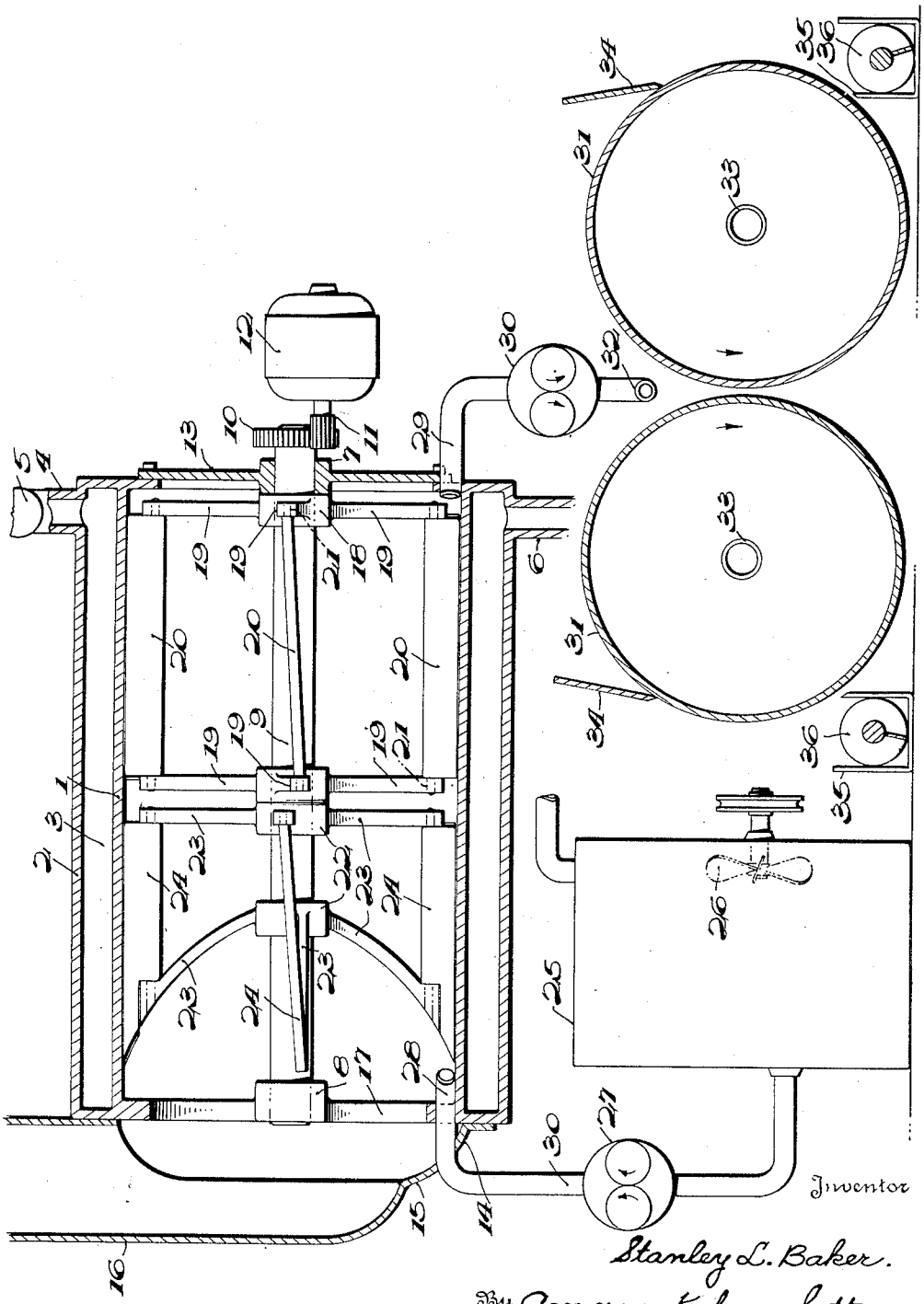
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PROCESS FOR DRYING YEAST

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PROCESS FOR DRYING YEAST

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9 Claims. (Cl. 195—98)

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This invention relates to drying dilute suspensions or slurries of yeast and especially brewers' yeast slurry which will be referred to hereinafter as an example, although it is to be understood that the invention is not restricted thereto. This application is a continuation in part of my prior application, Serial No. 521,246, filed February 5, 1946, which became abandoned July 28, 1947.

