(54) Title: PROCESS FOR PRODUCING LIQUID SUGAR FROM IMPURE RAW SUGAR

(57) Abstract: The process comprises: dissolving the raw sugar to a raw syrup (sucrose solution) with 65° Brix to 68° Brix, containing amide and dextran; chemically treating the raw syrup with acidulating and neutralizing agents and with flocculating agents, and by injecting air or carbonic gas in the raw syrup, for providing its flotation and production of a clarified syrup; filtering the clarified syrup; regenerating the clarified syrup by making it pass through a column for the immobilization of contaminant enzymes present in the raw syrup, and through ionic cationic and ionic anionic exchange columns disposed downstream and in series with the enzyme immobilization column; and filtering for final polishing of the clarified and regenerated syrup, with the removal of the undesirable residual color, turbidity, odor and flavor.
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))
— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))
PROCESS FOR PRODUCING LIQUID SUGAR FROM IMPURE RAW SUGAR

Field of the invention
The present invention refers to a process for the production of high purity liquid sugar used in the food industry in general, from impure raw sugar defined as crystal sugar in general, raw sugar in general, VHP sugar (Very High Polarization sugar), VVHP sugar (Very Very High Polarization sugar), magma B or C (intermediary products of the conventional process of producing crystal sugar) and mixtures of said sugars.

Background of the invention
The state of the art comprises a production process which allows obtaining high purity and quality sugar by using, as raw material, sucrose impure solutions prepared from at least one of the types of impure raw sugar, such as for example, white crystal sugar, sugar B, sugar C (magma), VHP sugar and VVHP sugar, crystal sugar in general, or combinations between the several types of sugar and/or syrups thereof.

The main difference between the types of sugar is measured in terms of color, purity, ash content, turbidity, insoluble materials, impurities, metal content, starch content and dextran content. Typically, the impure raw sugars (not refined), such as VHP and VVHP, are destined to exportation, for supplying the sugar refineries. The white crystal sugar can be of several types, which are widely used for domestic and industrial consumption, and the sugars of types B and C are intermediary sugars in the conventional process of producing crystal sugar and are not commercialized.

Food industries, in general, use sugar in their manufacturing processes. Depending on the type of product to be produced, the quality of the sugar used can vary
widely. The more demanding industries in terms of quality of the raw material, such as for example, soft drink and juice industries, either use the granulated refined sugar in the crystalline form, or in the dissolved form (liquid sugar (see table 1 in the last page of the specification)). It can also be used the white crystal sugar, classified as 2A or 2G (see table 1), with the color around 150 ICUMSA. However, with this type of sugar, it is necessary to promote purification, in order to obtain a liquid sugar with characteristics similar to those of the dissolved granulated refined sugar. Usually, the unitary operations involved in the purification comprise dissolving the sugar and obtaining a raw syrup with a concentration of 65°Brix, filtering in a pre-coat filter, in which a filtration auxiliary means and activated coal are dosed for color removal. Thus, a final syrup is obtained with a color of about 50 ICUMSA. Of course, the purer the sugar, the smaller will be the number of operations to be executed in the mill. However, the highest degree of purity of the sugar used, the highest will be the aggregated value. Companies which use the preliminary process of obtaining crystal sugar for posterior use also make restrictions as to the types of sugar, mainly regarding color, turbidity and impurity levels. Thus, the use of sugar of the VHP or VVHP types in a conventional sugar mill for the production of juices and soft drinks, is totally prohibitive, mainly due to the high content of impurities, color and levels of dextran, starch and ashes in this type of sugar, which can alter the properties, the aspect, and the organoleptic properties of the end product. In the conventional mills, in order to obtain the
granulated refined sugar from impure raw sugar, such as for example VHP and VVHP, several unitary operations (see figure 1 in the appended drawings) are required: dissolution of the crystal sugar to a raw syrup with about 65°Brix; chemical treatment of the raw syrup with phosphoric acid and lime milk; addition of flocculating agents (anionic and cationic); flotation with air injection; filtration of the syrup in a pre-coat filter on a bed defined by an auxiliary filtration means (diatomaceous earth) and activated coal; feeding the syrup into ionic exchange columns (cationic and anionic); concentration of the syrup in vacuum evaporators; crystallization of the sugar in evapo-crystallizers; centrifugation of the crystallized mass; drying of the crystals; and sending the remaining syrup to the sugar recovery process. The use of these unitary operations ensures the reduction of the initial color of the impure raw sugar, for example, VVHP (400 ICUMSA) or VHP (1000 ICUMSA), to 40-50 ICUMSA in the final granulated refined sugar.

