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Kelly

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[54] **METHOD AND APPARATUS FOR DRYING STILLAGE**

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[52] **U.S. Cl.** ..... **34/10**; 34/57 A; 432/14

[51] **Int. Cl.**[2] **F26B 3/08**

[58] **Field of Search** ..... 34/10, 57 A; 432/14

[56] **References Cited**

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[57] **ABSTRACT**

Stillage is flash dried in a drying conduit and chamber system by passing large volumes of air through the system having entrance temperatures in the range of about 325°F to about 425°F. Stillage material is rapidly circulated through the system a plurality of times. Water is separated from the stillage during each drying pass to form a dry (about 10% moisture content) nutrient food substance without emitting significant amounts of smoke or odors.

6 Claims, 2 Drawing Figures

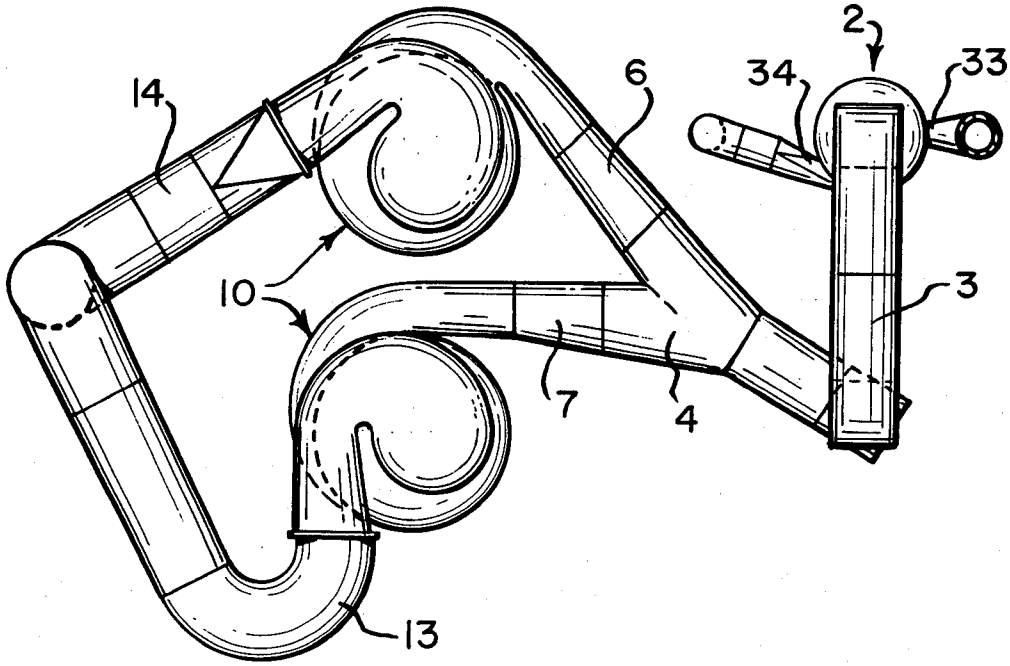