The yeast solids remaining after the manufacture of beer are very desirable as constituents of both human and animal diets, being rich in vitamins and highly nutritious. However, the slurry remaining in the brewers' vats is a dilute beery liquid from 4% to 18% and usually about 12% solids and saturated with CO_2 at a temperature of about 34° F. For general use in feed mixtures, the yeast solids must be dried to a moisture content of 7–8%. The slurry of living yeast becomes so thick and viscous that it can not be handled as a slurry above about 18% solids, but the yeast cells are killed by heat of evaporation and the slurry then remains flowable while hot up to about 45% solids. However, a slight rise in temperature of only a few degrees coupled with movement or agitation of the liquid is sufficient to initiate the formation of a characteristic heavy and persistent foam which is difficult to avoid and equally difficult to handle once it is formed. Moreover, the slurry is no longer flowable even while hot when its solids content increases above about 45%.

For the above reasons it is impractical to produce dry yeast solids from such slurries in internal film evaporators of centrifugal and like types, and drying has heretofore been performed to some extent by spraying but mainly on external drum dryers. However, drum drying operations have been inefficient and difficult to handle and control. The dilute yeast slurry striking the hot surface of the drum tends to foam and splatter as the gases and vaporizable materials are driven off, the film on the drum is uneven and spotty causing uneven and inefficient drying, and scorching or charring of the yeast solids is apt to take place at thin spots in the film.

My copending application, Serial No. 723,122, filed January 20, 1947, which also is a continuation in part of my aforesaid prior application, discloses a process for the partial concentration of brewers' yeast slurries to a solids content in the range of 25–45%. As disclosed in said copending application, this process is well suited for use in breweries because the partially concentrated slurry does not foam and is stable against putrefaction so that it can be shipped

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to relatively remote central plants for final drum drying. However, the use of the aforesaid process of partial concentration is highly advantageous for additional reasons in that the final drying of the partially concentrated slurry can be performed on the drum without encountering the above mentioned difficulties which arise when the original dilute slurry is fed directly to the drum and in that the combined two-stage drying operation is more efficient overall than when the dilute slurry is entirely drum-dried. Hence the aforesaid process of partial concentration is useful and desirable not only by itself in breweries as set forth in said copending application but also in combination with drum drying in drying plants as set forth hereinafter.

The process of partial concentration lends itself well to combination with drum drying as a continuous operation. At a partial concentration of about 20–25% solids and above, foaming and splattering on the drum are eliminated, a uniform film is obtained, and drying takes place evenly and uniformly without scorching or charring. Furthermore, the overall efficiency of the complete drying operation is improved, the output of the drum drying equipment is markedly increased, and a product is obtained which is better suited for the handling and processing incident to its incorporation in feed mixtures.

Broadly speaking, therefore, the present invention comprises the combination of partial drying of the dilute slurry by the process of the copending application mentioned above with subsequent drum drying of the partially concentrated slurry to the desired final moisture level of about 7–8% or less. The process is continuous, the dilute slurry (usually about 12% solids) being suitably supplied to and moved through the first partial concentration stage where it is preferably concentrated to about 25% solids, and the still flowable slurry leaving this stage being pumped or otherwise suitably passed directly to the drum dryer in which the final dry product is produced.

As disclosed in said copending application, the continuous partial concentration of the slurry in the first stage is effected by flowing a thin film of the slurry with agitation over a heated evaporating surface, the dilute slurry being fed continuously to and the partially concentrated slurry being discharged continuously from said surface. Various known types of film evaporators are available for this purpose. However, special measures are required to prevent foaming of the slurry film which otherwise would render the operation impractical. For the reasons set forth fully in

said copending application, such foaming can be prevented by limiting the thickness of the film on the evaporating surface to 0.3 inch. A practical and efficient operation is obtained under the above conditions and with a rate of heat input to the film sufficient to evaporate at least 35 and preferably about 70 lbs. of water per hour per square foot of film. While the evaporator is preferably operated at atmospheric pressure, higher pressure or vacuum can be used if desired.

Under the above conditions the dilute slurry can be concentrated to 25–45% solids after a maximum time period of approximately two minutes at the prescribed minimum rate of evaporation, and within 30–60 seconds if the rate of evaporation is increased to the preferred range. The hot, partially concentrated and still flowable slurry is then passed directly to the drum dryer. The concentration of the slurry leaving the first stage should be in the range of 20–30% in most cases, the optimum being approximately 25%. Higher concentrations can be used up to the point where the hot slurry is no longer flowable (about 45% soldis), but above about 30% special measures are required at the drum dryer such as the use of an air blast.

The drum dryer may be of any suitable type comprising for example a rotating drum or drums heated internally by steam or the like, the film of material on its outer surface being removed by a suitable scraper when dry. Too high temperatures of the drum may result in scorching or charring of the material, and hence it should not as a rule be operated at steam pressures higher than 70–75 lbs. The drum can be operated in a vacuum and heated to a lower temperature if desired.