Among all the required purification steps, the most important, with respect to the removal of color and impurities, is the crystallization, since this process is responsible for reducing color and ashes about 16 to 18 times the color of the initial syrup fed into the crystallizers (see, for example, Rein, P. "Cane Sugar Engineering", Bartens, ISBN 978-3-87040-110-8 and Chou, C.C. "Handbook of Sugar Refining", John Wiley & Sons, ISBN 0-471-18357-1, 2000).

One of the great problems for processing raw sugar in the refineries occurs when the levels of dextran and starch in the sugar are high. The remaining starch in the impure raw sugar is part of
the constituents of the sugar cane and is not eliminated in the production process.

The remaining dextran in the raw sugar is a polysaccharide produced by contaminant bacteria, generally *Lactobacillus*, *Leuconostoc*, *Streptococcus*, which are brought to the mill together with the contaminated sugar cane and/or are propagated throughout the raw sugar production process.

The starch and dextran provoke deleterious effects in the filtration process, reducing the filtration capacity or causing total obstruction. They also provoke harmful effects in the formation of crystals, leading to deformations (crystal stretching), impairing the centrifugation process and, consequently, the elimination of color. The processes involved in the sugar production, or even those carried out in the mills, are ineffective in eliminating said compounds, removing them only partially, in small fractions. As a way to overcome such problem, the greatest world buyers of impure raw sugar have limited the maximum content of dextran and starch in the raw sugar to 100 ppm.

In order to guarantee the required dextran levels, the sugarcane processing mills started to add, when necessary, commercial enzymes which are capable of hydrolyzing these polysaccharides (dextranase for dextran and alpha-amylase for starch). Presently, there are thermo-resistant commercial enzymes, which can be dosed in the heated syrup before the crystallization process. This is an important fact, since in the crystallization process only eventual residual enzymes remain in the syrup, and are not carried, in a significant amount, to the crystals. Since the impure raw sugar will be submitted again to purification and crystallization
processes in the mill, the presence of residual enzymes in the granulated refined sugar does not represent any risk.

With the worldwide shortage of sugar in the last three years, prices surged in the national and world markets and the availability of white crystal sugar as raw material for the soft drink industries has been sharply reduced, whereby the white crystal sugar became disputed in the market.

The shortage of the white crystal sugar forced said industries to accept sugar batches of lower quality, mainly with higher levels of impurity and color, causing a lot of worries to the consumer industries, which were not prepared to process this type of sugar. In view of these difficulties, said industries considered the possibility of producing sugar with lower patterns of quality, which fact requires the development of new technologies, as said industries are not provided with adequate plants to carry out processes for purifying and re-crystallizing the impure raw sugar, as it occurs in the mills.

The sugar shortage in the market has also forced the sugar buyers to accept sugar batches with dextran and starch specification above 100 ppm, making even worse the situation of industries which process sugar to be used in soft drinks and juices, due to the aforesaid problems. The presence of residual dextran or starch in the syrup prepared to be used in soft drinks causes the formation of flakes and turbidity, disqualifying the product to be commercialized.

On the other hand, the use of commercial enzymes, such as dextranase and alpha amylase for reducing the levels of dextran and starch is not feasible, since residual
presence of enzymes can exist in the end product. Unlike the sugar mills, it is not possible for the food industries which consume said sugars to use the crystallization processes, which are highly efficient to reduce impurities, color and eventual enzyme residues. As a function of the limitations of the prior art, it is desired to provide a simple and reliable process to produce high purity liquid sugar from impure raw sugar, that is, from sucrose impure solutions presenting high contents of dextran and starch.

Summary of the invention

As a function of the prior art limitations, it is the object of the present invention to provide a process, which is relatively simple to implement and presents a high degree of investment return, for the production of liquid sugar of high purity and devoid of enzyme residues, from impure raw sugar, that is, impure sucrose solutions presenting unacceptable contents of dextran and starch, prepared from raw crystal sugar, as for example, white crystal sugar in general, sugar B, sugar C (magma), VHP sugar (Very High Polarization sugar), VVHP sugar (Very Very High Polarization sugar), and combinations between the several types of sugar and/or syrups thereof.

