Feb. 3, 1953 R. E. MEADE 2,627,463

PROCESS FOR THE MANUFACTURE OF STABILIZED MILK PRODUCTS

Filed July 9, 1949 2 SHEETS—SHEET 1

FIG_1_

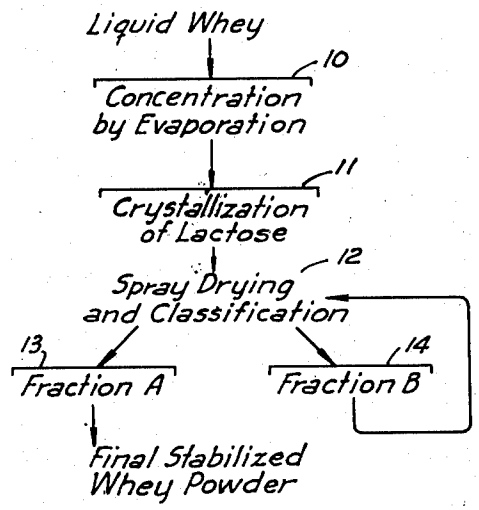
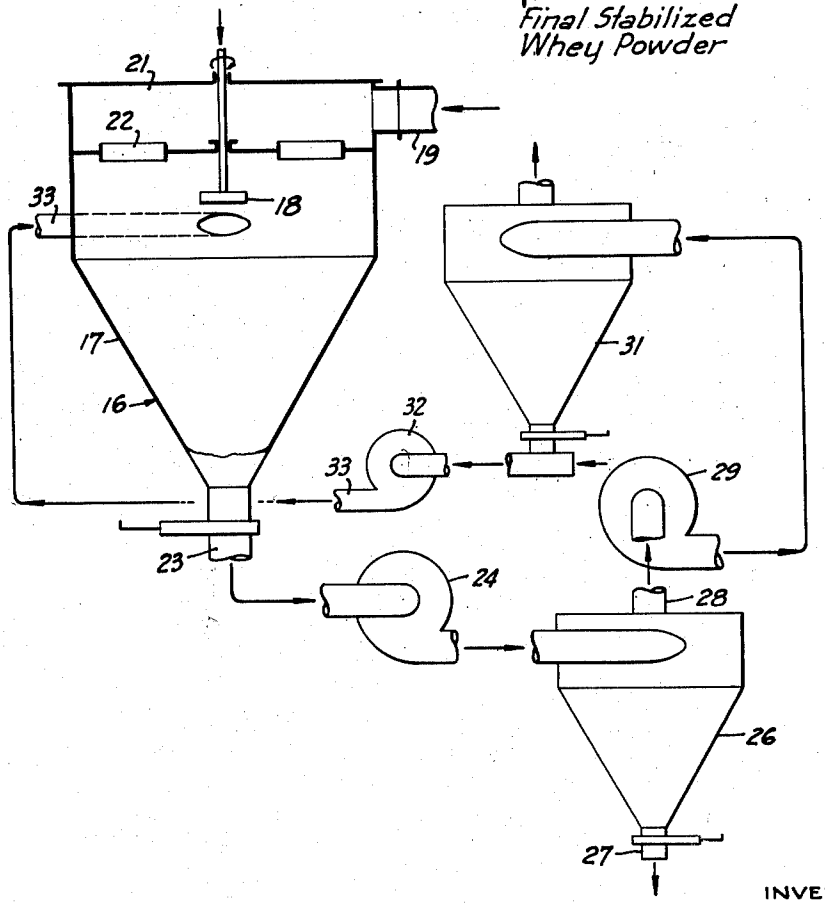