The time interval between the discharge of the partially concentrated slurry from the first stage and its application to the surface of the drum dryer should preferably not exceed about two minutes to minimize cooling effects and also to avoid undesirable physical and chemical changes which may take place in the material under these conditions. On the other hand, it has been found advantageous to allow about a minute to a minute and a half for this interval, since at shorter intervals there may be some blistering of the slurry on the hot drum surface analogous to that which occurs when the dilute 12% slurry is fed directly to the drum. This time interval can usually be provided simply by suitable arrangement of the feed lines from the first stage to the drum dryer.

The partially concentrated slurry does not foam or blister on the drum and has good wetting and adhering properties so that a uniform film of good thickness is formed and drying takes place evenly and efficiently. Hence it will be seen that the whole operation is simple, continuous, automatic and efficient. Moreover, the unexpected result is obtained that the output of the drum is markedly increased, with consequent increased production and reduced equipment cost. Some increase in drum output would of course be expected since part of the original water content of the slurry is evaporated in the first stage and also since the slurry delivered to the drum is at a high temperature (around 200° F.) as compared with the original dilute slurry (around 34° F.). With due allowance for these factors, however, the output of the drum is actually increased 50% or more beyond what would be expected.

The product removed from the drum is in the form of ribbons or flakes of the yeast solids containing about 7–8% moisture or less. This product can be broken up in any suitable manner and ground if desired and then stored for subsequent incorporation in feed mixtures, etc. It has been found that the product coming off the drum in the present process is less powdery and dusty than the product obtained when the original dilute slurry is dried directly on the drum and hence is better suited for the handling and processing incident to its subsequent use in feed mixtures.

Various types of film evaporators and drum dryers are known in the art and generally speaking any such apparatus can be used in practicing the process of the present invention, provided only that the conditions set forth above are established and maintained. For the first stage of the process, however, it is preferable to employ a closed externally heated cylindrical evaporator operating at atmospheric pressure with the slurry film on its inner surface. For the second stage of the process, a conventional double drum dryer is satisfactory. By way of example, the accompanying drawing illustrates the practice of the process with equipment of the above types.

The film evaporator, as shown diagrammatically in the drawing, may suitably comprise a double walled cylindrical vessel the inner wall 1 of which forms the evaporating surface and the outer wall 2 of which cooperates with the inner wall to form a jacket 3 to which steam or the like is admitted through a pipe 4 and valve 5 and from which the steam is exhausted through a pipe 6. Bearings 7 and 8 at the opposite ends of the cylinder carry an axial shaft 9 which is driven an any suitable manner as by means of gears 10, 11 and an electric motor 12. The ends of the cylinder are closed in any suitable manner, as by means of a plate 13 at one end and a plate 14 at the other end which is flared at 15 to connect with a vapor stack 16 through which the evaporated moisture escapes. Bearing 7 may be carried by the end plate 13, while bearing 8 is carried by supports 17 forming part of the drum at its other end.

The shaft 9 carries one or more blades or paddles which serve to distribute the slurry in a film on the inner surface of the drum and to agitate the material in the film while at the same time feeding the material both circumferentially and axially through the drum. These blades or paddles may have any one of various forms known to the art. As shown for purposes of illustration, the shaft 9 carries two blade units. The right-hand unit comprises spaced hubs 18 secured to the shaft 9 and having radially extending spokes 19, blades 20 being pivotally mounted at 21 between the ends of each pair of spokes. The spokes of each pair are off-set angularly relative to each other so that each blade 20 is inclined to the axis of the drum. The left-hand unit comprises a similar pair of hubs 22 secured at longitudinally spaced points on the shaft 9 and having radially extending spokes 23 carrying pivoted blades 24 similar to the blades 20 of the right-hand unit. Preferably the left-hand hub 22 nearest the vapor stack is set inwardly on the shaft from the end of the drum and its spokes 23 are arranged to extend both radially and also longitudinally away from the hub toward the end of the drum so as to minimize fan action at this end.

The dilute slurry to be concentrated is stored in a suitable supply tank 25 having agitating

means 26 to prevent settling of solids in the tank. The slurry is pumped from the tank by suitable means such as a gear pump 27 and passes through an inlet pipe 28 into the right-hand end of the drum. The concentrated slurry leaves the drum at its other end through an outlet 29.