The high degree of investment return mentioned above is mainly associated with the different prices between the raw sugar (lower price) and the white crystal or refined sugar, and the low OPEX value (costs regarding product inputs and processing).

The present process for producing high purity liquid sugar from impure raw sugar is of the type which comprises the steps of: dissolving the raw sugar to a raw syrup in the form of a sucrose solution with a concentration of 65°Brix to 68° Brix and containing amide
and dextran; chemically treating the raw syrup, by adding acidulating and neutralizing agents and cationic and anionic flocculating agents, and by injecting air or carbonic gas in the raw syrup, in order to provide flotation of the latter and the production of a clarified syrup and a foam containing the impurities of the sucrose solution; filtering the clarified syrup on a bed containing a filtration auxiliary means and activated coal; and regenerating the clarified syrup by making it pass through ionic cationic and ionic anionic exchange columns, with the removal of metals and color, respectively.

According to the invention, the process further comprises the steps of: adding, to the dissolved raw syrup, dosed amounts of dextranase and alpha amylase enzymes, in an amount sufficient to promote the hydrolysis of the amide and dextran present in the dissolved raw syrup; passing the clarified and filtrated syrup through a column containing a bed of anionic resins with the capability of immobilizing the contaminant enzymes that are present in the dissolved raw syrup, before the serial passage of the clarified syrup through the ionic cationic and ionic anionic exchange columns of the regeneration step; and filtering for the final polishing of the regenerated clarified syrup on a bed of diatomaceous earth and activated coal, with the final removal of the undesirable residual color, turbidity, odor and flavor.

Thus, the impure raw sugar to be used as raw material and which can present an unacceptable contamination by remaining polysaccharides produced by contaminant bacteria in the raw sugar manufacturing process, mainly a level of dextran and/or starch higher than for example, 100 ppm, can be processed by using the new regeneration
step proposed by the invention, by first passing the already clarified and filtrated but not yet discolored syrup, through an enzyme immobilization column, in which the dextranase and alpha amylase enzymes, which were previously added in doses to the raw syrup, are retained. When the already dissolved impure raw sugar presents a level of gravimetric ashes higher than 0.05% (p/p), the regeneration step can further include an ionic exchange system, in the form of an additional mixed bed column disposed in series with the cationic and anionic exchange columns.

**Brief description of the drawings**

The invention will be described below, with reference being made to the appended drawings, given by way of example of a possible embodiment of the invention, and in which:

Figure 1 represents a block diagram of the conventional process for producing granulated refined sugar from impure raw sugar;

Figure 2 represents a block diagram illustrating the conventional process for producing the syrup, from white crystal sugar, for the manufacture of soft drinks and juices; and

Figure 3 represents a block diagram of one of the possible ways of carrying out the process of the invention related to the production of high purity sugar syrup, from impure raw sugar, defined by crystal sugar in general, raw sugar in general, sugar VHP, sugar VVHP, or mixtures thereof.

**Detailed description of the invention**

As mentioned hereinbefore, the present invention is applied to the production of high purity liquid sugar, from impure raw sugar containing a level of starch and of
dextran higher than or equal to 100 ppm.
According to the invention, the impure raw sugar, for example raw crystal sugar, is dissolved under agitation, using water and steam or hot water and/or fresh water recovered from the process, until a raw syrup (or brown syrup) is obtained in the form of a sucrose solution with a concentration of 65 to 68°Brix and which is heated to a initial temperature of 50 to 55°C, so that it can receive the addition of dextranase and alpha-amylase enzymes, the sucrose solution being so maintained heated by at least 30 minutes.
The amounts of dextranase and alpha-amylase enzymes are dosed to be sufficient to hydrolyze the starch and the dextran present in the dissolved raw syrup.
Subsequently, the raw sugar syrup, defining the dissolved sucrose solution, is heated at a temperature of 75 to 85°C, and so maintained by at least 30 minutes, for increasing the enzymatic activity of the alpha-amylase. The raw syrup is then submitted to a chemical treatment with the addition of phosphoric acid, as a coagulation agent for the sucrose solution, and with the neutralization of the acidified raw syrup, by adding one of the agents selected from lime milk and calcium saccharate.
The addition of phosphoric acid is made so as to obtain a concentration, in terms of P₂O₅, between 200 and 1500 ppm, depending on the type of sugar utilized. The lime milk (or calcium saccharate) is added to correct the pH of the syrup to the range of 6.8 to 7.5. After the addition of said agents, there occurs an abundant coagulation of the non-sugars, denatured proteins and of the formed calcium phosphate.
The treated and coagulated syrup then receives the
addition of cationic and/or anionic flocculating agents, in order to provide an intense formation of flakes constituted by several units of the previously coagulated material and also of dispersed insoluble particles, usually remaining bagacillo (impurity present in the impure raw sugar).