FIG_2_



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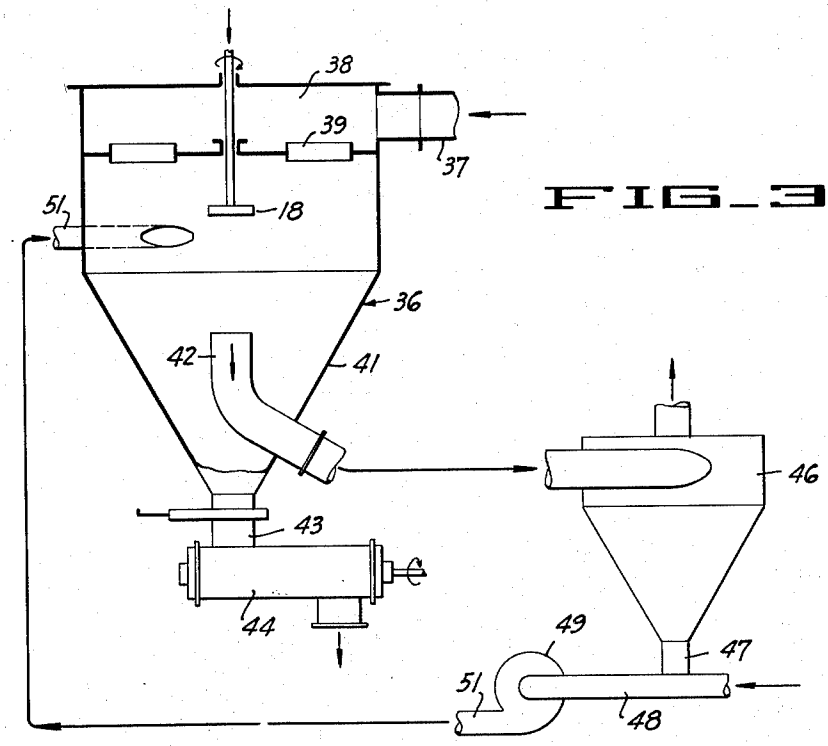


FIG_3_

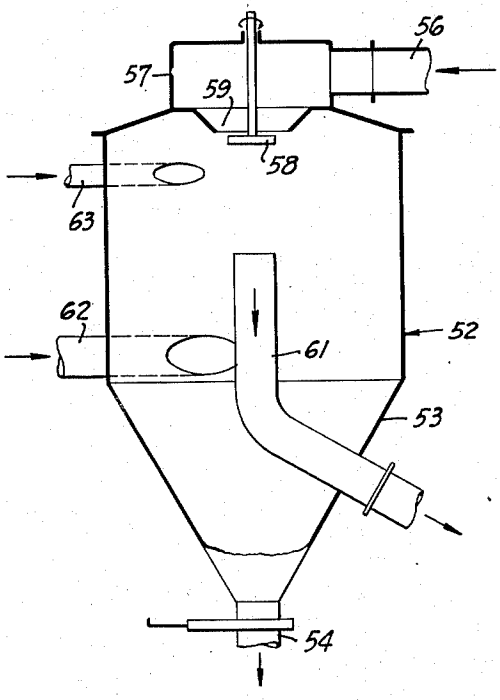


FIG_4_

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UNITED STATES PATENT OFFICE

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PROCESS FOR THE MANUFACTURE OF STABILIZED MILK PRODUCTS

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Application July 9, 1949, Serial No. 103,858

7 Claims. (Cl. 99—57)

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This invention relates generally to processes for the treatment of liquid lacteal materials containing substantial amounts of lactose, and to powdered products resulting from such processes.

In the past several processes have been developed for converting liquid lacteal materials containing lactose, such as commercial whey, to the form of relatively stable nonhygroscopic powder. Processes of this character are disclosed for example in Simmons 1,763,633 and Peebles and Manning 2,088,606.

In copending application filed simultaneously herewith and entitled "Milk Treatment Process and Product," application Serial No. 103,857, filed July 9, 1949, there is disclosed a new process of this character involving producing a concentrate having at least about 50% and preferably about 70% or more of its lactose content in the form of small sized crystals of alpha lactose monohydrate and then spray drying the concentrate without removing water of crystallization.

The present invention has been predicated upon the discovery that when a substantial part of the lactose in the feed to the spray drier is crystallized, the spray dried material can be readily classified into two fractions, one being more stabilized than the other. No adequate explanation can be given for this effect although it is attributed to formation of particles which vary as to classifying characteristics, and influenced at least in part by the presence of lactose crystals in the feed. The present process makes use of such classification and provides a novel procedure whereby the less stable fraction obtained is stabilized and merged with the stable material.

