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(73) Titulaire(s):
OUSHANGYUAN PROCESS & EQUIPMENT INTELLIGENT CO. – 300350 TIANJIN, Hebei (Chine)

(72) Inventeur(s):
SU Xin – Chine, TANG Haijing – Chine, ZHANG Tianti – Chine, GAO Jianguo – Chine, WANG Shengchang – Chine

(74) Mandataire(s):
MARKS & CLERK LLP –
1017 LUXEMBOURG (Luxembourg)

(54) Sucrose decoloring method and system.

(57) A sucrose decoloring method and system. The method comprises the following steps: (1) a decoloring process; (2) a sweet off process; (3) a backwashing process; (4) a regeneration process; and (5) a rinsing process. The sucrose decoloring system comprises a decoloring area, a sweet off area, a backwashing area, a regeneration area, and a rinsing area. According to the sucrose decoloring method and system of the present invention, the advantages of two different resins are fully utilized, the better decoloring effect is achieved, the decolored color value is decreased to 150IU or below from 1,200IU before decoloring, the decoloring rate is up to 85% or above, and meanwhile, the resin utilization rate is high and the resin dosage can be saved.

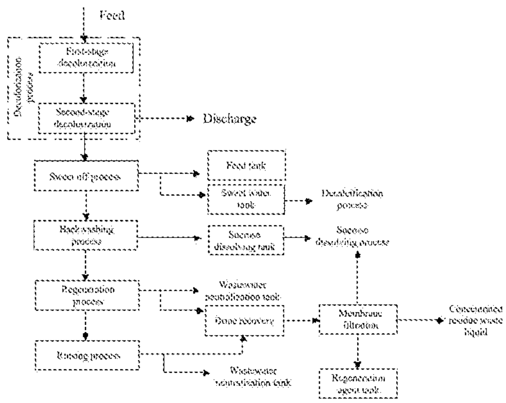

Figure 1

Sucrose decoloring method and system

Technical Field

The present invention relates to sucrose processing technology, in particular to a method and a system for sucrose decolorization.

Background Art

At present, in the sucrose refining production process using sugarcane as raw material, in order to increase the yield, the mother liquor separated from crystallization is repeatedly returned to a point before juice saturation for reuse, so that the chromatic value of the material before crystallization becomes higher and higher, which seriously affects the color quality of crystal products. In the traditional production process of sucrose decolorization, it is generally adopted to add activated carbon after juice saturation to remove pigments by decolorization and filtration. However, due to the high pigment content in the mother liquor, and the higher chromatic value of material due to repeated reuse, the decolorization effect of activated carbon is poor, and the decolorization rate can only reach 50% to 60%, and even by decolorization using activated carbon, the chromatic value of material is still as high as around 1200IU. Some manufacturers also use fixed bed resin for decolorization, but the amount of resin used is large, the utilization rate is low, and the decolorization rate is not desired.

Contents of the present invention

In order to solve the problem of poor sucrose decolorization effect in the prior art, the present invention adopts a multi-unit continuous decolorization process to perform two-stage decolorization, thereby achieving better decolorization effect.

The present invention provides a method for sucrose decolorization, comprising the following processes:

(1) Decolorization process: after feeding a sucrose solution into a plurality of acrylic anion resin columns arranged in parallel, feeding an effluent thereof into a plurality of styrenic anion resin columns arranged in parallel, thereby performing two-stage decolorization;

(2) Sweet off process: by using water carrying out sweet off process in an acrylic anion resin column and a styrenic anion resin column switched from the decolorization process, and the replaced material is recovered;

(3) Backwashing process: by using water backwashing an acrylic anion resin column and a

styrenic anion resin column switched from the sweet off process;

(4) Regeneration process: by using a regeneration solution regenerating an acrylic anion resin column and a styrenic anion resin column switched from the backwashing process, wherein the regeneration solution is a mixed solution of NaCl and NaOH;

(5) Rinsing process: by using water rinsing an acrylic anion resin column and a styrenic anion resin column switched from the regeneration process;

Wherein, the acrylic anion resin columns and the styrenic anion resin columns in the decolorization process, sweet off process, backwashing process, regeneration process, and rinsing process are switched according to the sequence of processes.

The decolorization process, sweet off process, regeneration process, and rinsing process each has two or more resin columns, and the backwashing process has one or more resin columns.

In each of the decolorization process, sweet off process, backwashing process, regeneration process and rinsing process, the acrylic anion resin columns are arranged adjacently to from an acrylic anion resin column unit, and the styrenic anion resin columns are arranged adjacently to form a styrenic anion resin column unit; in each of the sweet off process, backwashing process, regeneration process and rinsing process, the acrylic anion resin column unit and the styrenic anion resin column unit are arranged in parallel, and the same kind of resin columns are switched correspondingly when switching. For example, an acrylic anion resin column in the previous process is switched to an acrylic anion resin column unit in the next process, and a styrenic anion resin column in the previous process is switched to a styrenic anion resin column unit in the next process. In such arrangement, the decolorization process, sweet off process, backwashing process, regeneration process and rinsing process each has two or more resin columns, and each process has two kinds of resin columns at the same time.

In each of the decolorization process, sweet off process, backwashing process, regeneration process and rinsing process, the acrylic anion resin columns and the styrenic anion resin columns are arranged alternatively, and switched according to the order of the process positions where the resin columns are located when switching. Since the two kinds of resin columns are arranged alternatively, taking the procedure of switching from the decolorization process to the sweet off process as an example, the first column of the decolorization process is an acrylic anion resin column when switching, and the acrylic anion resin column is switched to the sweet off process after switching, while the adjacent styrenic anion resin column is switched to the first process position; and when switching again, the styrenic anion resin column is switched to the sweet off process. In such setting, the decolorization process, sweet off process, regeneration process and rinsing process each have two or more resin columns, and have two kinds of resin columns at the same time; while the backwashing process can have one or more resin columns, and when there is only one resin column, the kind of resin column varies for each switching cycle.

For the setting of resin columns arranged alternatively, in the regeneration process, in one switching cycle, the regeneration solution only regenerates one kind of resin column, and in the next switching cycle, it regenerates another kind of resin column.

The sucrose solution in the decolorization process has a temperature of 70 to 80 °C, and a sucrose mass percentage concentration of 50 to 55 %.

The regeneration solution is a mixed solution of a NaCl solution with a mass percentage concentration of 8 to 10 % and a NaOH solution with a mass percentage concentration of 0.5 to 1.0 %.

When the sweet off process has an effluent with a sucrose mass percentage concentration of ≥ 25%, the effluent is returned to a feed tank; when the effluent has a sucrose mass percentage concentration of < 25%, the effluent is returned to a sweet water tank.

When the regeneration process has an effluent with a sodium ion concentration of <2%, the effluent undergoes wastewater treatment, and when the sodium ion concentration is ≥ 2%, the effluent is recovered.

When the rinsing process has an effluent with a sodium ion concentration of ≥ 2%, the effluent is recovered, and when the sodium ion concentration is < 2%, the effluent undergoes wastewater treatment.

The present invention provides a system for sucrose decolorization, comprising:

Decolorization section: it comprises an acrylic anion resin column unit and a styrenic anion resin column unit, the acrylic anion resin column unit and the styrenic anion resin column unit are connected in series, the acrylic anion resin column unit comprises a plurality of acrylic anion resin columns connected in parallel, the styrenic anion resin column unit comprises a plurality of styrenic anion resin columns connected in parallel, and the decolorization section has an influent of sucrose solution;

Sweet off section: it comprises an acrylic anion resin column and a styrenic anion resin column switched from the decolorization section, and the sweet off section has an influent of water;

Backwashing section: it comprises an acrylic anion resin column and a styrenic anion resin column switched from the sweet off section, and the backwashing section has an influent of water;

Regeneration section: it comprises an acrylic anion resin column and a styrenic anion resin column switched from the backwashing section, and the regeneration section has an influent that is a mixed solution of NaCl and NaOH;

Rinsing section: it comprises an acrylic anion resin column and a styrenic anion resin column switched from the regeneration section, and the rinsing section has an influent of water;

Wherein, the acrylic anion resin columns and styrenic anion resin columns in the decolorization section, sweet off section, backwashing section, regeneration section, and rinsing section are switched according to the sequence of processes.

