

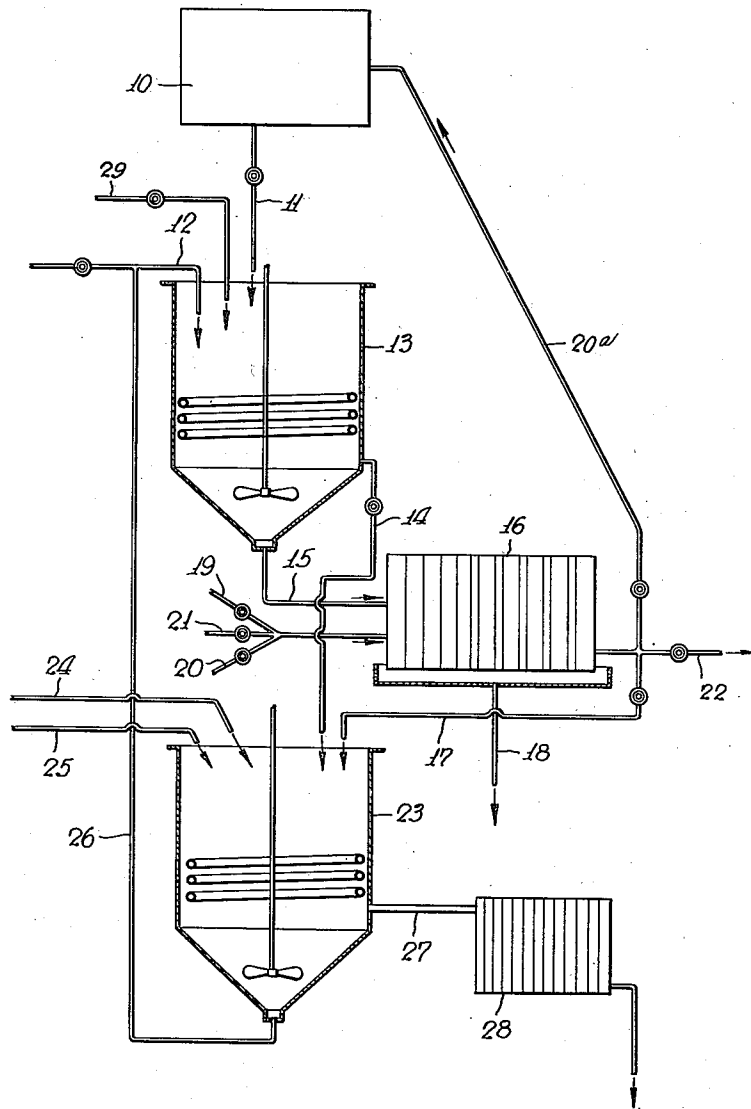
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REFINING OF SUGAR

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## REFINING OF SUGAR

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This invention relates generally to the treatment of sugar solutions, and more particularly to the refining of those types of sugar commonly known as turbinado, affined, refinery remelt sugars, washed raw sugar, and raw sugars which vary from 90 to 99% in sucrose content, the remainder being mineral ash, organic non-sugars including color ingredients, glucose, fructose, etc. The invention also has application to the treatment of invert sugar solutions and to the treatment of sugar solutions at intermediate phases of the process of producing sugar from sugar bearing materials.

In the ordinary process of treating such sugars for refining, a solution thereof is treated with lime to adjust the pH, a char is added, the solution and char are thoroughly agitated and then passed through a filter precoated with a filter aid, and then through a polishing filter. The purified solution from which the organic non-sugars have thus been substantially removed, is then sent to evaporators or to storage.

The main objects of the present invention are to reduce the cost of the purifying agents, to reduce the cost of equipment employed, to reduce the labor required, and to remove certain impurities not removable by the action of a char.

We effect a saving in cost of the purifying agents by using a very much smaller amount of the char, and accomplish that result by adding a very small amount of a much cheaper material, which removes other impurities.

We effect a saving in cost of equipment by effecting the main separation of the purifying agents by simple and rapid gravity separation instead of filtration.

We effect a saving in labor by reducing the amount of material which requires to be filtered.

Other objects and advantages will be pointed out hereinafter, or will be apparent from the following description of an embodiment of the invention.

As an important feature of our invention we add a suspension of a colloidal bentonite capable of forming a flocculent precipitate with impurities already present, and an activated carbon capable of adsorbing color imparting materials.

The colloidal bentonite used is far cheaper than the char, and we have discovered that by adding both the char and the colloidal bentonite we (1) need use very much less of the more expensive char to obtain effective color removal; (2) effect removal of certain impurities of the sugar which are not removed by the action of char; (3) obtain a purer sucrose solution as it is

free from both color imparting ingredients and colloidal impurities and thus facilitate the recovery, increase the yield and improve the character of the final recovered crystallized sugar; and (4) obtain rapid settling without the need for filtering out the added ingredients.