It is an object of the present invention to provide an improved process for the production of a spray dried and stable nonhygroscopic whey powder.

It is another object of the invention to provide a process of the above character which makes use of classification in conjunction with spray drying, and which returns the less stable classified fraction to the spray drying operation in such a manner that it is stabilized and merged with the stable fraction.

Additional objects and features of the invention will appear from the following description in which the preferred embodiments have been set forth in detail in conjunction with the accompanying drawing.

Referring to the drawing:

Figure 1 is a flow diagram illustrating one procedure carrying out the invention.

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Figure 2 is a diagrammatic view illustrating apparatus which can be used in carrying out the process.

Figure 3 is another diagram illustrating another embodiment of the invention.

Figure 4 is a diagram illustrating another type of spray drying equipment which can be used in carrying out the process.

The present process involves concentrating lacteal material by conventional evaporation, thereby producing a concentrate suitable for further treatment. A substantial part of the lactose in the concentrate is then crystallized, with formation of relatively small sized crystals of alpha lactose monohydrate, thereby producing a concentrate having a substantial part of its lactose content in stable crystallized form. This material, with the crystals in suspension, is then spray dried to form a powder. In conjunction with the spray during operation, the spray dried powder is classified into two fractions, one being a fraction which is substantially completely stabilized and nonhygroscopic, and the second being a fraction which is not completely stabilized. The second fraction is recycled in the process, thus causing the solids of the same to gradually merge with the first fraction, but without affecting the nonhygroscopic or stable character of the latter.

The general procedure followed in carrying out the present process can be best understood by reference to Figure 1. Assuming that the lacteal material being treated is whey, I may employ commercial liquid whey such as is formed as a by-product in the manufacture of cheese from milk, or as formed in the commercial manufacture of casein. The character of commercial whey varies considerably in accordance with the treatment to which it has been subjected. Typical analyses of commercial wheys show water content ranging from 93 to 94%, solids from 6.0 to 7.0%, fat from 0.3 to 0.1%, lactose from 4.00 to 5.25%, ash from 4.0 to 0.8%, and acid (as lactic) from 0.11 to 0.50%.

In the flow diagram of Figure 1 the raw liquid whey is shown being supplied to the concentrating operation 10, where it is concentrated by evaporation. Vacuum evaporating equipment can be used such as will deliver a concentrate of the order of 45 to 60% solids. The temperature of the concentrate as delivered from the last operating stage will vary in accordance with the vacuum employed, but in a typical instance it may be within the range of from 110 to 150° F.

All of the lactose content of the concentrate will be in solution.

In the next step 11 of the process, the concentrate is permitted to crystallize under such conditions as to cause a substantial part of the lactose content to crystallize out in the form of small crystals of alpha lactose monohydrate. The extent to which the concentrate is crystallized may vary depending upon the type of product which one desires to produce, and the drying conditions which one desires to maintain in and subsequent to the spray drying operation. Assuming concentrations of the order of 45% or more solids, small crystals of lactose quickly form as the concentrate is permitted to cool after leaving the vacuum evaporator. Cooling tanks provided with agitating means can be used, particularly where it is desired to employ higher percentages of crystallized lactose in the feed.

In the crystallizing operation it is not necessary to initially seed crystal formation. However seeding serves to accelerate crystal formation and can be carried out by introducing small amounts of a stabilized whey powder into the concentrate while the same is being cooled. It is convenient for this purpose to use stabilized dried whey powder such as is produced by the present process, and which has its lactose content in the form of alpha lactose monohydrate. Seeding can be limited to the initial stages of crystallization, or may also be employed throughout cooling.