It will be seen that the thickness of the film on the inner surface of the evaporator is a function of the quantity of slurry in the evaporator at any instant. For example, assume that the evaporator shown in the drawings is three feet in diameter and three feet in length. Then if the evaporator contains two gallons of slurry, the average film thickness will be between 0.11 and 0.12 inch. Allowing for decreasing depth of the film from the inlet to the outlet end of the evaporator for reasons set forth above, the depth of the film at the inlet end will approach 0.2 inch and its depth at the outlet end may be as low as 0.05 or 0.06 inch. Under these conditions, concentration of the slurry will take place without foaming. If the rate of evaporation is about 70 lbs. of water per square foot of film per hour, the total amount of water evaporated will be approximately 2,000 lbs. per hour and the output of the evaporator in terms of slurry concentrated to 25% solids will be about 200 gallons per hour.

The rate of feed of the slurry through the evaporator can be suitably controlled as by varying the speed of rotation of the shaft 11 and the angle of the blades. About 35 seconds is required in the above example. If a higher degree of concentration is desired, the feed of the material can be adjusted or the length of the evaporator can be increased to provide a longer time of exposure of the slurry to the hot evaporating surface. Thus in the case of the above example, the maximum of 45% solids is reached by increasing the length of the cylinder from three feet to about four and one-half feet. The time of exposure of the slurry to the evaporating surface is thus increased from about 35 seconds to 50–55 seconds.

From the outlet 29, the partially concentrated slurry passes through a pump 30 to the drum drying apparatus which suitably comprises a pair of drums 31 rotating in opposite directions, the partially concentrated slurry being discharged from a feed pipe 32 into the throat between the drums. The drums may be heated internally in any suitable manner as by steam introduced through their trunnions 33. As noted above, the steam pressure in the drums should not exceed 70–75 lbs., and also the time elapsing between the discharge of the slurry from the film evaporator and its discharge from the feed pipe 32 preferably should be about 1–1½ minutes. The partially concentrated slurry discharged into the throat forms a film on each drum and is further dried on the surfaces of the rotating drums until finally removed by suitable scrapers 34 by which time it is a sensibly dry product. The ribbons, sheets, or flakes of dried material removed by the scrapers fall into suitable receptacles 35 which may be provided with screw conveyors 36 or the like.

The required size of the drums 31 will depend on the output of the film evaporator, and one drum drier may be used in combination with a plurality of evaporators or vice versa as may be desired. By way of example, it has been found that with a slurry at 25% solids coming directly from the first drying stage and therefore already heated, a yield of 540 lbs. of dried solids per hour can be obtained with drums 36 inches in diameter and 7 feet long rotating at 12 R. P. M. and heated by steam at 70–75 lbs. pressure. The same drums operating under the same conditions but using a 12% cold slurry yield only about 120 lbs. of dried solids per hour. The increase of output from 120 to 540 lbs. per hour is accounted for in part by the work done in the first drying stage, but with due allowance therefor the output of 540 lbs. per hour is still 50% or more better than expected due to the increased efficieny of the operation.

It will be understood that the invention is not limited to the use of the particular equipment described above for purposes of example, and also that various changes may be made in the details of the process without departing from the spirit of the invention. Reference should therefore be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. A process for producing dry yeast solids from dilute yeast slurries containing not more than about 18% solids which comprises partially concentrating the slurry to a solids content in the approximate range of 20–45% by moving a film thereof with agitation over a heated evaporating surface, the maximum depth of film being not more than 0.3 inch and the rate of heat input to said film being sufficient to evaporate at least 35 lbs. of water per hour per square foot of film, then further drying the hot partially concentrated still flowable slurry by forming a film thereof on the heated surface of a rotating drum dryer, and finally removing the dried solids from the drum surface.

2. A process for producing dry yeast solids from dilute yeast slurries containing not more than about 18% solids which comprises partially concentrating the slurry by moving a film thereof with agitation over a heated evaporating surface, the maximum depth of film being not more than 0.3 inch and the rate of heat input to said film being sufficient to evaporate at least 35 lbs. of water per hour per square foot of film, the time of exposure to said surface being sufficient to increase the solids content of the slurry to approximately 25%, then removing the hot partially concentrated, still flowable slurry from said evaporating surface and forming a film thereof on the heated surface of a rotating drum dryer for further drying of the solids to a maximum moisture content of about 7–8%, and then removing the dried solids from the drum.

3. A continuous process for producing dry yeast solids from dilute yeast slurries containing not more than about 18% solids which comprises partially concentrating the slurry to a solids content in the approximate range of 20–45% by continuously flowing a film thereof with agitation over a heated evaporating surface, the maximum film depth being 0.3 inch and the rate of heat input to the film being sufficient to evaporate at least 35 lbs. of water per hour per square foot of film, then continuously feeding the hot partially concentrated still flowable slurry discharged from said surface to drum drying apparatus, then forming a film of the slurry on the heated rotating surface of said apparatus for further drying to the final dry solid state, and then removing the dried solids from said apparatus.