By using a very small amount of colloidal bentonite, for instance only about 0.1% of the sugar content of the liquid treated, and by using at the same time only about 40% of the amount of vegetable char which, if used alone would be required to obtain the desired decolorizing effect, we can obtain effective removal of colloidal impurities and at the same time obtain the full desired decolorizing.

As used herein the term colloidal bentonite is intended to cover that type of material, either in a natural or treated condition, defined and illustrated in Technical Paper No. 438 of the Bureau of Mines, Department of Commerce, entitled "Bentonite," by Davis and Vacher. The bentonite which we use is characterized by a substantial colloidal content and forms a stable colloidal suspension in water.

Our improved process may be carried out as batch operations or as a continuous process, and may be used in connection with other process steps and apparatus used in preparing sugar material to be treated by our process, the treatment of the purified solutions, the adjustment of pH value, etc.

In the accompanying drawing we have illustrated diagrammatically a layout of apparatus and pipe connections which may be employed for batch operations, but it is to be understood that other types of apparatus units may be employed, and by use of suitable units the process may be carried out continuously.

In carrying out the invention sugar which may be turbinado, refinery, affined remelt sugars, washed raw sugar or raw sugar from cane or beets, and which is about 90 to 99% sucrose, may be introduced into and dissolved in a melter which has any suitable heating and agitating means. The sugar solution, which preferably will be about 50° to 55° Brix, is directed through a conduit to an initial defecation, clarification and decolorizing apparatus, where it is mixed with the residual material derived through a pipe from a later stage of clarification and the clarification properties of which are not spent, and which includes colloidal bentonite and finely divided activated carbon such as vegetable char or animal char, for instance bone char.

The mixing may take place in a tank which

has suitable heating and agitating means, and the heating may be to about 80° to 85° C. A flocculent precipitate is formed which rapidly settles to the bottom as a fairly compact floc when the agitating is stopped, leaving a supernatant liquid which may be drawn off through a conduit 14 for further treatment with fresh treating material. The precipitant, including the bentonite and the activated carbon, as well as some coloring material, colloidal impurities and other non-sugars, may be drawn off through a conduit 15 and the contained sugar solution separated from the solid in any suitable manner. As the precipitate possesses very well defined filter aid characteristics, a wide variety of different batch or continuous filters or other mechanical separators may be used effectively.

We have diagrammatically shown a separating apparatus 16 which may be a frame and plate filter, a rotary vacuum filter, a centrifuge, or other equivalent. The separated solution may be delivered through a conduit 17 to mix with that drawn off from the tank 13, and the filter cake or dried solids may be discharged through a conduit or chute 18. If the apparatus be a rotary filter, a frame and plate filter, or other batch apparatus, the filter cake may be washed with water delivered through the conduit 19, and the sweet water from the filter may be returned to the melter 10 through a conduit 20a. Air from the conduit 20 may be blown through to remove water from the cake, and steam from a conduit 21 may be blown through to dry the cake and to initially heat the apparatus. Air, steam and solution too dilute for further recovery may be delivered to waste through conduit 22.

The partially purified sugar solution delivered from the tank 13 through conduit 14 and from the separator 16 through the conduit 17, is conducted to a second defecation, clarification and decolorizing apparatus, where it is mixed with fresh treating material. Such apparatus may include a tank 23 similar to the tank 13, and having suitable heating and agitating means.

Fresh activated carbon, preferably as a slurry, is delivered to the tank 23 through a conduit 24, and a bentonite slurry is delivered through a conduit 25. In some cases the dry activated carbon and the dry bentonite may be mixed, and one slurry made from such mixture, or the slurries may be made separately and then mixed and delivered through a single conduit. The bentonite slurry preferably contains about 2½% colloidal bentonite. As an example, the amount of bentonite added to the tank 23 may be about 0.1% of the solid content of the sugar solution, and the amount of activated carbon to obtain a decolorization equivalent to 1 on the Horne scale need be only about 40% of that which would have been required to give the decolorization to the same point if used without the bentonite. A suitable vegetable char which may be used is Darco S-51. Obviously the actual amount of the char or other activated carbon will vary with the amount of coloring material in the sugar being treated, and with the particular kind of char used. In general about .3% of char, based on the sucrose content of the solution, is sufficient to give a decolorization to 1 on the Horne scale. The bentonite slurry should not have too high a colloidal bentonite content as it is too difficult to thoroughly disperse in the sugar solution, and if too dilute a slurry is used the colloidal impurities of the sugar may not be completely

removed, or the separation of the precipitate is unduly delayed, or the water added as a part of the slurry is objectionable as diluting the sugar solution to too great an extent.