The decolorization section, sweet off section, regeneration section, and rinsing section each has two or more resin columns, and the backwashing section has one or more resin columns.

In each of the decolorization section, sweet off section, backwashing section, regeneration section and rinsing section, the acrylic anion resin columns are adjacently arranged to form an acrylic anion resin column unit, and the styrenic anion resin columns are adjacently arranged to form a styrenic anion resin column unit, the acrylic anion resin column unit and the styrenic anion resin column unit in the sweet off section, backwashing section, regeneration section and rinsing section are arranged in parallel, and the same kind of resin columns are switched correspondingly when switching. The decolorization section, sweet off section, backwashing section, regeneration section and rinsing section each has two or more resin columns, and each section has two kinds of resin columns.

In each of the decolorization section, sweet off section, backwashing section, regeneration section and rinsing section, the acrylic anion resin columns and styrenic anion resin columns are arranged alternatively, and switched according to the order of the process positions where the resin columns are located when switching. The decolorization section, sweet off section, regeneration section and rinsing section each has two or more resin columns, and each section has two kinds of resin columns. When one resin column is set in the backwashing section, the kind of resin column in the backwashing section is alternatively changed according to the switching cycle.

In one switching cycle, only one kind of resin column in the regeneration section is communicated with an inlet pipe of the regeneration solution, and in the next switching cycle, another kind of resin column in the regeneration section is communicated with an inlet pipe of the regeneration solution.

The last resin column in the rinsing section is connected in series with the same kind of resin column in the regeneration section.

The acrylic anion resin columns and the styrenic anion resin columns in the sucrose decolorization system are small columns with a column diameter of 800mm to 1400mm. This column diameter range is for production in large scale.

The present invention has obtained following beneficial effects:

1. It has high utilization rate of resins, which saves resin consumption;

2. It makes full use of the advantages of two different kinds of resins (the acrylic resin has a large pigment exchange capacity; and the styrene resin has a wide range of pigment adsorption selection), and achieves better decolorization effect. After decolorization, the chromatic value is reduced from 1200IU before decolorization to below 150IU, the decolorization rate is as high as 85% or more;

3. The sweet off process, rinsing process, regeneration process are performed in columns arranged in series, which reduces water consumption and regeneration agent consumption, and saves more than 50% of water;

4. During regeneration process, the brine (salt-containing waste liquid discharged from the regeneration process) is recovered, and reused after membrane filtration treatment, thereby saving more than 70% of the regeneration agent;

5. The rinsing process and the regeneration process adopt same kind of resin columns arranged in series, which reduces the mutual pollution and improves the treatment effect;

6. The sweet water is used to elute a column in the sucrose decalcification process; the backwashed water is reused in the sugar melting process, which greatly reduces the discharge of wastewater.

7. The sucrose decolorization system allows continuous feeding and discharging, continuous elution, and continuous regeneration, which can be fully automatic without manual operation.

Brief Description of the Drawings

Figure 1 shows a schematic flow diagram of the sucrose decolorization method of the present invention.

Figure 2 shows a process flow diagram of the sucrose decolorization method of Example 1.

Figure 3 shows a process flow diagram of the sucrose decolorization method of Example 2 (showing cycle 1).

Figure 4 shows a process flow diagram of the sucrose decolorization method of Example 2 (showing cycle 2 after switching).

Figure 5 shows a schematic structural view of the decolorization operation set of Comparative Example 2.

Figure 6 shows a schematic structural view of a standby set for decolorization of Comparative Example 2.

Figure 7 shows the cycle discharge pH curves of Comparative Example 1 and Example 3.

Figure 8 shows the cycle discharge chromatic value curves of Comparative Example 1 and Example 3.

Figure 9 shows the cycle discharge pH curves of Comparative Example 2 and Example 3.

Figure 10 shows the cycle discharge chromatic value curves of Comparative Example 2 and Example 3.

In the figures, the acrylic anion resin columns are abbreviated as "丙", and the styrenic anion resin columns are abbreviated as "苯".

Specific Models for Carrying Out the present invention

The embodiments of the present invention will be clearly and completely described below in conjunction with the examples and drawings. Apparently, the described examples are only some of the examples of the present invention, not all of them. The following description of at least one exemplary example is merely illustrative in nature and in no way taken as limiting the present invention, its application or uses. Based on the examples of the present invention, all other examples obtained by persons of ordinary skill in the art without creative efforts fall within the protection scope of the present invention.

A method for sucrose decolorization of the present invention comprises following processes:

Decolorization process: a sucrose solution with a mass percentage concentration of 50 to 55%, a temperature of 70 to 80°C, and a chromatic value of <1200IU is introduced into a plurality of acrylic anion resin columns arranged in parallel, then a effluent is fed into a plurality of styrenic anion resin columns arranged in parallel to undergo two-stage decolorization with a flow rate of 3BV (3 times the resin volume); the resulting effluent is checked whether it has a chromatic value of ≤150IU; the resulting effluent is introduced into a decolorization discharge tank and can be used in the next process;

Sweet off process: water is used to carry out sweet off process in an acrylic anion resin column and a styrenic anion resin column switched from the decolorization process, and the replaced material is recovered; when the effluent has a sucrose mass percentage concentration of ≥25%, the effluent is returned to a decolorization feed tank; when the effluent has a sucrose mass percentage concentration of <25%, the effluent is returned to a sweet water tank, and the sweet water in the sweet water tank can be used for the sucrose decalcification process;

Backwashing process: water is used to backwash an acrylic anion resin column and a styrenic anion resin column switched from the sweet off process; the effluent of the backwashing process can be recovered to a sucrose-dissolving tank for the sugar dissolving process;

Regeneration process: a regeneration solution is used to regenerate an acrylic anion resin column and a styrenic anion resin column switched from the backwashing process, the regeneration solution is a mixed solution of a NaCl solution with a mass percentage concentration of 8 to 10% and a NaOH solution with a mass percentage concentration of 0.5 to 1.0%; when the effluent of the regeneration process has a sodium ion concentration of <2%, it enters a wastewater neutralization tank for wastewater treatment, and when the effluent has a sodium ion concentration of ≥2%, it is recovered to a brine recovery tank;

Rinsing process: water is used to rinse an acrylic anion resin column and a styrenic anion resin column switched from the regeneration process; when the effluent of the rinsing process has a sodium ion concentration of ≥ 2%, it is recovered to the brine recovery tank, and when the effluent has a sodium ion concentration of <2%, it enters the wastewater neutralization tank for wastewater treatment; the liquid in the brine recovery tank undergoes membrane filtration and the filtrate is returned to a regeneration agent tank, and the concentrated residue is treated as a waste liquid;

Wherein, the acrylic anion resin columns and the styrenic anion resin columns in the decolorization process, sweet off process, backwashing process, regeneration process, and rinsing process are switched according to the sequence of processes.

Example 1 A system for sucrose decolorization, comprised:

Decolorization section: it comprised an acrylic anion resin column unit and a styrenic anion resin column unit, the acrylic anion resin column unit and the styrenic anion resin column unit were connected in series, the acrylic anion resin column unit comprised a plurality of acrylic anion resin columns connected in parallel, the styrenic anion resin column unit comprised a plurality of styrenic anion resin columns connected in parallel, and the decolorization section had an influent of sucrose solution;

Sweet off section: it comprised an acrylic anion resin column and a styrenic anion resin column switched from the decolorization section, the sweet off section had an influent of water;

Backwashing section: it comprised an acrylic anion resin column and a styrenic anion resin column switched from the sweet off section, and the backwashing section had an influent of water;

Regeneration section: it comprised an acrylic anion resin column and a styrenic anion resin column switched from the backwashing section, and the regeneration section had an influent that was a mixed solution of NaCl and NaOH;

Rinsing section: it comprised an acrylic anion resin column and a styrenic anion resin column switched from the regeneration section, and the rinsing section had an influent of water;

Wherein, the acrylic anion resin columns and the styrenic anion resin columns in the decolorization section, sweet off section, backwashing section, regeneration section, and rinsing section were switched according to the sequence of processes.