In the following step, it is made an injection of air or carbonic gas in the acidified, neutralized and coagulated syrup. The injection is made by a gas dispersing device, which produces a large amount of micro-bubbles of air or carbonic gas, producing, in the flotated raw syrup, a clarified syrup, and a flotated foam containing impurities removed from the sucrose solution. The micro-bubbles produced in the raw syrup allows obtaining a high flotation efficiency, producing, in the upper part of the syrup under flotation, the foam (sludge) containing the flotated impurities and, in the lower part, the clarified syrup.

In the flotation step, from about 40 to 70% of the turbidity of the syrup, as well as from about 20 to 50% of its initial color are removed.

The flotated and clarified syrup is then separated from the foam (sludge) and the latter is diluted in water and filtrated on a bed containing a filtration auxiliary means, producing a cake and a sugar-containing filtered syrup which is returned to the dissolution step.

The clarified syrup is subsequently submitted to a filtration step on a bed containing a filtration auxiliary means, for example, a diatomaceous earth and activated coal, to be then submitted to a regeneration step, in which the clarified and filtered syrup is passed through ionic cationic and ionic anionic exchange columns for the removal of earthy alkaline salts and metals, and
of color materials, respectively.
According to the invention, the regeneration is carried out by passing the clarified and filtered syrup through an enzyme immobilization column, containing a resin bed with high capability of immobilizing the enzymes added in the previous steps (and which are potential contaminants of the end product) and still present in the dissolved raw syrup. Said enzyme immobilization column is positioned upstream and in series with the ionic cationic and ionic anionic exchange columns of the regeneration step.
As schematically illustrated in figure 3, the process has its regeneration step carried out by the sequence of serial columns defined: by an enzyme immobilization column; by an ionic cationic exchange column, with a cationic resin bed for the removal of cations, for removing earthy alkaline metals and metals; by an ionic anionic exchange column of primary discoloration; and by an ionic anionic exchange column of secondary discoloration.
The regeneration columns commented above are used when the impure raw sugar is a sugar presenting dextran and starch contents higher than 100 ppm and ash content lower than 0.05% (p/p).
The provision of the enzyme immobilization column upstream and in series with the other columns of the regeneration step allows some eventual residual enzymes, which are present in the clarified and filtered syrup, to remain retained in said enzyme immobilization column ("enzyme trap"), not contaminating the end product (high purity liquid sugar syrup).
The clarified syrup, filtered and deprived of residual enzymes is then fed, in an upward flow, flowing through
the cationic resin bed of the ionic cationic exchange column and, subsequently, through the anionic resin bed of the ionic anionic exchange column of primary discoloration; and of the ionic anionic exchange column of secondary discoloration, completing the cycle of removing cations and color elements which are present in the clarified and filtered syrup.

The application rates of the raw syrup may vary between 1 bed volume per hour (1.0 BV/h) to 4.0 BV/h, and for a total volume ranging from 20 to 50 BV, depending on the type of sugar being processed.

The clarified and regenerated syrup, effluent from the ionic exchange regeneration system, is then sent to the final polishing step of the product, in a pre-coat filtration on a bed of diatomaceous earth and activated coal, for the final removal of undesirable residual turbidity, color, flavor and odor. The final liquid sugar syrup should comply with the specifications described in Table 1.

In another way of carrying out the invention, when the already dissolved impure raw sugar, which is used as raw material, presents, besides the levels of dextran and/or starch superior to 100 ppm, a level of gravimetric ashes superior to 0.05% (p/p), the regeneration step further includes a mixed bed ionic exchange system, in the form of an additional mixed bed column, disposed in series and downstream the ionic anionic exchange column of secondary discoloration and which is responsible for the retention of salts in general, such as the alkaline and earthy alkaline metals.

