

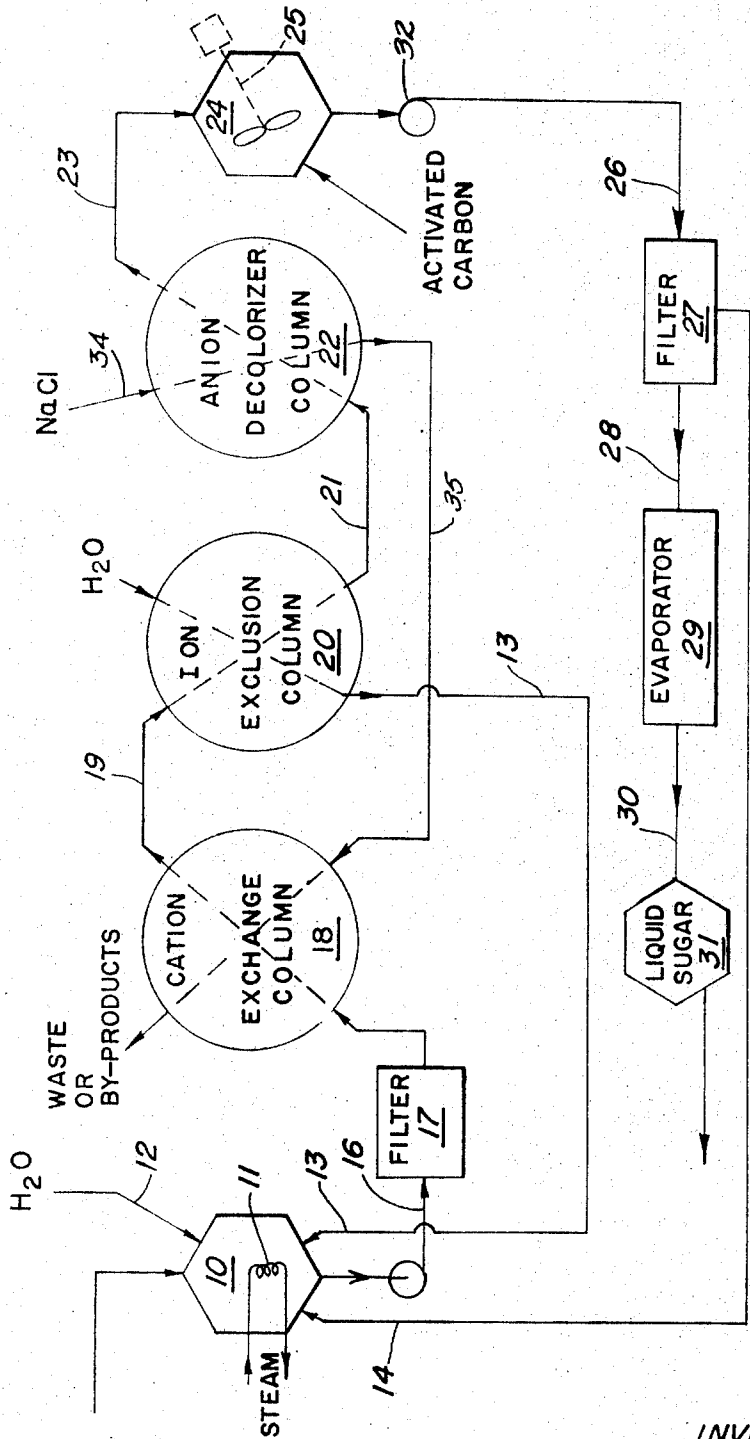
May 1, 1973

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3,730,770

SUGAR RECOVERY METHOD

Filed April 7, 1971



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3,730,770

SUGAR RECOVERY METHOD

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Filed Apr. 7, 1971, Ser. No. 131,912

Int. Cl. C13d 3/12, 3/14

U.S. Cl. 127—46 B

9 Claims

ABSTRACT OF THE DISCLOSURE

A sugar recovery process and apparatus utilizes fresh activated carbon particles to treat a sugar solution after it has been deionized and purified in an ion exclusion process and reuses the activated carbon particles to treat the sugar solution prior to its deionization and ion exclusion treatment.