As shown in Figure 2, the acrylic anion resin columns and the styrenic anion resin columns in each of the decolorization section, sweet off section, backwashing section, regeneration section, and rinsing section were arranged separately to form independent acrylic anion resin column unit and styrenic anion resin column unit, and the resin columns of the acrylic anion resin column unit and the styrenic anion resin column unit of the previous section were switched to the next section at the same time during continuous switching. The acrylic anion resin column unit and the styrenic anion resin column unit in each of the sweet off section, backwashing section, regeneration section and rinsing section were arranged in parallel.

In each of the sweet off section, regeneration section and rinsing section, the acrylic anion resin column unit comprised a plurality of resin columns connected in series, and the styrenic anion resin column unit comprised a plurality of resin columns connected in series. The backwashing section comprised two resin columns, one of which was an acrylic anion resin column and the other was a styrenic anion resin column.

The last acrylic anion resin column in the rinsing section was connected in series with the first acrylic anion resin column in the regeneration section; and the last styrenic anion resin column in the rinsing section was connected in series with the first styrenic anion resin column in the regeneration section.

In the present example, the sucrose decolorization system could have altogether 1 to 20# acrylic anion resin columns and 1 to 20# styrenic anion resin columns, and the number of acrylic anion resin columns and the number of styrenic anion resin columns allocated in each section could be determined according to the amount of sucrose processed.

Example 2 A system for sucrose decolorization, comprised:

Decolorization section: it comprised an acrylic anion resin column unit and a styrenic anion resin column unit, the acrylic anion resin column unit and the styrenic anion resin column unit were connected in series, the acrylic anion resin column unit comprised a plurality of acrylic anion resin columns connected in parallel, the styrenic anion resin column unit comprised a plurality of styrenic anion resin columns connected in parallel, and the decolorization section had an influent of sucrose solution;

Sweet off section: it comprised an acrylic anion resin column and a styrenic anion resin column switched from the decolorization section, and the sweet off section had an influent of water;

Backwashing section: it comprised an acrylic anion resin column and a styrenic anion resin column switched from the sweet off section, and the backwashing section had an influent of water;

Regeneration section: it comprised an acrylic anion resin column and a styrenic anion resin column switched from the backwashing section, and the regeneration section had an influent that was a mixed solution of NaCl and NaOH, i.e., a mixed solution of a NaCl solution with a mass percentage concentration of 8 to 10% and a NaOH solution with a mass percentage concentration of 0.5 to 1.0%;

Rinsing section: it comprised an acrylic anion resin column and a styrenic anion resin column switched from the regeneration section, and the rinsing section had an influent of water;

Wherein, the acrylic anion resin columns and the styrenic anion resin columns in the decolorization section, sweet off section, backwashing section, regeneration section, and rinsing section were switched according to the sequence of processes.

As shown in Figure 3 and Figure 4, the acrylic anion resin columns and the styrenic anion resin columns in the decolorization section, sweet off section, backwashing section, regeneration section, and rinsing section were arranged alternatively. When switched continuously, the acrylic anion resin columns and the styrenic anion resin columns were switched to the next section in turn, and one resin column was switched each time. As shown in Figure 3, the No. 4 column in the decolorization section was an acrylic anion resin column, and the adjacent No. 5 column was a styrenic anion resin column, after switching, as shown in Figure 4, the No. 4 column was switched to the sweet off section, and the No. 5 column was switched to the process position originally occupied by the No. 4 column. Each time one resin column was switched, one cycle was completed.

The sweet off section comprised a plurality of resin columns connected in series, in which the acrylic anion resin columns and the styrenic anion resin columns were arranged alternatively and connected in series. As shown in Figure 3, the sweet off section comprised No. 1 column (styrenic anion resin column), No. 2 column (acrylic anion resin column) and No. 3 column (styrenic anion resin column), the three columns were connected in series, and water flowed through No. 1 column, No. 2 column and No. 3 column in sequence. After switching, as shown in Figure 4, the sweet off section comprised No. 2 column (acrylic anion resin column), No. 3 column (styrenic anion resin column) and No. 4 column (acrylic anion resin column), in which the No. 2 column, No. 3 column and No. 4 column were also connected in series.

The backwashing section comprised one resin column, and the resin column in the backwashing section was switched from the sweet off section, so there were different kinds of resin columns in different cycles, as shown in Figure 3, the resin column in the backwashing section at cycle 1 was No. 20 column (acrylic anion resin column). After switching, as shown in Figure 4, the resin column in the backwashing section was No. 1 column (styrenic anion resin column).

The regeneration section comprised a plurality of resin columns, in which the acrylic anion resin columns and the styrenic anion resin columns were arranged alternatively, and the same kind of resin columns were connected in series, as shown in Figure 3, the regeneration section comprised No. 17 column (styrenic anion resin column), No. 18 column (acrylic anion resin column) and No. 19 column (styrenic anion resin column), in which the No. 17 column and No. 19 column were connected in series, and the regeneration solution flowed through the No. 17 column and No. 19 column in sequence. After switching, as shown in Figure 4, the regeneration section comprised No. 18 column (acrylic anion resin column), No. 19 column (styrenic anion resin column) and No. 20 column (acrylic anion resin column), in which No. 18 column (acrylic anion resin column) and No. 20 column (acrylic anion resin column) were connected in series, and the regeneration solution flowed through No. 18 column and No. 20 column in sequence.

The rinsing section comprised a plurality of resin columns, in which the acrylic anion resin columns and the styrenic anion resin columns were arranged alternatively, and the same kind of resin columns were connected in series, as shown in Figure 3, the rinsing section comprised No. 14 column (acrylic anion resin column), No. 15 column (styrenic anion resin column) and No. 16 column (acrylic anion resin column), in which the No. 14 column and No. 16 column were connected in series, and water flowed through the No. 14 column and No. 16 column in sequence.

At the same time, No. 16 column was connected in series with No. 18 column in the regeneration section, and the No. 16 and No. 18 columns were of the same kind. After switching, as shown in Figure 4, the rinsing section comprised No. 15 column (styrenic anion resin column), No. 16 column (acrylic anion resin column) and No. 17 column (styrenic anion resin column), in which the No. 17 column (styrenic anion resin column) and No. 19 column (styrenic anion resin column) in the regeneration section were connected in series.

Example 3, The system of Example 2 was used to decolorize sucrose (the amount of resin was based on the level of the small test, and there were also 20 columns, 10 columns of each kind).

The decolorization section was divided into first-stage decolorization (even-numbered columns filled with acrylic anion resin) and second-stage decolorization (odd-numbered columns filled with styrenic anion resin), as shown in Figure 1, a sucrose solution was introduced into the columns for decolorization in a countercurrent manner (bottom in, top out), feed conditions: 6L/h, 70°C, Bx 55%, pH 8.51, chromatic value 1165 ICUMSA, fed into the resin columns in the direction of the arrow shown in the diagram, and the feed volume was 30L. The discharge was collected for the determination of pH and chromatic value. The adsorption resins used in the resin column were shown in Table 1. Figure 3 shows the arrangement of the resin columns in cycle one. When the No. 4 column shown in Figure 3 was saturated, it was switched to the next cycle, that was, the arrangement of the resin columns shown in Figure 4. The following shows the material entry in other sections as shown in Figure 4.

In the sweet off section, as shown in Figure 4, 400ml of pure water was introduced into the top of No. 2 column, as shown in Figure 4, which was connected series with No. 3 and No. 4 columns, and the water was discharged from the bottom of No. 4 column. After several cycles of switching, the No. 4 column would be transferred to the backwashing section, regeneration section and rinsing section in turn.

In the backwashing section, water was introduced into the bottom of No. 1 column shown in Figure 4, and the water was discharged from the top of No. 1 column to backwash the resin.

In the regeneration section, columns arranged in series were used for regeneration. Because the resin columns were filled with two different kinds of resins alternatively, the columns arranged in series for regeneration were two adjacent odd-numbered columns arranged in series as a group for regeneration; two adjacent even-numbered columns arranged in series were used as another group for regeneration; only one group was regenerated in each cycle, and the two groups were regenerated alternately in turn. As shown in Figure 4, 400ml of regeneration agent that was a mixed solution of NaCl with a concentration of 10% and NaOH with a concentration of 0.5% was introduced into the top of No. 18 column, discharged from the bottom of No. 18 column, then introduced into No.20 column, and discharged from the bottom of No.20 column, in which the first 160ml was discharged to a wastewater neutralization tank, and then the last 240ml was discharged to a brine recovery tank.

