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DRYING OF SUGAR SOLUTIONS

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ABSTRACT OF THE DISCLOSURE

In a process for continuously preparing dried, solid, sucrose-containing products from a sucrose-containing solution by drying droplets of the said solution in a current of heated air and in the presence of separately introduced recycled dried product solids, the improvement comprising continuously controlling the average particle size of the recycled product below about 200 microns.

This invention relates to improvements in the production of dried sucrose-containing products from sucrose-containing solutions. In one particular embodiment it relates to a procedure for ensuring continuous operation of a process for spray drying sucrose-containing solutions in the presence of recycled product solids.

In the conventional methods of producing crystalline sucrose, the virgin syrup, as extracted from sugar cane or sugar beets, is first decolorized and deionised. The clarified syrup is then evaporated and fractionally crystallized in a series of precisely controlled steps, caramelization being reduced as much as possible by the use of vacuum to reduce the evaporation temperature. Fractional crystallization is essential since, during processing, inversion of the cane sugar takes place, usually to the extent of about 15% by weight of the original sucrose content by the time processing is completed. This invert sugar, which is substantially uncrystallizable, is discarded together with up to about 20% of non-recoverable sucrose and finds its way into commerce as animal feed or other low grade sugar products generally referred to as molasses.

Other methods for producing dry crystalline sucrose-containing products proposed by the prior art include fluid energy milling (Reimers et al.—U.S. Pat. 3,140,201) drying intimate blends of sugar solids and sugar solutions (Oikawa—U.S. Pat. 3,271,194 and British Pat. 1,099,723) and simultaneous centrifugal distribution and spray drying of powdered sugar solids and a sugar solution (Japanese patent publication 20,384/69). Agglomeration of pulverized sugar using a liquid sugar syrup binder and drying of the agglomerated product is taught in Harding et al.—U.S. Pat. 3,518,095. A similar agglomeration process is disclosed in Gidlow et al.—U.S. Pat. 3,506,457. Spray drying of high D.E. glucose solutions in the presence of recycled solids is disclosed by Repsdorph et al. in U.S. Pat. 3,477,874 and corresponding British Pat. 1,075,161. Bishop—U.S. Pat. 2,698,815 suggests spray drying of molasses in the presence of very small amounts of calcium phosphate dust.

Belgian Pat. 742,249 dated Jan. 30, 1970 discloses a process for drying sucrose-containing solutions by dispersing sucrose particles in a current of heated air, separately dispersing the solution on the said particles, evaporating the water from the solution coated on the particles and recovering the resulting dry product from the hot air stream. In a preferred embodiment of the disclosed process a portion of the dried product is recycled as the solids dispersed in the drying zone. In the process of the said Belgian patent, the use of sucrose particles, e.g., recycled dry product, is necessary to the process of drying the sucrose-containing solution. Attempts to directly spray dry the solution in the absence of such solid particles results in caramelization and degradation of the sugars in the solution and irreversible adhesion and sticking of the freshly formed, incompletely crystallized solids to the walls of the dryer.

The presence of recycle solids provides a practicable process for spray drying sucrose-containing solutions. However, some problems still remain in attempting to practice this process on a commercial, high production rate, continuous basis. For example, in pilot plant runs of the process described in the aforementioned Belgian Pat. 742,249, the product coming from the dryer is typically a plastic-like mass of incompletely crystallized material. In a short period of time (e.g., 5 to 10 minutes) crystallization of the product will be complete and a free flowing product results, comprising agglomerates of sucrose microcrystals with agglomerates ranging in size from about 1,000 microns (roughly the size of the individual crystals of commercial white household sugar) to as low as about 150 microns and made up of individual microspheres ranging in size from about 25 to about 150 microns. Average agglomerate particle size typically ranges from about 200 to 600 microns (i.e., 50 weight percent of the product particles or agglomerates will be above and 50 weight percent below a given particle size in the range of about 200 to 600 microns).

When the 200 to 600 micron product particles or agglomerates are recycled to the drying step they tend to promote heavy accumulation of the plastic mass on the dryer walls. Portions of this mass "flake" off the walls and discharge from the dryer in a random intermittent fashion. From time to time the size of the randomly discharged portion is so large that it effectively blocks the dryer outlet, forcing a shut-down and interruption of continuous operation.