4. A continuous process for producing dry yeast solids from dilute yeast slurries containing not more than about 18% solids which comprises con-

tinuously flowing a film of the slurry with agitation over a heated evaporating surface, the maximum film depth being 0.3 inch and the rate of heat input to the film being sufficient to evaporate at least 35 lbs. of water per hour per square foot of film, the time of exposure of the film to the surface being sufficient to concentrate the slurry to approximately 25% solids, then continuously feeding the hot partially concentrated still flowable slurry discharged from said surface to drum drying apparatus, then forming a film of the slurry on the heated rotating surface of said apparatus for further drying of the solids to a maximum moisture content of about 7–8%, and then removing the dried solids from said apparatus.

5. A continuous process for producing dry yeast solids from dilute yeast slurries containing about 12% solids which comprises partially concentrating the slurry to a solids content in the approximate range of 20–45% by continuously flowing a film thereof with agitation over a heated evaporating surface, the maximum film depth being 0.3 inch and the rate of heat input to the film being sufficient to evaporate at least 35 lbs. of water per hour per square foot of film, the time of exposure to said surface being not more than about two minutes, then continuously feeding the hot partially concentrated still flowable slurry discharged from said surface to drum drying apparatus, then forming a film of the slurry on the heated rotating surface of said apparatus for further drying of the solids to a maximum moisture content of about 7–8%, and then removing the dried solids from said apparatus.

6. A continuous process for producing dry yeast solids from dilute yeast slurries containing about 12% solids which comprises partially concentrating the slurry to a solids content in the approximate range of 20–45% by continuously flowing a film thereof with agitation over a heated evaporating surface, the maximum film depth being 0.3 inch and the rate of heat input to the film being sufficient to evaporate at least 35 lbs. of water per hour per square foot of film, the time of exposure to said surface being not more than about two minutes, then continuously feeding the hot partially concentrated still flowable slurry discharged from said surface to drum drying apparatus, the time of transit of the slurry from said surface to said apparatus being about 1–1½ minutes, then forming a film of the slurry on the heated rotating surface of said apparatus for further drying of the solids to a maximum moisture content of about 7–8%, and then removing the dried solids from said apparatus.

7. A continuous process for producing dry yeast solids from dilute yeast slurries containing about 12% solids which comprises partially concentrating the slurry to a solids content in the approximate range of 20–45% by continuously flowing a film thereof with agitation over a heated evaporating surface, the maximum film depth being 0.3 inch and the rate of heat input to the film being sufficient to evaporate about 70 lbs. of water per hour per square foot of film, the time of exposure to said surface being in the approximate range of 30–60 seconds, then continuously feeding the hot partially concentrated still flowable slurry discharged from said surface to drum drying apparatus, then forming a film of the slurry on the heated rotating surface of said apparatus for further drying of the solids to a maximum moisture content of about 7–8%, and then removing the dried solids from said apparatus.

8. A continuous process for producing dry yeast solids from dilute yeast slurries containing about 12% solids which comprises continuously flowing a film of slurry with agitation over a heated evaporating surface, the maximum film depth being 0.3 inch and the rate of heat input to the film being sufficient to evaporate about 70 lbs. of water per hour per square foot of film, the time of exposure to said surface being approximately 35 seconds whereby the slurry is partially concentrated to about 25% solids, then continuously feeding the hot partially concentrated still flowable slurry discharged from said surface to drum drying apparatus, then forming a film of the slurry on the heated rotating surface of said apparatus for further drying of the solids to a maximum moisture content of about 7–8%, and then removing the dried solids from said apparatus.

9. A continuous process for producing dry yeast solids from dilute yeast slurries containing about 12% solids which comprises continuously flowing a film of slurry with agitation over a heated evaporating surface, the maximum film depth being 0.3 inch and the rate of heat input to the film being sufficient to evaporate about 70 lbs. of water per hour per square foot of film, the time of exposure to said surface being approximately 35 seconds whereby the slurry is partially concentrated to about 25% solids, then continuously feeding the hot partially concentrated still flowable slurry discharged from said surface to drum drying apparatus, the time of transit of the slurry from said surface to said apparatus being about 1–1½ minutes, then forming a film of the slurry on the heated rotating surface of said apparatus for further drying of the solids to a maximum moisture content of about 7–8%, and then removing the dried solids from said apparatus.

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