.). The aminoacids can be recovered through elution with a solution of ammonia and the detention the cations NH_4^+ on cationic resin, the final solution of aminoacids having a advanced purity.

3.3 The sugar purification

The sugar purification with help of ion exchangers consists in the dissolution of crystallized sugar and the discolouration solution through pass over a layer of resin.

3.4 Demineralizatio of molasses

The molasses represents the resulted sirup from the centrifugal action of crystallized sugar, sirup from which not yet can crystallize, in economic mode, the content sugar. On an average, are obtained 5 kg molasses to 100 kg beet processed, this report depending by initially chemical composition of sugar beet, and also by the technology of obtain the sugar. Generally, molasses has the next composition: - 80-85% s.u., from which 60% sugar and 40% nonsugar (cations: K^+, Na^+,Ca^{2+}, Mg^{2+}anions:Cl^-,SO_4^{2-},CO_3^{2-},PO_4^{3-}, organic acids, aminoacids, coloured compounds, peptides etc.), 15 - 20% water. [4, 6]

Componentes mentioned prevent the crystallization of sugar content by molasses . From this reason, molasses is subdued a process of demineralization, through her crossing across a layer of cationite strong acid, in form H, and across a layer of anionite thin basic, in form OH. Consumed resins are regenerated, after previous indulgtion, so: the cationite through treatment with a solution of H_2SO_4, while the anionite with a solution of NaOH.

4. THE APPLICATIONS OF ION EXCHANGERS IN ALCOHOL BEVERAGES TECHNOLOGY

Through anology with the effect water softner of used cationites to the waters purifying, did tries, still from 1935, of removal of eliminate the cations Ca^{2+} and Mg^{2+} from wines with help natural aluminium silicate. It observed so through the treatment with with bentonites is enlarged the pH value of wines concomitantly, with the cast iron content decrease and of proteins.The wines tralate with bentonite are cleared in 24-48 h, without addition of tannin. The protean azote can be eliminated nearly quantitative, while the total azote drops off much, which shows as the bentonites acts as over proteins and over to some simpler combinations with azote too [1,2,11, 5].

The colloidal particles of the bentonite loaded negative, coagulates the protein substances, which to wine's pH are loaded positive. In the acid environment, the bentonites realize a weakly ion exchange with cationites Fe^{3+} and Cu^{2+} which turn out the wine breakage. Inertly from chemical point of view, the bentonites does not confer wine an its taste stranger smell. Over diverses colloidal organic suspensions from wines, and also over about the tannins and substances coloured, the bentonites exerts an action highly languid. In 1945 was conferred a patente in S.U.A concerning the use of zeolites for the potash exchange from wine with sodium from alumosilicate structure [2,3,6].

Treatment tries of wines with ion exchanger resins were done beginning from 1938, when were conferred some patents concerning the stabilization come through cationic exchange [11]. In the next years published a series of studies which opened the view of the introduction ion exchangers in oenology technology for the solution to the knottiest problems concerning the faults prevention, the quality amendment, keeping quality and the wines stability. It proposed in 1946 the use to ion exchangers for the the amendment wines taste. In the next years were published studies and were conferred patents concerning the wines stability through ion exchange [16,17,18,].

4.1 The must stabilization

The method permits the sterilization and the preservation a longer time of must. Cationic and anionic resins keep the ions Fe^{2+}, Ca^{2+}, Mg^{2+}, aminoacids, combinations with azote_therethrough, being inhibited activity of the yeasts. So, the treaty must originally with a cationite in form H get an breeded acidity, which is eliminated a with of a help of anionite in form OH. The obtained must are maintained the initial taste and does not ferment for 180 of days.[9, 13]

4.2 The wines quality amendment

Through the wines treatment with ion exchangers are eliminated the components which affects the conservation and the quality to those. In this sense, on cationites in form H or Na are keeped, the iron and copper traces which induc the iron brownness of wine and rescission copper (the iron brownness of wine consists in the formation to some insoluble and intensive coloured complex irons after reaction among ionii Fe^{3+} and some tannins or coloured compounds from wine; the rescission copper represents the appearance to some precipitated brown, which manage to the wine disorder, being the outcome present in wine of solts of derived copper from the vine treatment). The advantages of this process are: avoids the treatment with yellow prussiate of potash, which can not be applied red wines; does not cause the wines alteration quality; permits the concomitance removal of ions Ca^{2+} and Mg^{2+}, inhibiting the activity of the microorganisms, which drives to the elimination of the treatment removal with SO_2; favours the decomposition of bitartrate of potash, escaping tartric acid, being, so, avoided depositions of tartrate from the obsolete wines; is efficient and economic.[4,5]

The most evinced resins for this aim are the ones polystyrene-sulphonates netlikes with 7 - 9% divinylbenzene, obtained through copolymerization of sulphonate styrene with divinylbenzene or with divinylethylbenzene. These cationites possesses a chemical heaved stability and selectivity for cations which must eliminate from wine. At the same time, the wines treatment with cationites confer to those a more gracious bunch,as resulted of formation esters and acetates through the reactions among the alcohols and the aldehydes from catalyses wines by cationites. The wines acidity decrease is done with help of anionic resins. This process is indicated and for the amendment to some deficiencies created of the former treatments with SO_2 or metabisulfites. In this sense, the anionic resins permit the elimination of H_2S, of the alkyl hydrosulphides of H_2S0_4.