It is an object of the present invention to resolve these prior art problems.

It is a specific object of the invention to provide a procedure for inhibiting or preventing large build-ups of uncrystallized plastic materials on the dryer walls, thus ensuring continuous operation for long periods of time.

Other objects and the advantages of the invention will be evident from the following description thereof.

In accordance with the present invention, build-up of solids on the dryer walls during the drying of sucrose-containing solutions in the presence of recycled product solids is inhibited or prevented by maintaining the average particle size (i.e., that size where 50 weight percent of the particles are larger and 50 weight percent are smaller) of the recycled product at about 200 microns or less, preferably about 150 microns or less and most preferably between about 50 and 100 or 150 microns. In this way wall accumulation in the spray dryer is significantly reduced or eliminated. In those cases where some wall accumulation is still present it is reduced to such an extent that the size of any random, intermittent discharge of flaked off masses is small enough to pass unhindered through the dryer outlet without interrupting continuous operation.

In one particular embodiment the present invention is applied to the sucrose solution spray drying process which has been described in the aforementioned Belgian Pat. 742,249. In general, the process involves atomization of the sucrose-containing solution to be dried into the hot air flowing in the spray dryer while separately feeding substantial proportions of solid sucrose particles. The sucrose-containing solution may contain from about 60 to about 90 weight percent solids. Where appropriate or desirable, the solution is pre-heated, e.g., to a temperature of 50 to 100° centigrade to preclude premature crystallization and to aid in feeding and atomization. The

solid sucrose, preferably recycled product, is separately and concurrently fed to the dryer in amounts sufficient to provide a weight ratio of from 0.5 to 4.0, preferably about 1.5 to about 3 parts of solids, for each part, by weight, of solids in the solution to be dried. Stated conversely, the weight ratio of solids in the solution to the separately introduced product solids ranges from about 0.25 to about 2, preferably from about 0.33 to about 0.67. The drying temperature (i.e., the ambient temperature in the dryer after substantially steady state conditions have been established for continuous operation) will vary with other process conditions and the particular sucrose-containing solution to be dried but typically ranges from about 50° to about 130° centigrade, preferably about 80° to about 100° centigrade. Temperature can be controlled by controlling the temperature or feed rate of the incoming sugar syrup or the recycled solids or the temperature of the incoming hot air, or the average residence time in the dryer.

The particle size of the recycled solids is maintained in the desired range by size reduction prior to the recycle. This can be accomplished by an intermediate grinding step, by appropriately designing the recycle system so that the product solids are de-agglomerated by attrition or impact in the course of being returned to the dryer solids feed inlet, or in any other suitable manner. In any event it is essential that the average particle size of the recycled solids be reduced to not greater than about 200 microns prior to reintroduction into the dryer. Preferably, the average particle size is reduced to not greater than about 150 microns and most preferably to between about 50 and 100 or 150 microns. For reasons of overall process economy, dusting losses and the like it is generally undesirable to reduce the average particle size of the recycle solids lower than about 25 microns, particularly since no substantial further improvement in results will be observed.

Any number of sucrose-containing solutions may be dried in accordance with the present invention; including, for example, refined sugar syrups, raw sugar syrups, affination syrups, syrups resulting from various strikes (e,g., the second, third or subsequent strikes) in conventional sugar crystallization processes, remelt syrups, edible molasses, and the like; or mixtures of the foregoing. The solutions are appropriately decolorized, where required, if a white product is desired and are concentrated or diluted to the desired solids content prior to drying.

The invention will be further understood from the following illustrative examples.

EXAMPLE A.—(COMPARATIVE EXAMPLE)

A pilot plant run was conducted utilizing the process and apparatus described in Belgian Pat. 742,249. The spray dryer apparatus had a 7½ foot diameter with a 3½ foot high cylindrical section and a 60° conical bottom giving an overall dryer capacity of approximately 240 cubic feet. The liquid atomizer was a high vane centrifugal wheel rotating at 22,900 revolutions per minute.

The sucrose solution feed was affination syrup from a commercial cane sugar refinery. This syrup contained about 70.5 weight percent solids. It was preheated and fed to the dryer at a temperature of about 170° Fahrenheit and at a rate of 16.2 gallons per hour, providing a syrup solids feed rate of about 128 pounds per hour.