Upon completion of the syrup regeneration operating cycle by ionic exchange, there are carried out the operations of draining the sugar syrup by injecting air and
pressurizing the columns, and sending the syrup for storage and posterior reprocessing. Water is introduced for washing the sugar syrup remaining in the columns, at a rate from 2.0 to 4.0 BV/h, reaching a total ranging from 1.2 to 3.0 BV/h, with the fresh water being sent to the sugar dissolution section, subsequently starting the regeneration process of the columns, according to the operations described below.

The regeneration of the cationic columns, of the enzyme immobilization column and of the primary and secondary anionic columns is effected with a brine solution (10% of NaCl), alkalized with soda (0.5% of NaOH), at 60-80°C, at a rate of about 1-2 BV/h, totalizing about 2-3 BV. Upon completion of the regeneration cycle of the columns, it is conducted an operation of rinsing with hot water (60 to 80°C), at a rate of 1-2 BV/h for a total volume of about 2 BV. The following operation is a quick rinse, applying heated water from 60 to 80°C, at an application rate of 10-20 BV/h for a total volume of 3 to 5 BV.

Sequentially, it is re-started the process of feeding the sugar syrup of 65-68° Brix, at 75-85°C, which is sent to storage and posterior use.

In the way of carrying out the invention which uses a mixed bed column in combination with the other columns, the regeneration should be carried out with a solution of hydrochloric acid (6% of HCl), at 60-80°C at a rate of about 1-2 BV/h, making a total of about 2-3 BV. The remaining operations are identical to those described hereinabove.

See Table 1 in the next page (page 14).
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Unit</th>
<th>Types of sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tybe E</td>
</tr>
<tr>
<td>Color/CUNSA</td>
<td>UL</td>
<td>max.</td>
</tr>
<tr>
<td>Insoluble Residues</td>
<td>1 a 10</td>
<td>max.</td>
</tr>
<tr>
<td>Black Spots</td>
<td>nP/100 g</td>
<td>max.</td>
</tr>
<tr>
<td>Magnetic Particles</td>
<td>mg/kg</td>
<td>max.</td>
</tr>
<tr>
<td>Polarization</td>
<td>%</td>
<td>≥ 99.80</td>
</tr>
<tr>
<td>Humidity</td>
<td>%</td>
<td>max.</td>
</tr>
<tr>
<td>Ashes</td>
<td>%</td>
<td>max.</td>
</tr>
<tr>
<td>Sulfite</td>
<td>mg/kg</td>
<td>max.</td>
</tr>
<tr>
<td>Dextran</td>
<td>mg/kg</td>
<td>max.</td>
</tr>
<tr>
<td>Starch</td>
<td>mg/kg</td>
<td>max.</td>
</tr>
<tr>
<td>Tubidity</td>
<td>NTU</td>
<td>max.</td>
</tr>
<tr>
<td>Alcoholic Flake</td>
<td>Abs. 420</td>
<td>max.</td>
</tr>
<tr>
<td>Granulometry</td>
<td>AM (mm)</td>
<td>max.</td>
</tr>
<tr>
<td></td>
<td>CV %</td>
<td>max.</td>
</tr>
<tr>
<td></td>
<td>% Pass #70</td>
<td>max.</td>
</tr>
<tr>
<td>Arsenic</td>
<td>mg/kg</td>
<td>max.</td>
</tr>
<tr>
<td>Lead</td>
<td>mg/kg</td>
<td>max.</td>
</tr>
<tr>
<td>Coliforms (45°)</td>
<td>SPC/g</td>
<td>max.</td>
</tr>
<tr>
<td>Salmonella sp</td>
<td>in 25 g</td>
<td>Absent</td>
</tr>
<tr>
<td>Insoluble Residues Gray</td>
<td>mg/kg</td>
<td>max.</td>
</tr>
<tr>
<td>Appearance</td>
<td></td>
<td>White Crystal Flows Freely</td>
</tr>
<tr>
<td>Flavor</td>
<td>Characteristic Sweet</td>
<td>Characteristic, without Unpleasant Odor</td>
</tr>
<tr>
<td>Odor</td>
<td></td>
<td>Characteristic Sweet</td>
</tr>
</tbody>
</table>
CLAIMS