FIG. 1

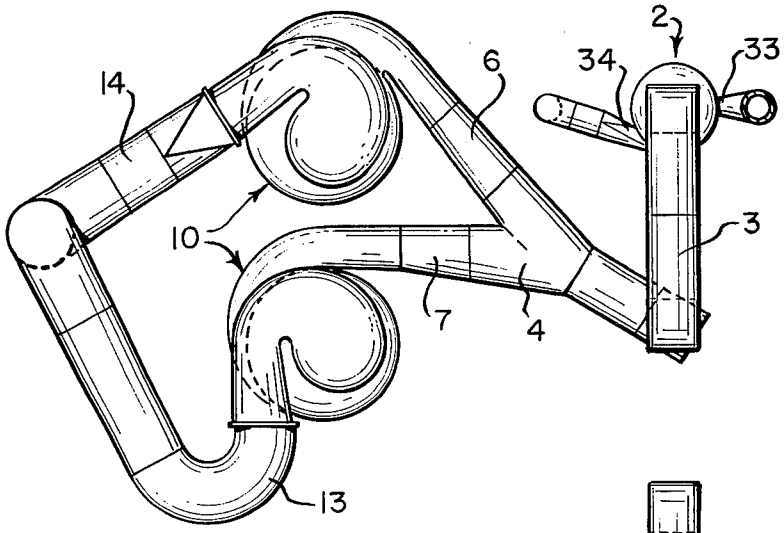
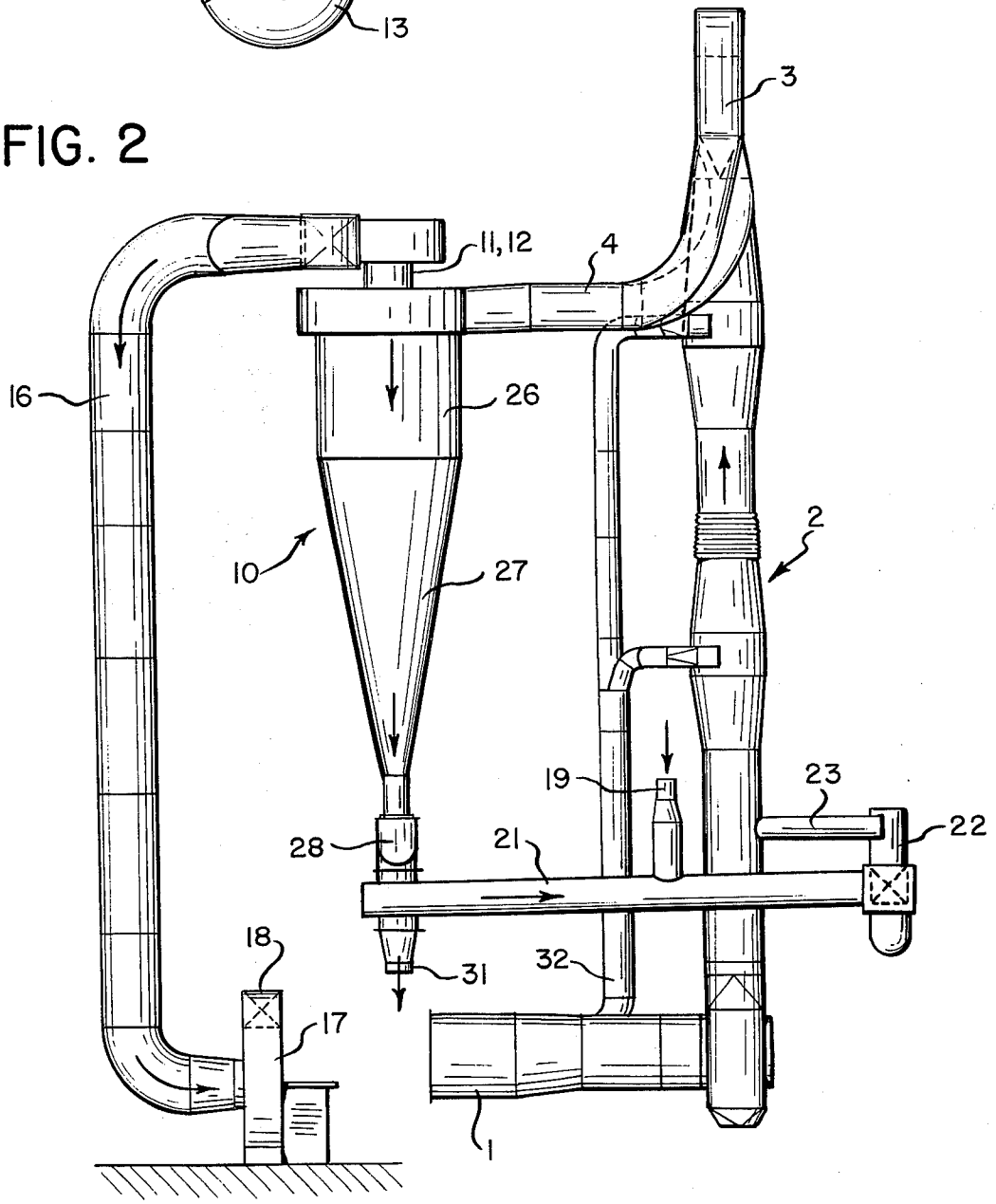


FIG. 2



METHOD AND APPARATUS FOR DRYING STILLAGE

BACKGROUND OF THE INVENTION

Spent stillage is the grain slurry remaining after completion of the fermentation and distillation processes in the production of distilled liquors. Stillage has for years been treated to produce a conglomerate of particulate material suitable for animal consumption.

Spent stillage in initially a slurry consisting of over 90% water which is first mechanically treated to separate the liquid from the solid materials by mechanical means, such as centrifuging or pressing. The liquid phase is further concentrated by evaporation providing a syrup including about 55% water. The solid materials or cake from the mechanical separation step and the syrup are mixed together to form a wet mixture which is then dried using dispersion or flash drying to reduce the moisture to about 10%.