Assuming that the whey concentrate has been crystallized whereby from 20% to 70% of the lactose content is in the form of small crystals of lactose monohydrate in suspension, this slurry is then supplied to the spray drying operation 12, where it is atomized in contact with hot drying air. Conventional spray drying equipment can be used for this operation, although it is preferable to utilize a centrifugal type of atomizer such as will handle the concentrate. The flow rate of drying air through the desiccating chamber, together with the inlet and outlet temperatures of the air, should be adjusted to avoid removal of water of crystallization from the lactose crystals, while at the same time reducing the free moisture content of the material to produce a final powder of the desired free moisture content.

As indicated in Figure 1, in conjunction with or immediately after the spray drying operation, the powdered material is subjected to pneumatic classification to form two fractions (13 and 14) which in Figure 1 have been described as fractions A and B. I have discovered that a concentrate crystallized in the manner previously described, produces on spray drying a powdered material which is amenable to classification, whereby the two fractions differ considerably as to characteristics. In general the average free moisture content of fraction 14 will be less than fraction 13. On analysis fraction 13 will generally show a higher lactose content than fraction 14. Fraction B however is only partly stabilized, and possesses sufficient hygroscopic characteristics so that it is not suitable for direct marketing.

As indicated in Figure 1 fraction B is reprocessed by recycling it to the spray drying operation 12. Suitable apparatus and methods for this process will be presently described with reference to Figures 2 to 4 inclusive. As indicated this incompletely stabilized powder can be returned into the spray drying chamber, and caused to gradually merge with the stable fraction A.

Figure 2 illustrates suitable apparatus for carrying out the process of Figure 1, and in which classification is carried out immediately after spray drying in a desiccating chamber. In this instance a desiccating chamber 16 is provided with a lower conical shaped portion 17, and an axially disposed centrifugally atomizing nozzle 18. Hot drying air is introduced continuously through conduit 19 and flows from the upper chamber 21 into the main desiccating chamber and between the inclined louvres 12. These louvres serve to cause swirling of air about the interior of the desiccating chamber, in order to prolong contact between the atomized particles and the drying gas.

The powdered material from the desiccating chamber is shown being removed through the lower conduit 23, and delivered by blower 24 to the pneumatic classifier 26. The classifier 26 is arranged to separate the material into two fractions of different classifying characteristics, namely the fractions A and B of Figure 1. Fraction A, the completely stabilized powder, is removed through the lower conduit 27.

Fraction B is shown being withdrawn through conduit 28, and delivered by blower 29 to the separator 31. The powdered material separated out in collector 31 is shown being delivered by a blower 32 and conduit 33, to the desiccating chamber. Normally fraction B is a relatively minor percentage (e. g. 5 to 20%) of fraction A, and therefore its continuous return does not interfere with proper functioning of the spray drying equipment.

In place of carrying out classification separate from the desiccating chamber, it is desirable to utilize desiccating equipment which will perform both the spray drying and classifying operations. Such equipment is illustrated in Figure 3. The spray drying chamber 36 in this instance is likewise supplied with hot drying air from the conduit 37, which connects with the hot air chamber 38 for discharging the air into the desiccating chamber between the inclined louvres 39. The lower conical shaped portion 41 of the desiccating chamber forms in effect a part of a pneumatic classifier, in conjunction with the exhaust conduit 42. The inner open end of conduit 42 is located axially, and is intermediate the atomizer 18 and the lower end of the conical portion 41. Collected powder is withdrawn from the lower end of the desiccating chamber through conduit 43, and the screw discharge device 44.

Air, together with entrained classified fraction B, is withdrawn through conduit 42 and delivered to the separator or collector 46. The powder collected in this manner is delivered through conduit 47 to the inlet conduit 48 of the blower 49. The discharge conduit 51 from blower 49 returns this fraction back into the desiccating chamber.

In place of the spray drying equipment illustrated in Figures 2 and 3, I prefer to utilize a spray drier as illustrated in Figure 4. In this instance the desiccating chamber 52 has a lower conical shaped portion 53, from which powder is removed through conduit 54. Hot air is supplied through conduit 56 to chamber 57, from which the air is delivered downwardly about the centrifugal atomizing nozzle 58, through the downwardly directed opening 59. The exhaust conduit 61 is located similar to the conduit 42 of Figure 3. Additional hot air is continuously

supplied through the conduit 62, which connects tangentially with chamber 52 well below the level of the upper open end of conduit 61. Conduit 63 of Figure 4 corresponds with the conduit 33 of Figure 2, and serves to reintroduce the classified fraction B back into the desiccating chamber for retreatment.