The present invention generally relates to an ion exclusion process and apparatus for recovering sugar from an impure, sugar bearing solution such as molasses; and it relates more particularly to a new and improved process and apparatus which utilizes fresh activated carbon as a final decolorizer and thermophile inhibitor and once-used activated carbon as an initial decolorizer, and which also uses a sodium chloride solution as the regenerant for both an anion decolorizer resin and a cation exchange resin used in the recovery process.

For many years the sugar industry has used the process of carbonation to purify sugar juices. While the carbonation process has many advantages over other sugar purifying processes, as practiced in the past it has had several severe limitations. For example, the impure sugar juices ordinarily contain large amounts of monovalent mineral salts, the anions of amino acids, and other organic acids; yet these impurities are relatively untouched by the prior art carbonation process.

In recent years, the use of an ion exclusion process in conjunction with, and as a supplement to the carbonation process has been suggested and given serious consideration as a possible solution to the aforementioned problem of removing ionic impurities not removed by the carbonation process alone. Additional benefits achieved by the use of ion exclusion are increased sugar extraction, virtual elimination of scaling in the evaporator, and improved color.

An object of the present invention is, therefore, to provide a new and improved sugar purification process and apparatus utilizing both ion exclusion and carbonation in an efficient and economical manner.

A further object of this invention is to provide a new and improved carbonation process for refining sugar.

While the process and apparatus of the present invention finds use in purifying numerous sugar solutions, it finds particular application in the production of clear, liquid sugar from molasses. Molasses, being a syrupy residue left over after much of the sucrose has been removed in a refining or purification process, contains a substantial amount of sucrose and inverts with large amounts of various impurities including monovalent and multivalent salts, amino acids and large molecules such as color bodies.

Another object of the present invention is to provide an economical method and apparatus for extracting sugar from molasses.

A further object of the present invention is to provide a new and improved system using both carbonation and ion exclusion to purify a sugar bearing solution.

A still further object of this invention is to provide a new and improved process for regenerating cation and anion exchange resins used in a liquid purification system.

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Briefly, the above and further objects may be realized in accordance with the present invention by adding and then filtering out activated carbon particles just prior to the final evaporation step in an ion exclusion sugar recovery process, mixing the thus used and partially spent activated carbon with the initial sugar juices, heating said mixture, filtering out the carbon particles and other entrained solids, and then passing the solution through a cation exchange column and into an ion exclusion column. The purified sugar bearing fraction from the ion exclusion column is then passed through an anion exchange column prior to adding the fresh activated carbon thereto. In accordance with a further aspect of the invention, the cation and anion exchange resins are regenerated by passing a solution of NaCl first through the anion exchange column and then through the cation exchange column, the chlorine ions in the regenerant functioning to regenerate the anion exchange resin and the sodium ions therein functioning to regenerate the cation exchange resin.

Further objects and advantages and a better understanding of the present invention may be had from the following detailed description taken in connection with the accompanying drawing wherein the single figure is a schematic flow diagram of a sugar recovery system embodying the present invention.

Referring now to the drawing, the sugar bearing solution, such, for example, as molasses at 80° brix is fed to a heating and mixing receptacle 10 where it is heated to a temperature of about 130° F. by means of a steam fed heating coil 11. Water is added from line 12 and a dilute aqueous sugar solution is added from a line 13 to reduce the density of the liquor in the receptacle 10 to about 60° brix. Particulate activated carbon at a mesh size of about —325 is supplied to the tank 10 from the line 14. The heated, impure sugar bearing liquor from the tank 10 is pumped through a line 16 and through a filter 17 to a cation exchange column 18. The filter 17 is of any suitable type which removes the fine activated carbon particles as well as larger entrained solids from the solution. If desired, and depending upon the economics of the particular installation and the type of filter employed, the liquor may be heated to as high a temperature as about 170° F.