The rinsing section comprised: (1) Slow rinsing, 400ml of pure water was introduced into the top of No. 15 column, and the water was discharged from the bottom, then introduced into No. 17 and No. 19 columns in turn, and discharged from the bottom of No. 19 column, in which the first 200ml was discharged to the brine recovery tank, and then the last 400ml was discharged to the wastewater neutralization tank; (2) Fast rinsing, pure water was introduced into the top of the No. 15 column to elute the residual sodium chloride and sodium hydroxide in the column, and discharged from the bottom to the wastewater neutralization tank.

The above system for decolorization of sucrose solution was repeatedly regenerated 20 times (20 cycles), and the pH values and chromatic values of the sucrose solutions discharged in the 1^{st}, 5^{th}, 10^{th}, 15^{th}, and 20^{th} cycles were detected, the detection data are shown in Table 2; and the exchange performance analysis data of the resins after 20 cycles are shown in Table 3.

Table 1: Resins used in Example 3

	Number of resin column	Kind of resin	Ion form	Resin volume of single column (ml)
Example 3	Odd-number column	Styrenic strong base anion resin	OH^-	400
	Even-numbered column	Acrylic strong base anion resin	OH^-	400

Table 2: Parameters of sucrose solution discharged in each cycle of Example 3

Cycle No.	1	5	10	15	20
pH	8.51	8.42	8.4	8.38	8.36
Chromatic value	90	105	125	136	139

Table 3: Resin exchange performance parameters after 20 cycles in Example 3

Resin column No.	Total exchange capacity (equivalent/L resin)		Reduction rate (%)
	New resin	After use	

Odd-numbered column	1.108	1.04	6.14
Even-numbered column	0.93	0.89	4.3

Comparative Example 1

The resins packed in the odd- and even-numbered resin columns were all styrenic strong base anion resin, and the decolorization and purification of the sucrose solution were carried out in the same way as in Example 3. The resin used in this comparative example was shown in Table 4 below.

The sweet off, backwashing, regeneration, and rinsing processes of the decolorization system were the same as in Example 3.

The above system for decolorization of sucrose solution was repeatedly regenerated 20 times (20 cycles), and the pH values and chromatic values of the sucrose solutions discharged in the 1st, 5th, 10th, 15th, and 20th cycles were detected as in Example 3, and the detection data are shown in Table 5; and the analytical data of the exchange resin after 20 cycles are shown in Table 6.

Table 4: Resin used in Comparative Example 1

	Resin column number	Kind of resin	Ion form	Resin volume of single column (ml)
Comparative Example 1	Odd- and even-numbered columns	Styrenic strong base anion resin	OH^-	400

Table 5: Parameters of sucrose solution discharged in each cycle of Comparative Example 1

Cycle No.	1	5	10	15	20
pH	8.54	8.46	8.35	8.33	8.26
Chromatic value	106	131	154	186	218

Table 6: Resin exchange performance parameters after 20 cycles in Comparative Example 1

Number of resin column	Total exchange capacity (equivalent/L resin)		Reduction rate (%)
	New resin	After use	
Odd- and even-numbered column	1.108	0.91	17.9

The comparison results between Example 3 and Comparative Example 1 are shown in

Figure 7 and Figure 8; after 20 cycles of cyclic decolorization, Comparative Example 1 shows a chromatic value increased by about 56.8% compared with Example 3, indicating a relatively large extent of increase; and Comparative Example 1 also shows a greater reduction of pH value compared with Example 3. The changes of pH value and chromatic value of Example 3 are more stable.

According to the results in Table 3 and Table 6, it could be seen that the acrylic anion exchange resin in the even-numbered column as the first-stage decolorization column can effectively adsorb macromolecular pigments and is not easily polluted by pigments and the like, so that the rapid fouling of the styrenic anion resin in the odd-numbered columns as the second-stage decolorization column can be avoided. Compared with Comparative Example 1, Example 3 can effectively suppress the reduction of the total exchange capacity of the styrenic anion resin, and the reduction extent of resin exchange capacity in Comparative Example 1 is about 11.8% higher than that of Example 3.

Comparative Example 2 (small test level)

Floating bed ion-exchange two-stage decolorization method was adopted, which consisted of 4 columns, one for use and one for backup; 1# column was filled with acrylic strong base anion resin, 2# column was filled with styrenic strong base anion resin, 1# column and 2# column were connected in series for passing material to carry out two-stage decolorization; 3# column and 4# column were the same as 1# and 2# columns, respectively, which were used as regeneration and backup columns. The specific process is shown in Figures 5 and 6.

Decolorization: The feeding method for decolorization was the same as that in Example 3, except that there were only two floating beds with larger volume. The material entered countercurrently from the bottom of 1# column, passed through the resin layer and was discharged from the top, then was introduced into the bottom of 2# column, and was discharged from the top after being adsorbed by the resin layer;

After 1# and 2# resin columns were saturated by adsorption, they were transferred to the sweet off process, backwashing process, regeneration process, and rinsing process. At the same time, 3# column and 4# column entered the decolorization process until 3# column and 4# column were also saturated by adsorption. This was one cycle.

In Example 3, a plurality of columns performed different processes at the same time. In Comparative Example 2, only one group of columns performed decolorization, and the other group of columns performed other processes in sequence.

The resin used in this comparative example is shown in Table 7, and one cycle of the decolorization system of this comparative example was divided into 5 time periods equally, and the pH values and chromatic values of the discharged sucrose solution in different time periods were detected, and the average values of repeated 3 cycles were taken, the data of the discharges of these 5 time periods could correspond to the pH values and the chromatic values of the discharged sucrose solutions in the 1st, 5th, 10th, 15th, 20th cycle of Example 3 (for the convenience of corresponding to Example 3, the cycles were directly written as cycle 1, 5, 10, 15, and 20), and the detection data are shown in Table 7, Table 8, and Figures 9 and 10.

Table 7: Resins used in Comparative Example 2

	Number of resin column	Kind of resin	Ion form	Resin volume of single column (ml)
Comparative Example 2	1# column	Acrylic strong base anion resin	OH^-	4000
	2# column	Styrenic strong base anion resin	OH^-	4000

Table 8: Parameters of sucrose solution discharged in each cycle of Comparative Example 2

Cycle	1	5	10	15	20
pH	8.82	8.76	8.37	8.32	8.16
Chromatic value	85	106	132	167	220

According to the comparison between Table 7, Table 8 and Tables 1 and 2, as well as the curves in Figures 9 and 10, it could be seen that the detection indexes of discharges in cycles of Comparative Example 2 change significantly in larger extent than those of Example 3, and the pH and chromatic values are not as stable as Example 3. The greater changes in the detection indexes of the discharges will significantly impact on the quality. The quality of the discharged material of Comparative Example 2 is lower than that of Example 3.

According to the comparison of the resin amounts of the two, the resin amount of Example 3 is reduced by 50%; at the same time, because Example 3 adopts small column, the influents in the columns of the sweet off, rinsing, backwash, regeneration processes have a small pressure, are uniformly distributed in the columns, and thus the regeneration agent and water can be effectively saved.

The above description of the disclosed examples is provided to enable any person skilled in the art to make or use the present invention. Various modifications to these examples will be readily apparent to those skilled in the art, and the general principles defined herein may be implemented in other examples without departing from the spirit or scope of the present invention. Therefore, the present invention will not be limited to the examples shown herein, but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

What is claimed is:

1. A method for sucrose decolorization, comprises the following processes:

(1) Decolorization process: after feeding a sucrose solution into a plurality of acrylic anion resin columns arranged in parallel, feeding an effluent thereof into a plurality of styrenic anion resin columns arranged in parallel, thereby performing two-stage decolorization, in which the sucrose solution in the decolorization process has a temperature of 70 to 80 °C, and a sucrose mass percentage concentration of 50 to 55%;

(2) Sweet off process: by using water carrying out sweet off process in an acrylic anion resin column and a styrenic anion resin column switched from the decolorization process;

(3) Backwashing process: by using water backwashing an acrylic anion resin column and a styrenic anion resin column switched from the sweet off process;

(4) Regeneration process: by using a regeneration solution regenerating an acrylic anion resin column and a styrenic anion resin column switched from the backwashing process, wherein the regeneration solution is a mixed solution of a NaCl solution with a mass percentage concentration of 8 to 10% and a NaOH solution with a mass percentage concentration of 0.5 to 1.0%;

(5) Rinsing process: by using water rinsing an acrylic anion resin column and a styrenic anion resin column switched from the regeneration process;

Wherein, the acrylic anion resin columns and the styrenic anion resin columns in the decolorization process, sweet off process, backwashing process, regeneration process, and rinsing process are switched in sequence;

The acrylic anion resin columns and the styrenic anion resin columns in the decolorization process, sweet off process, backwashing process, regeneration process and rinsing process are arranged alternatively, and switched according to the order of the process positions where the resin columns are located when switching, and only one resin column is switched each time;

The same kind of resin columns are arranged and treated in series during the rising process and the regeneration process.