Upon heating and agitating the solution with the activated carbon and the bentonite in the tank 23, a solid flocculent precipitate is quickly formed and quickly settles to the bottom when the agitating ceases. The clear, supernatant sugar solution, free from color and colloidal impurities, may be drawn off through the conduit 27. The precipitate which contains all or substantially all of the remaining impurities and the bentonite and char, may be drawn off through a conduit 26 and delivered to the tank 13 for further use, because the bentonite and char are not completely spent.

Although such sugar solution will ordinarily be free of all ingredients which can be removed by filtration or further settling, it is preferable to deliver the solution through a polishing filter 28 to remove any traces of suspended solid. This may be a frame and plate filter or a precoated filter of any suitable batch or continuous type.

Although the drawing indicates the tanks 13 and 23 as performing the function of a mixer and a separator, it is obvious that these functions may be performed in separate units. For continuous operation the tanks 13 and 23 may serve merely for mixing, heating and agitating which may take about 15 or 20 minutes, and the mixture instead of being permitted to settle in the tank may be continuously withdrawn and delivered through any suitable type of clarifier, such as a multiple tray clarifier of the Dorr type, or a settler such as a Deming apparatus.

If it is desired to adjust the pH of the solution the usual procedure may be employed. For instance, lime or other materials may be delivered to the tank 13 through the conduit 29, and in the proper amount.

The sugar solution delivered from the polishing filter is superior to that obtained by the use of either char or bentonite alone, as both the colloidal non-sugar impurities such as gums, waxes, etc. and the color have been removed. Thus a larger amount of crystallized sugar may be obtained with fewer successive reconcentrations and centrifuging separations, and the crystals are of better appearance because of the removal of waxes and gums, which if present form films on the sugar crystals. Inversion losses are also reduced or avoided. In addition to being in a form suitable for treatment to recover crystallized refined sugar, the solution may also be used directly as liquid sugar.

The vegetable char is far more expensive than the bentonite, and a very substantial saving is effected by the reduction in the amount of char required for a given decolorization. The main body of the sugar solution does not need to be filtered except in the final polishing filter, and thus a substantial saving is effected in the cost of equipment, and a substantial saving in labor is effected. Only one main filter need be used, and this treats only the mud or precipitate from the tank 13, which is of relatively small volume, for instance 15% of the volume of the sugar solution. No filtering is required to remove the char from the solution, as is the case where no bentonite is used, because the bentonite in settling carries down the fine particles of char.

Although it is preferable to treat the sugar solution first with partly spent material and then with fresh material, and thus reuse the material,

it will be obvious that the sugar solution may be given only a single treatment by fresh bentonite and vegetable char, and the spent or partially spent filter cake or separated solids may be discarded or used in another operation, or it may in some cases be revived or reactivated and re-used as fresh material, or as a supplement to fresh material.

Where only a single treatment is employed, the conduits 24 and 25 may deliver directly to the tank 13, and the sugar solution withdrawn from the tank 13 may be delivered to the polishing filter 28, and the solution from the filter 16 delivered to the tank 13 or the polishing filter 28.

Although we have referred to the use of vegetable char in giving an example of the invention, the invention broadly considered includes the use of equivalent materials, in finely divided form and which may be removed with the flocculated material.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. The process of refining sucrose solutions, which includes adding to and mixing with the solution a partially spent suspended colloidal bentonite which will be flocculated by ingredients of the sucrose solution, and a solid decolorizing material in finely divided condition, heating and agitating the mixture, separating the solids from the solution of sucrose by gravity, and adding to and mixing with said last mentioned solution fresh suspended colloidal bentonite which will be flocculated by ingredients of the sugar solution, and a solid decolorizing material in finely divided

condition, separating the solids from the solution and returning them for use in the first mentioned step.

2. The process of refining sucrose solutions, which includes adding to and mixing with the solution a partially spent suspended colloidal bentonite which will be flocculated by ingredients of the sucrose solution, and an activated carbon, heating and agitating the mixture to form a coagulum including the bentonite and carbon, separating the solids from the solution of sucrose by gravity, adding to and mixing with said last mentioned solution fresh suspended colloidal bentonite, and an activated carbon, heating and agitating this mixture, separating the solids from the solution by gravity and returning them for use in the first mentioned step.

3. The process of refining a solution having 90% to 99% sucrose content and 50° to 55° Brix, which includes adding to and mixing with the solution a partially spent coagulum of colloidal bentonite and solid decolorizing material in finely divided form, heating and agitating the mixture, separating by gravity from the solution of sugar the coagulum resulting from the action of the first mentioned coagulum and impurities of the solution, adding to and mixing with said last mentioned solution fresh suspended colloidal bentonite and solid decolorizing material in finely divided form, heating and agitating this mixture, separating the resulting coagulum from the solution by gravity and returning it for use in the first mentioned step.

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