Also resins strong basic catalyses reaction of condensation aldehyde condensation of the aldehydes from wines, while the ones weakly the basic reactions of esterification (for instance, the ethan changed to the acetate of ethyl, improving the wine quality. The wines treatment with anionites, after the treatment with cationites, contributes to the sterilization more advanced of those. Cationic and anionic resins are utilized in wines processing derived from hybrids, for in the aim discolouration partial and of unpleasant smell and taste removal.[6, 17]

4.3 The wastes valorification from wine industry

The derived wastes from wine industry (marc, the yeasts deposited to clear etc.) are processed for saving to some structural valuable compounds, such as: the tartric acid, the lactic acid, the malic acid etc. The tartric acid, under form of tartrate, diverges in wide quantities pending wines storage. Its retaining from the clear which wines contain the bitartrate of his potassium from wastes, and also of other structural compounds, is done through the crossing battery of which columns contains a column with anionite in form OH, which keeps the free tartric acid, a column with cationite H, which released the liberation from its solts. [6, 12]The regeneration of resine from the first column is realizeed with a diluted solution of KOH, the eluate eluatul containing tartrate of potash. The last column is treated with a diluted solution of one mineral acid, escaping the acid tartric.

4.4 The treatment of cider

The cider is is an alcohol beverage obtained through aerobic fermentation of apples or pears juice. Comparatively with the wines, cider offers a much better environment for the activity microbiane, having a superior content in sugars (75% the fructose, 10% the glucose,15% the sucrose) and mineral compounds. From this reason, the cider spoils with a heightened speed toward wines. The stabilization cider can do through the detention of the cations and of compounds with azote on cationic resins in form H, followed of the treatment with an anionic resins in form OH, for the acidity redress.[6, 11]
But through this process, the cider misses its specific taste, as effect of to some catalyzed reactions of anionites. The avoidance of this disadvantage realizes through the its treatment with ion exchangers in present CO_2 which softens the basic pronounced effect of anionites. Because the qualities amendment of cider with ion exchanger resins is difficult technology of realized, acts only to the acidity redress, with the acid recovery acid malic through sorption on anionites

5. THE APPLICATIONS OF ION EXCHANGERS IN MILK TECHNOLOGY

5.1 The partial elimination of calcium from milk

The cow milk is not tolerated by sucklings, owing to coagulation in stomach of casein, challenging indigestion and gastric. Comparatively with the motherly milk, the coagulated process is the effect to a more heaved content of ion Ca^{2+} in the cow milk. The partial detention of ca1ciului from the necessary milk alimentation of the sucklings, dust milk manufacture and of those condensed, processing to the different cream etc., Is done with sated cationic exchangers with ionii K^+ and Na^+. In this mode, Ca^{2+} from the cow milk replaces K^+ and Na^+ ions from resin, the effluent having a report between Ca^{2+} and $K^+ + Na^+$ ions suchlike with one of motherly milk.

5.2 The content reduction of sodium from milk

Is utilized in the treatment milk destined of alimentation of the invalids of high blood pressures, of the heart, of reins (the fresh milk contains, generally,about 900 - 960 mg sodium/l). The milk is passed over_a layer of cationite under form K or H, being keeped partial, outwards Na^+ ion and ions Ca^{2+} and Mg^{2+}, but either the affected nourishing value of milk.

5.3The separation of lactin from milk whey

Is passed the whey, cleared preliminarily,_the column with a cationite strong acid H, resulting a acid effluent from which were were keeped the cations.The effluent are mixed with an untreated whey quantity, until to the touch to a pH = 3 - 4,2 and warms easy for coagulation of proteins. From the clear liquid are separated the lactin through concentration and crystallize. The salting -out of whey, for favouring of separating of the lactin, is can achieved and through the electrodialysis membranous ionites,obtaining in ending, lactin of purity of about 97%.[3,8]

5.4 The purification of the casein

The casein is a fosfoprotein used to the manufacture to some special glues,to the procurance, through hydrolysis, of to some aminoacids, to the processing to some culture averages etc. These uses impose absence metallic cations. The casein precipitated from milk washes with demineralizated water, being transformed in a fine suspension, which is mixeed, next, with a cationite Na.Through the ion exchange is obtained soluble sodium caseinate in water. After the separation of resin, the sodium caseinate is concentrated or is dried through atomized of ash).[6,13]

5.5 The holding back of lactic acid (Neutralizing of sour milk)

The sour milk is a layer of anionites strong basic, which hold back the acid lactic. The elution lactic acid is realized with a solution of NaOH, resulting lactate of sodium. For the acid lactic liberation from from its salt, the solution of lactate of sodium is passed trough the column with cationite in form H,which it holds back Na^+ [4, 9].

6. CONCLUSIONS

In the present stage of technology, ion exchangers used on the scale more and more_large in all sectors of food industry, simplificating the technological process of manufacture, reducing the expenditures of investments and of explotation, swelling the productive power of labour productivity and installations, with the realization to some sterling products to smaller cost than the realized cost processes which do not they apply the ion exchange.

The use to the ion exchangers, in laboratory and to industrial level, constitutes today an essential promotional criteria of the most advanced technology.

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