1. Process for producing high purity liquid sugar from raw sugar, comprising the steps of:
   - dissolving the raw sugar into a raw syrup in the form of a sucrose solution with a concentration from 65°Brix to 68° Brix and containing amide and dextran;
   - chemically treating the raw syrup by adding phosphoric acid as a coagulation agent of the sucrose solution, and by neutralizing the acidified raw syrup, by adding one of the agents selected from lime milk and calcium saccharate, until obtaining a pH from 6.8 to 7.5;
   - flocculating the treated syrup, by adding cationic and/or anionic flocculating agents;
   - injecting air or carbonic gas in the acidified, neutralized and coagulated raw syrup, dispersing therein micro-bubbles of air or carbonic gas and producing, in the flotated raw syrup, a clarified syrup and a foam;
   - separating the flotated and clarified syrup from the foam containing impurities of the sucrose solution;
   - filtering the clarified syrup on a bed containing a filtration auxiliary means and activated coal; and
   - regenerating the clarified and filtered syrup, by passing it through ionic cationic and ionic anionic exchange columns, with the removal of metals and color, respectively, the process being characterized in that it further comprises the steps of:
   - adding, to the dissolved raw syrup, dosed amounts of dextranase and alpha-amylase enzymes, sufficient to hydrolyze the starch and the dextran present in the dissolved raw syrup;
   - passing the clarified and filtered syrup through a column containing a resin bed, with the capability of immobilizing the contaminant enzymes present in the
dissolved raw syrup, and which is positioned upstream and in series with the ionic cationic and ionic anionic exchange columns; and
- filtering for final polishing of the clarified and regenerated syrup, on a bed of diatomaceous earth and activated coal, with the final removal of the undesirable residual color, turbidity, odor and flavor.

2. Process, according to claim 1, characterized in that the dissolved raw sugar syrup is heated at 50-55°C, for receiving the addition of the dextranase and alpha-amylase enzymes, being maintained in this heated condition by at least 30 minutes.

3. Process, according to claim 2, characterized in that the dissolved raw sugar syrup is heated at a temperature of 75-80 °C, by at least 30 minutes, increasing the enzymatic activity of the alpha-amylase.

4. Process, according to any one of claims 1, 2 or 3, characterized in that the regeneration of the clarified and filtered syrup is carried out by an ionic cationic exchange column for removal of cations and, in series with the latter, by an ionic anionic exchange column of primary discoloration and an ionic anionic exchange column of secondary discoloration.

5. Process, according to any one of claims 1 to 4, characterized in that the raw sugar is a crystal sugar, a sugar VHP or a sugar VVHP presenting contents of dextran and starch higher than 100 ppm and a content of ashes lower than or equal to 0.05%(p/p).

6. Process, according to any one of claims 1 to 4, characterized in that the clarified and filtered syrup, which passes through the ionic cationic and ionic anionic exchange columns in the regeneration step, is caused to pass through a mixed bed column, disposed in series and
downstream in relation to said ionic exchange columns.

7. Process, according to claim 6, characterized in that the raw sugar is a crystal sugar, a sugar VHP or a sugar VVHP presenting contents of dextran and starch higher than or equal to 100 ppm and an ash content higher than or equal to 0.05\%(p/p).

8. Process, according to any one of claims 1 to 7, characterized in that the flotated foam, which is separated from the clarified syrup in the flotation step of the raw syrup, is diluted in water and filtered on a bed containing a filtration auxiliary means, producing a cake and a sugar-containing filtered syrup which is returned to the dissolution process.

9. Process, according to any one of claims 1 to 8, characterized in that the final liquid sugar syrup presents a color inferior or equal to 50 UI, and a turbidity lower than or equal to 5 NTU (or 20 ppm).
RAW SUGAR