2. The method for sucrose decolorization according to claim 1, wherein in the regeneration process, during one switching cycle, the regeneration solution only regenerates one kind of resin column, and during the next switching cycle, another kind of resin column is regenerated.

3. A system for sucrose decolorization, comprising:

Decolorization section: comprising an acrylic anion resin column unit and a styrenic anion resin column unit, in which the acrylic anion resin column unit and the styrenic anion resin column unit are connected in series, the acrylic anion resin column unit comprises a plurality of acrylic anion resin columns connected in parallel, the styrenic anion resin column unit comprises a plurality of styrenic anion resin columns connected in parallel, the decolorization section has an influent of sucrose solution, the sucrose solution has a temperature of 70 to 80°C and a sucrose mass percentage concentration of 50 to 55%;

Sweet off section: comprising an acrylic anion resin column and a styrenic anion resin column switched from the decolorization section, in which the sweet off section has an influent of water;

Backwashing section: comprising an acrylic anion resin column and a styrenic anion resin column switched from the sweet off section, in which the backwashing section has an influent of water;

Regeneration section: comprising an acrylic anion resin column and a styrenic anion resin column switched from the backwashing section, in which a regeneration solution is a mixed solution of a NaCl solution with a mass percentage concentration of 8 to 10% and a NaOH solution with a mass percentage concentration of 0.5 to 1.0%;

Rinsing section: comprising an acrylic anion resin column and a styrenic anion resin column switched from the regeneration section, in which the rinsing section has an influent of water;

Wherein, the acrylic anion resin columns and the styrenic anion resin columns in the decolorization section, sweet off section, backwashing section, regeneration section, and rinsing section are switched according to the sequence of processes;

The acrylic anion resin columns and the styrenic anion resin columns in the decolorization section, sweet off section, backwashing section, regeneration section and rinsing section are arranged alternatively, and switched according to the order of the process positions where the resin columns are located when switching, and only one resin column is switched each time;

The same kind of resin columns are arranged and treated in series in the rinsing section and the regeneration section.

4. The system for sucrose decolorization according to claim 3, wherein, in one switching cycle, only one kind of resin column in the regeneration section is communicated with a regeneration solution inlet pipe, and in the next switching cycle, another kind of resin column in the regeneration section is communicated with a regeneration solution inlet pipe, and at the same time, the last resin column in the rinsing section is communicated in series with the same kind of resin column in the regeneration section.

Drawings:

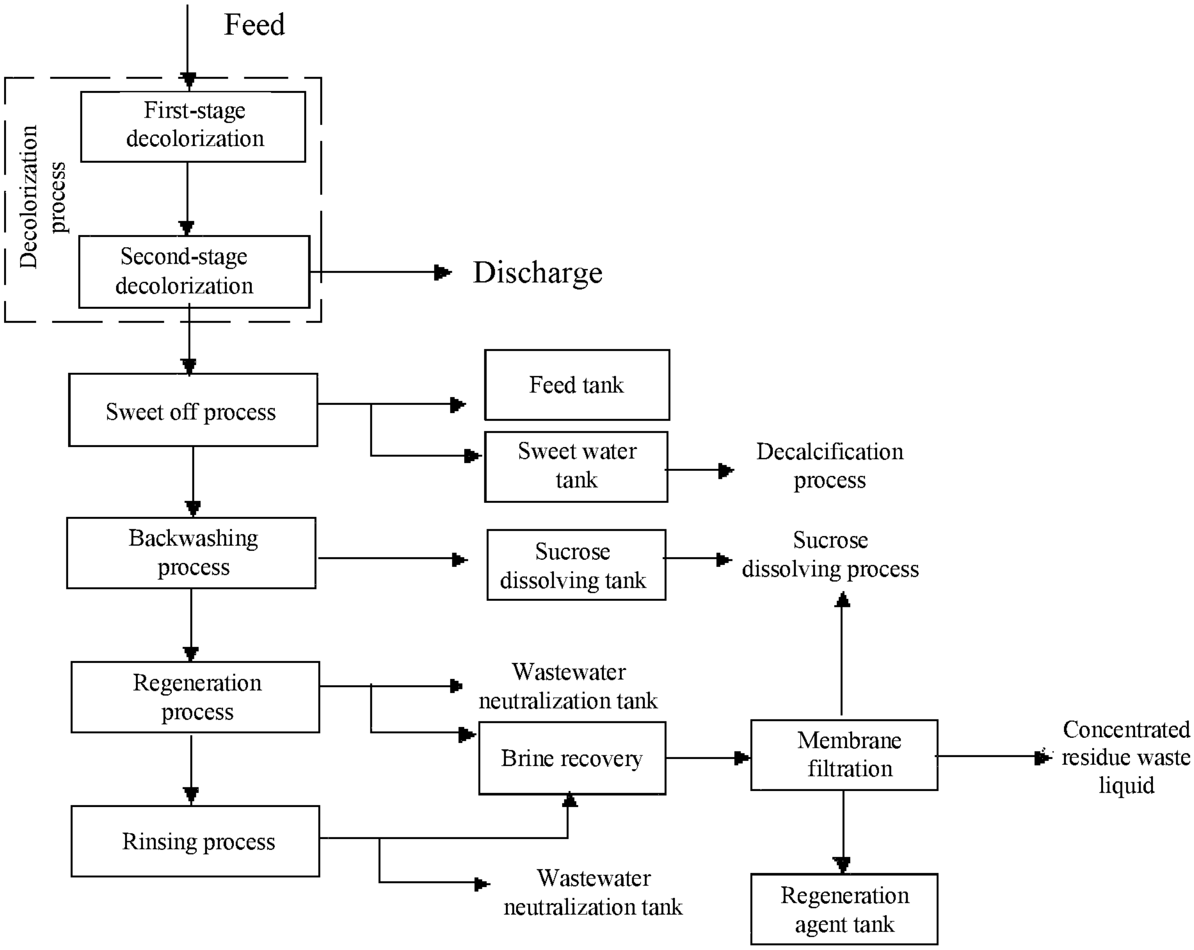

Figure 1

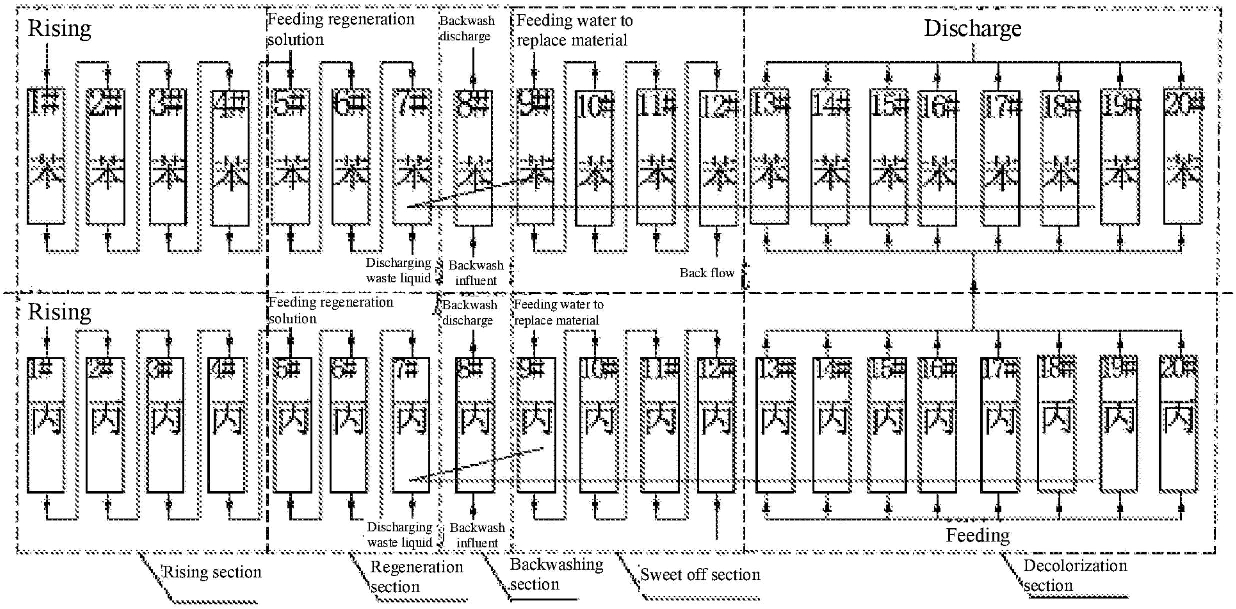
Rising
Feeding regeneration solution
Backwash discharge
Feeding water to replace material
Discharge
1# 2# 3# 4# 5# 6# 7# 8# 9# 10# 11# 12# 13# 14# 15# 16# 17# 18# 19# 20#
Discharging waste liquid
Backwash influent
Back flow
Rising
Feeding regeneration solution
Backwash discharge
Feeding water to replace material
Discharging waste liquid
Backwash influent
Feeding
Rising section
Regeneration section
Backwashing section
Sweet off section
Decolorization section

Figure 2

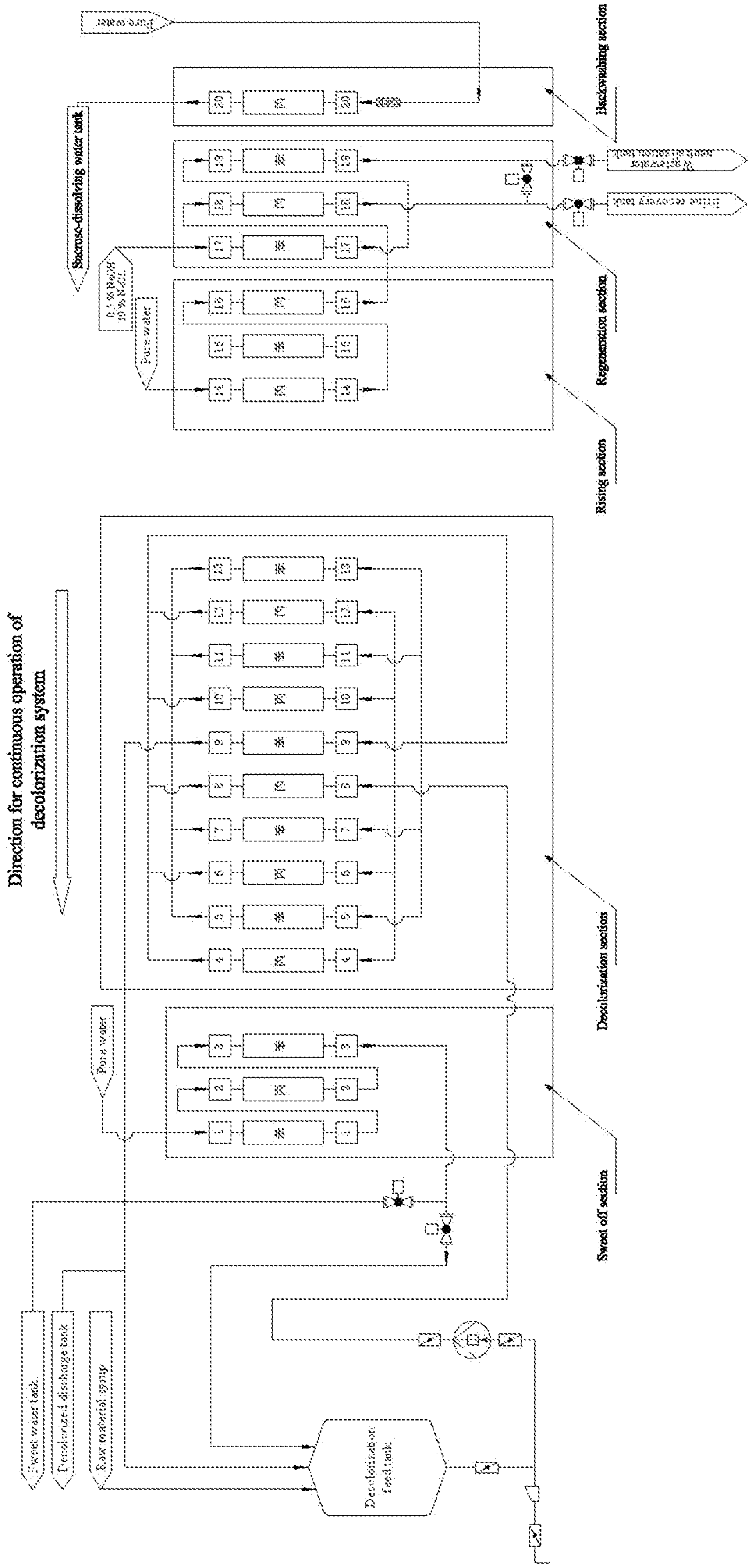