The liquor flowing through the column 18 passes across the surfaces of a bed of cation exchange resin beads disposed in the column. Preferably, the liquor flows down through the column 18. Any suitable resin, such, for example, as a sulphonated styrene-divinylbenzene polymerizate of the type sold by Dow Chemical Company under the trade name Dowex 50 may be used. In the column 18 the monovalent ions such as calcium and magnesium replace sodium ions in the exchange positions on the resin particles.

After leaving the column 18, the softened liquor flows through a line 19 into an ion exclusion column 20 which, in the present example, contains an ion exclusion resin of the cation type. Resins of this type are well known in the art. A typical such resin is a strongly acid cation exchange resin comprising a sulfonated styrene-divinylbenzene polymerizate having a cross-linkage or percent of divinylbenzene in the hydrogen form no greater than four and a mesh range of 50 to 100, i.e., a particle size in the range of .149 to .297 mm. One such resin is sold by Dow Chemical Company under the trade name Dowex 50X4. It will be understood by those skilled in the art that a cross-linked anion exchange resin can also be used for ion exclusion, but for reasons of cost it is preferable to use a cation exchange resin.

The ion exclusion column 20 is operated in the normal manner well known in the art as described, for example, in U.S. Pat. 2,890,972, to provide an aqueous solution

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rich in sugar and containing little, if any multivalent ionized solute or larger molecular color bodies. Briefly, the column 20 is filled with the softened sugar solution. It will be understood by those skilled in the art that sweet water may be introduced into the column 20 ahead of the high brix sugar solution. The sugar molecules are absorbed into the gel of the resin particles in the column 20 and then, water is flowed through the column. Initially, the impure interstitial liquid is carried from the column by the wash water and is discharged to the sewer or otherwise treated as a waste product. After substantially all of the interstitial liquid has been removed, the sugar molecules are released into the wash water by the resin and a substantially pure sugar solution flows from the column. This pure sugar solution at a brix value of about 26 or greater is removed as a fraction from the column 20 during the passage of water therethrough and by means of suitable valving, not shown, is caused to pass through a line 21 to an anion exchange resin contained in a column 22. Such anion exchange resins are well known in the art and may, for example, be the type sold by Rohm and Haas Company under the trade name "Rohm and Haas 401 S" or "Rohm and Haas 900."

When the resin has become substantially depleted of sugar molecules and the effluent from the column 20 has too low a brix value to be economically usable, the flow thereof to the line 21 is interrupted and the dilute aqueous sugar solution is supplied through the line 13 to the tank 10. In the art, this fraction is known as sweet water.

In the column 22, color bodies not removed by the ion exclusion resin are removed and the substantially pure aqueous sugar solution at a brix value of at least about 25 is supplied through a line 23 to a tank 24 to which fresh activated carbon particles at a mesh value of about -325 are added to remove the last traces of color from the solution. Where necessary, a motor driven mixer 25 may be provided in the tank 24 to thoroughly mix the activated carbon particles with the sugar solution. The purpose of the activated carbon is to inhibit the growth of thermophiles and to improve the color of the sugar solution by absorbing the smaller color bodies which pass the ion exclusion resin and the ion exchange resins.

The liquor is then pumped by a pump 32 from the tank 24 through a line 26 and a filter 27 which removes the carbon particles. The filter 27 may be of any suitable type such as a pressure leaf or tube type. The liquid effluent from the filter 27 flows under pressure through a line 28 to an evaporator 29 wherein the concentration of the liquid is increased to a value in the range of 60 to 70 brix by the evaporation of water from the solution. The liquid leaving the evaporator 29 is a purified sugar solution at a concentration of between about 60 and 70 brix which flows through a line 30 to a storage tank 31.