In general the drying conditions maintained in the desiccating chamber should be such that the material is reduced to the form of a powder without removal of water of crystallization of the lactose. The amount of free moisture permitted to remain in the fraction A as it leaves the desiccating chamber is dependent upon the drying conditions maintained. It is practical to operate the process whereby on the average from about 12 to 16% of free moisture is permitted to remain in the powder, having reference particularly to the powder removed as fraction A. About 14% free moisture appears to provide optimum hydration of the lactose.

Assuming that fraction A is removed with a free moisture content ranging from 12 to 16%, or 14% optimum, it is subjected to suitable secondary drying to reduce the free moisture content to a value suitable for sacking and marketing. Secondary drying can be carried out in various ways, such as by use of a drier of the drum type, or cyclone type of drier in which the powder is contacted with warm drying air. A final free moisture content ranging from 1 to 4% has been found satisfactory.

During operation of the process it has been noted that varying amounts of material tend to accumulate on the lower inclined walls of the desiccating chamber (i. e. the walls of the lower conical portion) and that there is a continuous sloughing off of such material in the form of cake-like masses. It appears that such accumulations of material in the desiccating chamber change in physical character from moist powder to readily crushable or friable masses, before the material sloughs off and merges with the powder being withdrawn as fraction A. Masses of fragments formed in this fashion can be readily crushed prior, during, or following secondary drying.

When the percentage of crystallized lactose in the feed is increased, there appears to be a decrease in the percentage of material removed as fraction B, or in other words a greater proportion of the material possesses heavier classifying characteristics and is hydrated to such an extent as to be completely stable and nonhygroscopic.

An example of the process is as follows: Raw commercial whey was concentrated by vacuum evaporation to 45.3% solids. This concentrate was permitted to cool to 94° F., at which time 24.7% of its lactose was in the form of small crystals of alpha lactose monohydrate. This concentrate was then supplied to the centrifugal atomizer of a spray drier similar to that indicated in Figure 4. The fraction removed at 44 had a free moisture content of 7.75%, and about 68.1% of its lactose was hydrated. The material removed through the pipe 44 contained on the average, about 2.8% free moisture, and on the average about 79% of the lactose was hydrated. After secondary drying of fraction A, it contained about 4.15% total moisture, 1.4% free moisture, and about 72% of its lactose was hydrated. The finished product was a highly stable and marketable material.

In the foregoing description particular reference has been made to the treatment of raw liquid commercial whey. It should be understood however that the process is applicable to other liquid lacteal materials, particularly materials containing substantial amounts of lactose. For example the process can be used to advantage in the treatment of skim milk and other lacteal materials of relatively high lactose content which may result as by-products in the treatment of various lacteal products.

Reference is made to my copending application Serial Number 673,392, filed May 31, 1946, which has now become abandoned.

I claim:

1. In a process for the manufacture of stable nonhygroscopic powder from liquid lacteal material containing substantial amounts of alpha lactose monohydrate, the steps of concentrating the material, causing a substantial part of the lactose content of the concentrate to be crystallized in the form of small sized particles of alpha lactose monohydrate, spray drying the concentrate to form a powdered material, said spray drying being carried out by atomizing the concentrate and causing the atomized particles to be suspended in a drying gas in a drying zone, continuously removing the powdered material from the drying zone and continuously classifying the same into a stabilized fraction and an incompletely stabilized fraction, said fractions differing in that the stabilized fraction has a higher percentage of its lactose in the form of lactose monohydrate, the lactose content of both said fractions being substantially entirely in the alpha form, and continuously returning the last named fraction to said drying zone to cause the same to commingle with the atomized particles therein, whereby material thus retained is more completely stabilized to merge with the stabilized fraction.