Direction for continuous operation of decolorization system
Backwashing section
Regeneration section
Rising section
Decolorization section
Sweet off section
Pure water
Sucrose-dissolving water tank
Sweet water tank
Decolorization feed tank

Figure 3

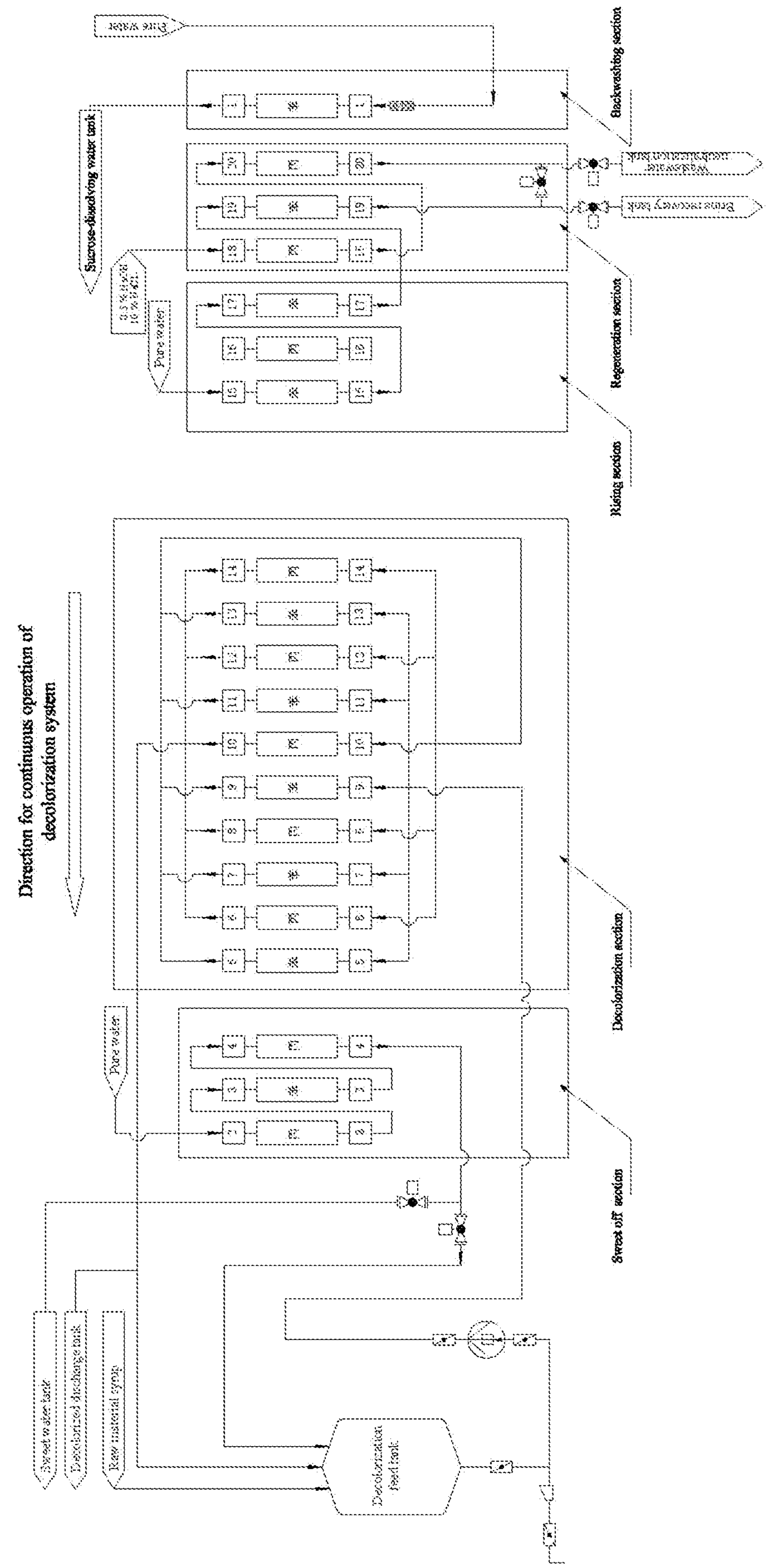
Pure water
Backwashing section
Sucrose-dissolving water tank
Brine recovery tank
Regeneration section
Rising section
Direction for continuous operation of decolorization system
Decolorization section
Sweet off section
Sweet water tank
Decolorized discharge tank
Raw material syrup
Decolorization feed tank