The carbon particles removed by the filter 27 build up as a cake on the perforate filter elements of the filter and are periodically supplied through the line 14 to the initial mixing tank 10 when the filter elements are cleaned by removal of the filter cake. It may thus be seen that the activated carbon is used in the fresh state as a final decolorizer near the end of the process just prior to evaporation, and the once-used activated carbon is again used at the beginning of the process before it is finally removed, together with any other entrained solids, by the filter 17 and discarded. In this manner, maximum use of the carbon is achieved without any deleterious effect on the final product.

Periodically when the ion exchange resins in the columns 18 and 22 become spent, on-line flow through these columns is interrupted and the resins contained therein are rinsed by a conventional backwashing operation wherein water is pumped upwardly through the resin beds to loosen the bed and to remove any solids mechanically trapped therein. Then a regenerant solu-

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tion of NaCl having a concentration of about 12 to 15 percent by weight is flowed from a line 34 first through the anion exchange resin in the column 22 and then through a line 35 to the cation exchange resin contained in the column 18. While passing through the anion exchange resin contained in the column 22, the chlorine ions in the regeneration solution replace the monovalent anionic impurities previously captured by the anion exchange resin. These anionic impurities and the sodium cations then flow through the column 18 wherein the previously captured cationic impurities on the exhausted cation exchange resin are replaced with the sodium cations in the regeneration solution. When entering the cation exchange column 18 the regenerant solution has a concentration of about 7 percent NaCl which is adequate for regenerating the cation exchange resin. The effluent from the column 18, the spent regenerant solution, may be discharged to the sewer or otherwise treated as a waste product as the economics of the situation dictates.

While the present invention has been described in connection with particular embodiments thereof, it will be understood that many changes and modifications of this invention may be made by those skilled in the art without departing from the true spirit and the scope thereof. Accordingly, the appended claims are intended to cover all such changes and modifications as fall within the true spirit and scope of the present invention.

What is claimed is:

1. A process for recovering sugar from an impure sugar solution, comprising the steps of
mixing once-used activated carbon particles with said impure sugar solution,
passing the mixture through a filter to remove said particles therefrom,
treating the filtered solution with an ion exchange resin to remove monovalent ions therefrom,
then using an ion exclusion resin to separate sugar molecules from the larger molecules in the solution,
passing water across said ion exclusion resin to provide a purified aqueous sugar solution,
mixing fresh activated carbon particles with said purified aqueous sugar solution,
then passing the mixture of activated carbon particles and purified aqueous sugar solution through a filter to remove said carbon particles therefrom,
evaporating the effluent from said last-mentioned filter to increase the brix value thereof, and
using the carbon particles from said last-mentioned filter for the initial step of mixing once-used activated carbon particles with said impure sugar solution.

2. A process according to claim 1 wherein said impure sugar solution is molasses.

3. A process according to claim 1 comprising the additional step of heating the impure sugar solution to a temperature of at least 130° F. before the passage thereof through the first-mentioned filter.

4. A process according to claim 3 comprising the additional step of mixing a dilute aqueous sugar solution having a brix value less than 26 with said impure sugar solution before the passage thereof through the first-mentioned filter.

5. A process according to claim 4 comprising the step of obtaining said dilute aqueous sugar solution by washing said ion exclusion resin with water.

6. A process according to claim 5 comprising the steps of
treating the filtered impure sugar solution with an ion exchange resin of the same polarity as that of said ion exclusion resin,
treating said purified aqueous sugar solution with an ion exchanger resin of the opposite polarity from that of said ion exclusion resin, and

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regenerating said ion exchange resins by passing a solution of NaCl first across the surface of one of said ion exchange resins and then across the surface of the other ion exchange resin.

7. A process according to claim 6 wherein said one of said ion exchange resins is anionic and said other is cationic.

8. A process according to claim 7 wherein said regenerant has an initial concentration of NaCl in the range of about 12 to 15 percent by weight.

9. A process according to claim 8 wherein said regenerant has a concentration of NaCl in the range of about 6 to 8 percent by weight after being used to regenerate said one of said ion exchange resins.

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U.S. Cl. X.R.

127—9, 46 A; 210—24, 39