Dried, solid sucrose product from an earlier run was used for the initial "recycle." This product had an average particle size of about 300 microns. Thereafter, product solids from the run, with an average particle size of 300 to 400 microns, was used. The recycle solids were fed via four one-inch diameter tubes evenly spaced about the outside of the centrifugal atomizer at a rate of 512 pounds per hour (recycle weight ratio of 4).

Hot air was introduced into the dryer at about 1,000 cubic feet per minute and a temperature of 336° Fahrenheit. The temperature of the outlet air was 161° Fahrenheit and the temperature of the product exiting from the dryer was 138° Fahrenheit.

While operating under the foregoing conditions a rapid build-up of accumulated solids on the dryer walls was observed. Within an hour the total wall accumulation amounted to 219 pounds and the accumulated material had built up to a depth as high as 10 inches at some locations on the dryer walls. There was a large mass of flaked-off solids over the dryer solids product outlet. Conditions were judged to be so poor that the run could no longer be continued.

The following example illustrates the practice of the present invention.

EXAMPLE 1

A subsequent run was conducted in the same equipment and under conditions generally similar to those described in comparative Example A. In this run the syrup feed rate was equivalent to 174 pounds of syrup solids per hour and the recycle solids were fed at a rate of 556 pounds per hour (recycle solids ratio of about 3.1). The recycled solids were made up from the product of a previous run for start-up and thereafter from the run in progress. All recycle solids were ground in a Cumberland mill (a commercially available attrition mill) to an average particle size within the range from 100 to 150 microns prior to being fed to the dryer. The inlet air temperature was 437° Fahrenheit, outlet air temperature 161° Fahrenheit and product temperature 151° Fahrenheit.

The recovered product had an average particle size within the range from 200 to 300 microns and a moisture content of 1.2 to 1.6 weight percent.

During the course of this run the dryer walls remained relatively clean, with no heavy wall accumulations. No difficulty was experienced with large solids masses plugging the outlet. Total wall accumulation after 1.3 hours operation was only about 60 pounds, distributed in thin layers. The general condition of the dryer was judged to be quite satisfactory for prolonged continuous operation.

What is claimed is:

1. In a process for continuously preparing a dried, solid sucrose-containing product from a sucrose-containing solution by continuously drying droplets of the said solution in a current of heated air and in the presence of 0.5 to 4 parts by weight of separately and continuously introduced recycle product solids per part by weight solids in the solution to be dried, the improvement which comprises inhibiting or preventing accumulations on the dryer walls by continuously maintaining the average particle size of the recycled product solids at about 200 microns or less.

2. Improvement as defined in claim **1** in which the size of the recycle solids is maintained within the range of from about 50 to about 150 microns.

3. Improvement as defined in claim **2** in which the size of the recycle solids is maintained within the desired range by deagglomeration of the product in the dryer recycle system.

4. Continuous process for preparing dry sucrose-containing products comprising:

(a) continuously dispersing in a current of heated air sucrose particles having an average particle size of about 200 microns or less;

(b) continuously and separately dispersing in the heated air from about 0.25 to about 2 parts by weight, dry solids basis, of droplets of a sucrose-containing solution, per part by weight of said particles;

(c) evaporating the water from the droplets;

(d) continuously separating the resulting dry product from the hot air stream;

(e) reducing the average particle size of at least the necessary amounts of said resulting dry product to provide the particles used in step (a) to about 200 microns or less;

(f) continuously recycling the necessary amounts of reduced size material from step (e) to the dispersion step (a); and

(g) recovering the remainder of the dry product.

5. Process as defined in claim 4 wherein the size reduction in step (e) is sufficient to provide an average particle size within the range of from about 50 to about 150 microns.

6. Process as defined in claim 5 wherein the size reduction is accomplished by deagglomeration of the dry product of step (d) in the course of the recycle step (f).

7. Process as defined in claim 5 wherein the sucrose-containing solution is an affination syrup.

8. Process as defined in claim 5 wherein the sucrose-containing solution is a last-strike liquor from conventional sugar refinery crystallization.

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