Figure 4

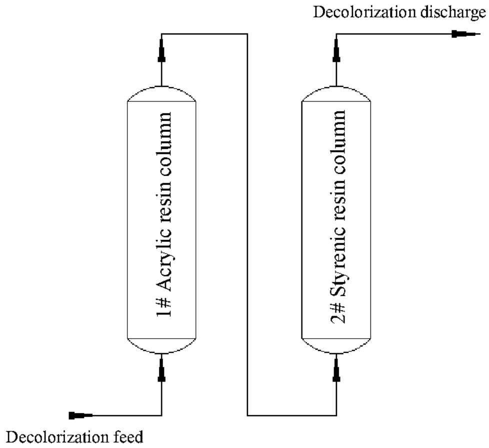

Figure 5

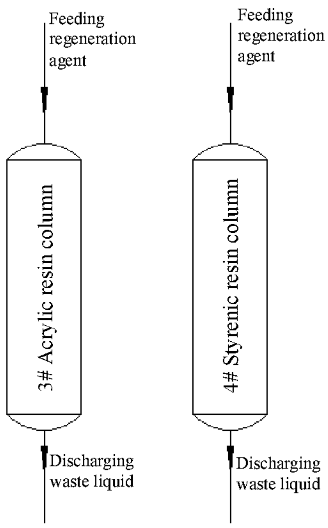

Figure 6

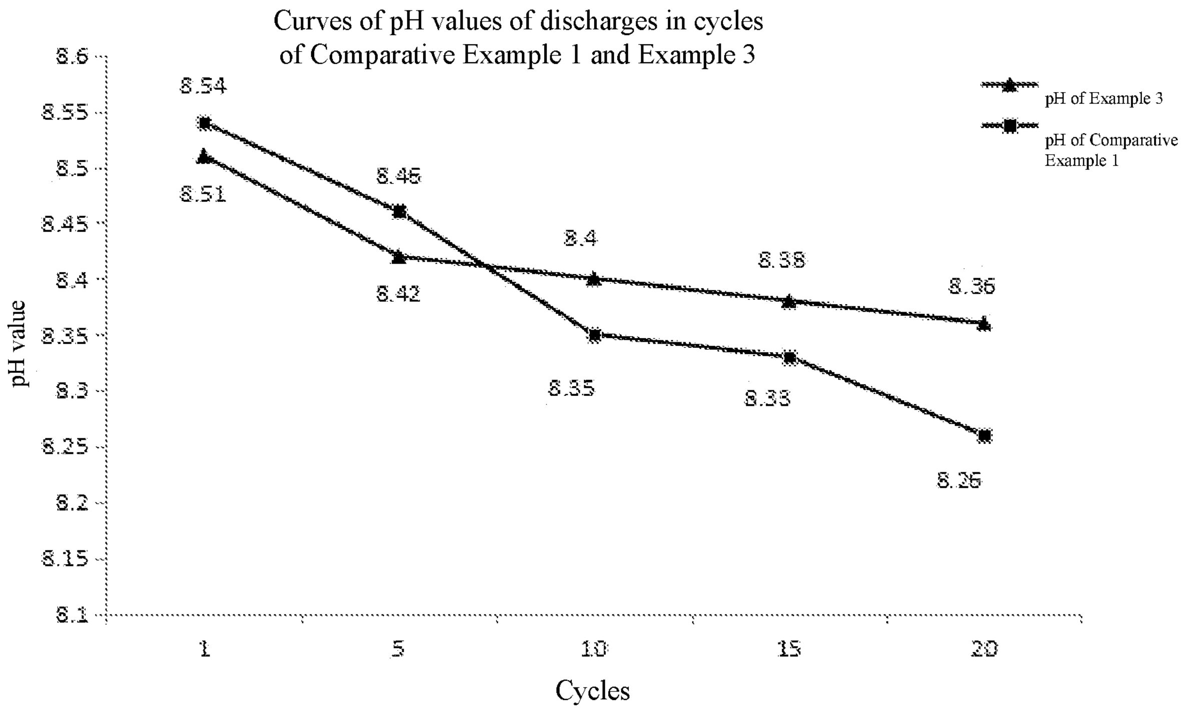

Figure 7

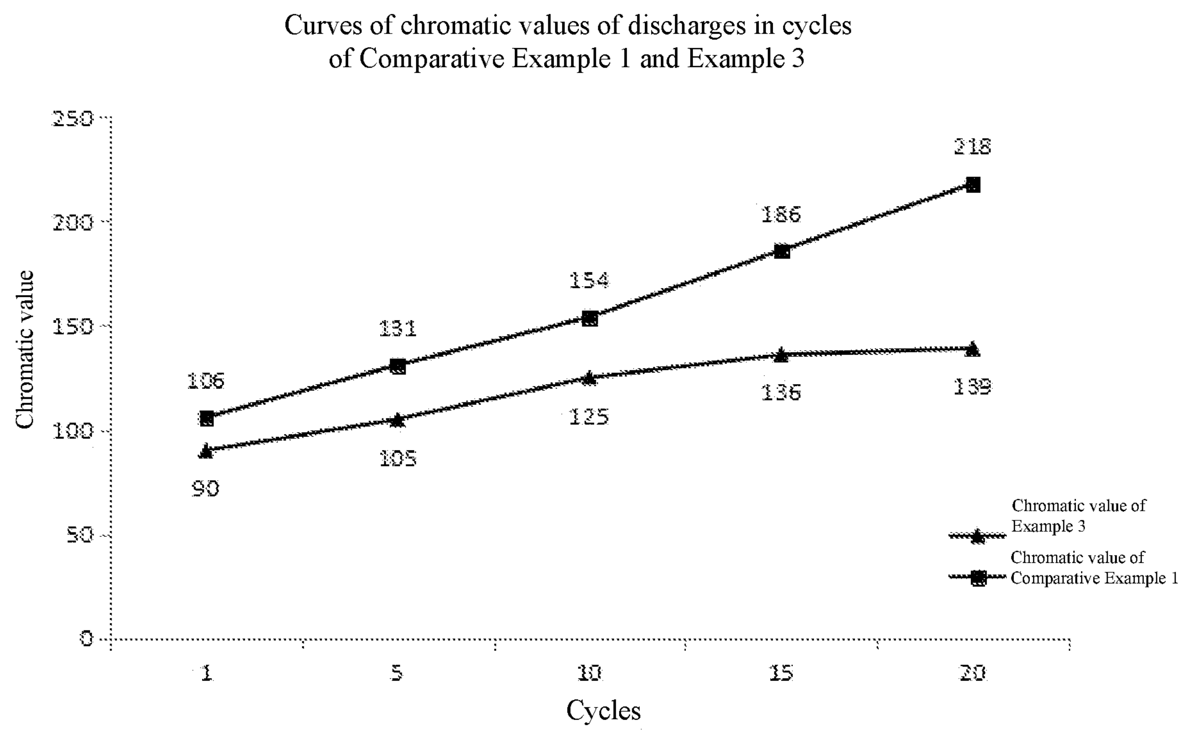

Figure 8

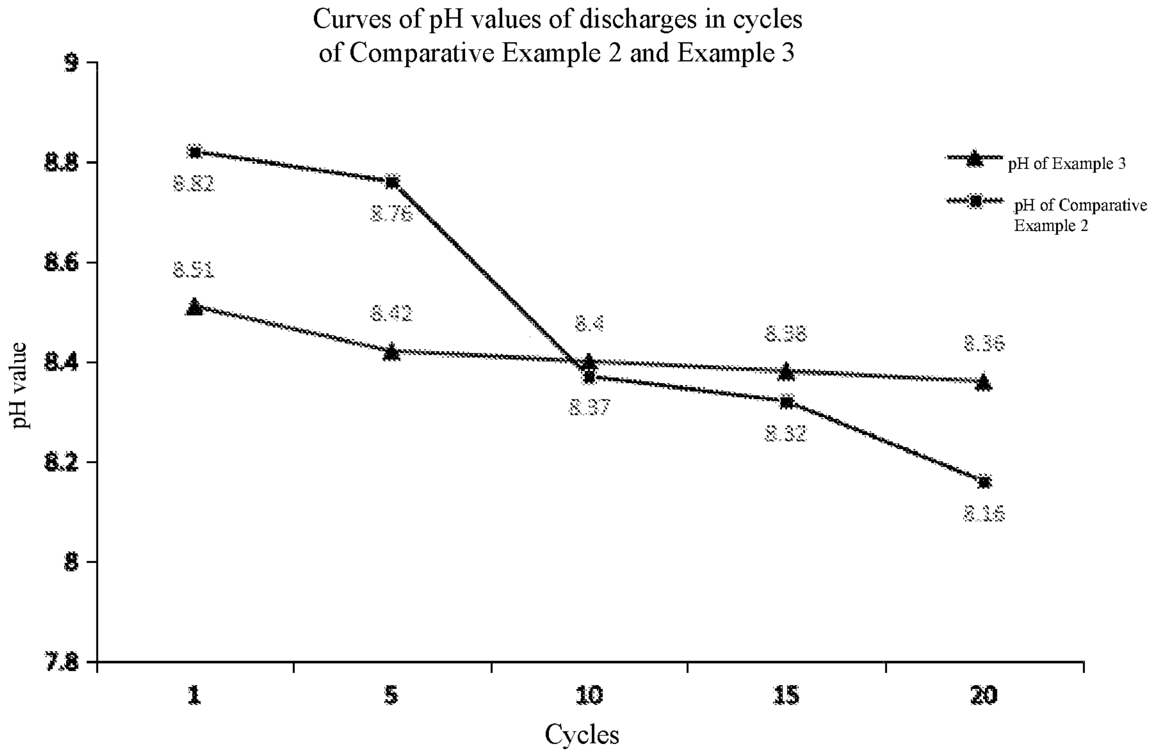

Figure 9

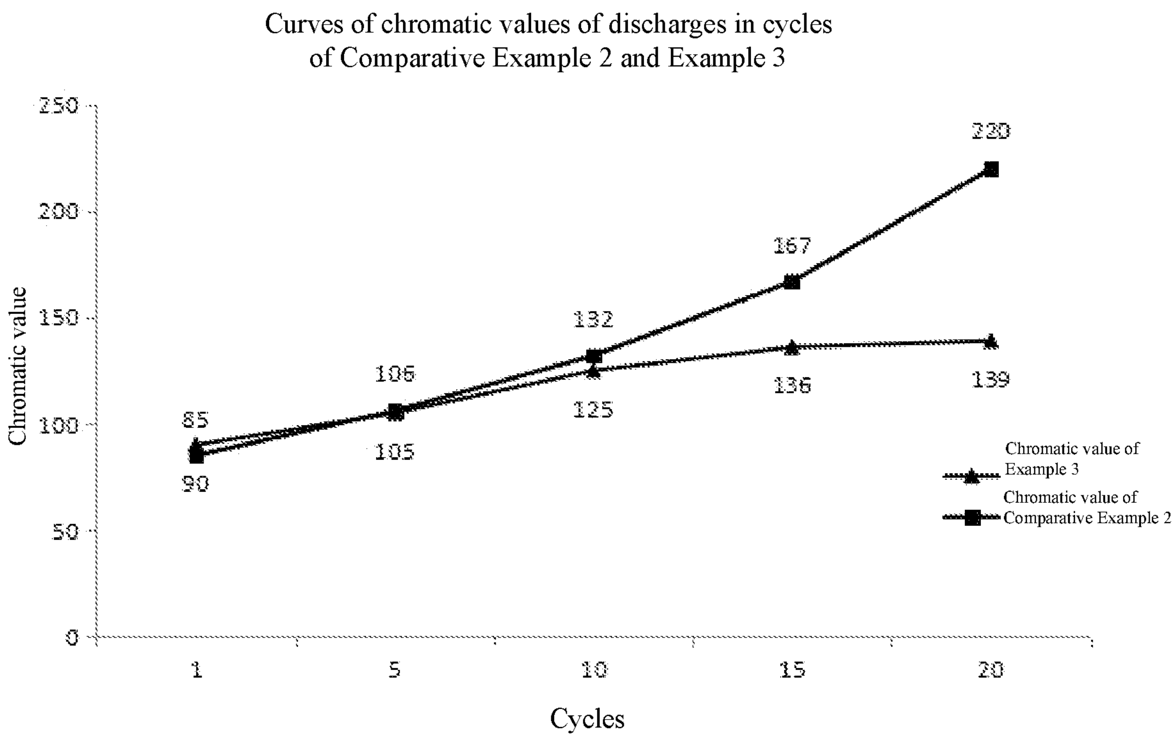

Figure 10

TRANSLATION

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/076190

LU505449

A. CLASSIFICATION OF SUBJECT MATTER

B01J49/60(2017.01)i;B01J49/57(2017.01)i;C13B20/14(2011.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:B01J,C13B

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)

CNKI, CNTXT, DWPI, CNABS, CJFD: 蔗糖, 糖, 脱色, 吸附, 水顶, 反洗, 再生, 淋洗, 丙烯酸, 苯乙烯, 树脂, 串联, 并联, 排列, sucrose, sugar, decolorization, adsorption, water, wash, regeneration, rinse, acrylic acid, styrene, resin, series, parallel, arrangement

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 114606348 A (OUSHANGYUAN (TIANJIN) CO., LTD.) 10 June 2022 (2022-06-10) claims 1-4	1-4
PX	CN 114807456 A (OUSHANGYUAN (TIANJIN) CO., LTD.) 29 July 2022 (2022-07-29) claims 1-4	1-4
A	CN 1817195 A (ZHEJIANG UNIVERSITY) 16 August 2006 (2006-08-16) description, embodiment, and figure 1	1-4
A	CN 105765084 A (ORGANO CORP.) 13 July 2016 (2016-07-13) claim 1	1-4
A	CN 112062796 A (CSPC GROUP SHENGXUE GLUCOSE CO., LTD.) 11 December 2020 (2020-12-11) description, paragraphs 5-6	1-4

☐ Further documents are listed in the continuation of Box C. ☑ 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
- "D" document cited by the applicant in the international application
- "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
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 March 2023	**26 April 2023**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088**	
Facsimile No. **(86-10)62019451**	Telephone No.

TRANSLATION

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/076190

LU505449

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	114606348	A	10 June 2022	None			
CN	114807456	A	29 July 2022	None			
CN	1817195	A	16 August 2006	CN	100401916	C	16 July 2008
CN	105765084	A	13 July 2016	JP	2015156838	A	03 September 2015
				JP	6283235	B2	21 February 2018
				WO	2015129698	A1	03 September 2015
CN	112062796	A	11 December 2020	CN	112062796	B	22 February 2022