2. In a process for the manufacture of powdered products from liquid lacteal material containing substantial amounts of alpha lactose, the process comprising concentrating the lacteal material, converting the bulk of the lactose present to the form of small sized particles of alpha lactose monohydrate, spray drying the concentrate to form a powdered material, the spray drying being carried out by atomizing the concentrate and causing the atomized particles to be suspended in a drying gas in a drying zone, continuously classifying the powdered material into a completely stabilized nonhygroscopic fraction and an incompletely stabilized hydroscopic fraction, said fractions differing in that the stabilized fraction has a higher percentage of its lactose in the form of lactose monohydrate, the lactose content of both said fractions being substantially entirely in the alpha form, and continuously returning the last named fraction to the drying zone to commingle the same with the atomized particles, whereby material thus retained is more completely stabilized to merge with the stabilized fraction.

3. In a process for the manufacture of powdered products from lacteal material containing substantial amounts of alpha lactose, the steps of concentrating the lactose material, cooling the concentrate together with agitation to cause crystallization of the majority of the lactose present to the form of small sized particles of alpha lactose monohydrate, spray drying the concentrate to form a powdered material, the spray drying being carried out by atomizing the concentrate and causing the atomized particles to be suspended in a drying gas in a drying zone, continu-

ously classifying the powdered material to provide a substantially completely stabilized nonhygroscopic fraction containing the bulk of the precrystallized lactose and an incompletely stabilized fraction, said fractions differing in that the stabilized fraction has a higher percentage of its lactose in the form of lactose monohydrate, the lactose content of both said fractions being substantially entirely in the alpha form, and continuously returning said last named fraction to the drying zone of the spray drying operation to commingle the same with the atomized particles and to effect continual merging of the same with said first named stabilized fraction.

4. In a process for the manufacture of powdered material from liquid lacteal material containing substantial amounts of lactose, the steps of concentrating the liquid lacteal material, cooling the concentrate together with agitation to effect crystallization of the majority of the lactose present in the form of crystals of alpha lactose monohydrate, continuously spray drying the concentrate to form powdered material, the spray drying being carried out by atomizing the concentrate and causing the atomized particles to be suspended in a drying gas in a drying zone, simultaneously with said drying operation and while the atomized particles are in suspension, subjecting the powdered material to pneumatic classification to form two fractions, one fraction being completely stabilized nonhygroscopic powder containing the majority of said precrystallized lactose and the other fraction being incompletely stabilized powder, said fractions differing in that the stabilized fraction has a higher percentage of its lactose in the form of lactose monohydrate, the lactose content of both said fractions being substantially entirely in the alpha form, and continuously returning said last named incompletely stabilized powder to the drying zone to commingle the same with the atomized particles and to cause continual merging of the same with said first named fraction.

5. In a process for the manufacture of stabilized whey powder from liquid commercial whey, the steps of concentrating the whey by evaporation to produce a concentrate containing from about 45 to 60% solids, causing crystallization of the bulk of the lactose present to cause formation of crystals of alpha lactose monohydrate, spray drying the concentrate to form a powdered material, said spray drying being carried out by atomizing the concentrate and suspending the atomized particles in a drying gas in a drying zone, continuously subjecting the powdered material produced by said spray drying to pneumatic classification to separate the same into two fractions, one fraction being a substantially completely stabilized whey powder containing substantially all of the precrystallized lactose, and the other fraction being incompletely stabilized powder, said fractions differing in that the stabilized fraction has a higher percentage of its lactose in the form of lactose monohydrate, the lactose content of both said fractions being substantially entirely in the alpha form, and continuously returning said last named fraction to the drying zone of the spray drying operation to cause the same to intermingle with the atomized particles and to continually merge with said first named fraction.

6. A process as in claim 3 in which the spray dried material is removed from the drying zone, classified pneumatically and then said other fraction returned pneumatically into the drying zone.

7. A process as in claim 3 in which the spray dried material is subjected to pneumatic classification in the spray drying operation and while the atomized particles are in suspension, and in which said other classified fraction is pneumatically returned to the drying zone.

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