STEAM → DISSOLUTION
WATER → DISSOLUTION

H<sub>3</sub>PO<sub>4</sub> → TREATMENT
LIME MILK → TREATMENT

FLOCCULATING AGENT → FLOCCULATION
AIR → FLOCCULATION

FILTRATION AUXILIARY MEANS AND ACTIVATED COAL → FLOCCULATION

WATER → FILTRATION

FOAM → FILTRATION

CAKE → FILTERED FOR DISSOLUTION

WATER → FILTRATION AUXILIARY MEANS

EFFLUENTS → IONIC CHANGE COLUMNS

WATER CONDENSATION → CONDENSER

STEAM → EVAPORATION

WATER FOR COOLING TOWER → CONDENSER

CRISTALLIZATION → CENTRIFUGATION

DRYING → GRANULATED REFINED SUGAR

FIG. 1
PRIOR ART
FIG. 2
PRIOR ART
## INTERNATIONAL SEARCH REPORT

**International application No**  
PCT/BR2012/000406

### A. CLASSIFICATION OF SUBJECT MATTER

<table>
<thead>
<tr>
<th>INV.</th>
<th>C13B10/00</th>
<th>C13B35/06</th>
<th>C13B20/12</th>
<th>C13B20/14</th>
<th>C13B20/00</th>
</tr>
</thead>
<tbody>
<tr>
<td>B01D15/36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### B. FIELDS SEARCHED

- Minimum documentation searched (classification system followed by classification symbols)  
  C13B  
  B01D

- Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

- Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
  - EPO-Internal
  - WPI Data

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US 3 799 806 A (MADSEN R) 26 March 1974 (1974-03-26) claims 1, 5</td>
<td>1-9</td>
</tr>
<tr>
<td>A</td>
<td>US 2010/307485 AI (BOJORQUEZ VALENZUELA MARIO CESAR [MX] ET AL) 9 December 2010 (2010-12-09) claim 1</td>
<td>1-9</td>
</tr>
<tr>
<td>A</td>
<td>GB 889 823 A (AMERICAN SUGAR REFINING COMPAN) 21 February 1962 (1962-02-21) the whole document</td>
<td>1-9</td>
</tr>
</tbody>
</table>

[X] Further documents are listed in the continuation of Box C.  
[X] See patent family annex.

* Special categories of cited documents:
- **A** document defining the general state of the art which is not considered to be of particular relevance
- **E** earlier application or patent but published on or after the international filing date
- **L** document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- **O** document referring to an oral disclosure, use, exhibition or other means
- **P** document published prior to the international filing date but later than the priority date claimed
- **T** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- **X** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- **Y** document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- **S** document member of the same patent family

### Date of the actual completion of the international search

20 February 2013

### Date of mailing of the international search report

27/02/2013

### Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040,  
Fax: (+31-70) 340-3016

Authorized officer

Pi cout, Davi d

Form PCT/ISA/210 (second sheet) (April 2005)
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>US 3799806</td>
<td>26-03-1974</td>
<td>NONE</td>
</tr>
<tr>
<td>US 2010307485</td>
<td>09-12-2010</td>
<td>AR 071675 AI</td>
</tr>
<tr>
<td>US 2010307485</td>
<td>09-12-2010</td>
<td>CA 2720496 AI</td>
</tr>
<tr>
<td>US 2010307485</td>
<td>09-12-2010</td>
<td>EP 2272990 AI</td>
</tr>
<tr>
<td>US 2010307485</td>
<td>09-12-2010</td>
<td>PA 8825501 AI</td>
</tr>
<tr>
<td>US 2010307485</td>
<td>09-12-2010</td>
<td>PE 01152010 AI</td>
</tr>
<tr>
<td>US 2010307485</td>
<td>09-12-2010</td>
<td>US 2010307485 A</td>
</tr>
<tr>
<td>US 2004255934</td>
<td>23-12-2004</td>
<td>AP 2153 A</td>
</tr>
<tr>
<td>US 2004255934</td>
<td>23-12-2004</td>
<td>AU 2004252288 AI</td>
</tr>
<tr>
<td>US 2004255934</td>
<td>23-12-2004</td>
<td>BR PI0411622 A</td>
</tr>
<tr>
<td>US 2004255934</td>
<td>23-12-2004</td>
<td>CN 1856581 A</td>
</tr>
<tr>
<td>US 2004255934</td>
<td>23-12-2004</td>
<td>EC SP066296 A</td>
</tr>
<tr>
<td>US 2004255934</td>
<td>23-12-2004</td>
<td>US 2004255934 A</td>
</tr>
<tr>
<td>GB 889823</td>
<td>21-02-1962</td>
<td>WO 2005001144 A2</td>
</tr>
<tr>
<td>US 4795494</td>
<td>03-01-1989</td>
<td>US 4795494 A</td>
</tr>
<tr>
<td>GB 889823</td>
<td>21-02-1962</td>
<td>WO 8908635 A</td>
</tr>
</tbody>
</table>