In the past the flash drying processes that were used included limited air volumes, high drying chamber inlet air temperatures and material circulation techniques which often caused the emission of substantial amounts of smoke and odors during the drying operation.

The process and apparatus of the present invention is an improvement in the dispersion drying operation which uses substantially more air and lower temperatures to obtain a dried material which is improved in its nutrient value. The process is carried out with a substantial reduction in smoke and odor and in fire and explosion hazards.

SUMMARY OF THE INVENTION

Broadly, the present invention is an improvement in a stillage flash drying process in which cake, syrup and recycled stillage material having a moisture content of over about 10% is introduced into a large-volume rapidly moving air column heated to a temperature in the range of about 325°F to about 425°F, is mixed with the air, is carried a distance to a separator means where the particulate material is separated from the air and collected. Substantially all the material is then recycled a large number of times with the moisture content being reduced during each pass to dry the material until the moisture content is reduced to the desired level.

It is a feature of the process that the product has improved nutritive value. It is also a feature that the process produces less smoke and odors.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top plan view of the drying and

FIG. **2** is an elevational view of apparatus that is used to practice the process of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. **1** and **2**, air entering furnace **1** is heated and is caused to pass through the system in a generally counterclockwise path in which the air passes from furnace **1** through vertical mixing and drying column **2**, through column extension duct **3**, to Y-shaped duct section **4** where the air splits into two streams which flow along entrance ducts **6** and **7** to cyclone upper separator sections **8** and **9** of separator units **10**. Two separator units are preferred but one, two or more may be used. The air passes around the cyclone entrance sections **8** and **9** causing the heavier

stillage material to move to the outer peripheries of the separator sections **8** and **9** while the air is drawn off through the centered upper outlets **11** and **12** through cyclone exit conducts **13** and **14** and then down vertical air fan intake duct **16** through fan **17** and exhaust pipe **18**. The exit temperature of the air is normally in the range of 150°F to 200°F.

Turning now to the flow pattern of the stillage material, wet material is fed into the system through down pipe **19** onto horizontal conveyor **21** where it is mixed with recycled stillage grain in a ratio from 5–40/1, then mixed further in subsequent conveyors **22** or mixers of appropriate length, orientation and capacity (not shown) and then fed by gravity, mechanical or pneumatic means (not shown) along feed chute **23** into the vertical column **2**. Concentrated stillage syrup can be applied to the grain before or after the wet cake stillage is added to the recycled grain in whole or in part and at various points along the mixing conveyors or at a mixer immediately prior to introduction to the dryer column **2**. The introduced material is mixed with and carried along by the heated gas stream until it is centrifugally separated in the separator portions **8** and **9** of the separator units **10**. The separated and partially dried material then descends through cylindrical sections **26** and conical section **27** of the separator units **10** until the material reaches the bottom and is discharged through rotary locks **28**.

During operation all the material is recirculated in the range of from 5–40 times with the composite mixture extracted at substantially the same rate off conveyor **21** as the rate of input of new material through pipe **19**. Normally, drying down to about 10% is desired; however, it should be noted that each discrete portion of the material exiting pipe **31** is not exactly at 10% moisture but the average moisture content will be in the neighborhood of 10%. For example, if the system were operated with a 5,000 lbs./hr. input at 64% moisture and the material made only one pass about 54% of the moisture would have to be removed to bring the moisture down to 10%. However, if two passes were used in which the moisture reduction on the first pass was from 64% to 14% and from 14% to 6% on the second pass, about half the material would be extracted down to a 14% moisture content and one half down to a 6% moisture content thus providing the desired average of 10%. Again looking at averages, the average inlet moisture would drop to 39%. Thus, it is seen that as a larger number of passes is used, the average inlet moisture content is lowered. It should also be noted that with a greater volume of material in the system a large percent change in input flow through pipe **19** will have a lesser effect on the moisture content of the extracted mixture unless the large increase or decrease in input is continued for a substantial period of time.

The larger the number of recycle passes that are used the less water is extracted from each individual grain or particle during each drying pass. A plurality of passes, each interrupted by the time required to convey the material between passes, provides a retention time in the system adequate for proper moisture equilibration in each particle which is in part accomplished by moisture migration from the inside of the particles to their outside surface areas. The fact that the drying and evaporation can be more efficiently accomplished with lower temperatures and higher velocities of gas movement than previously employed is due in part to the use of step-by-step moisture extraction starting with re-

moval of moisture from the outside of the particle, migration of interior moisture to the surface and the subsequent removal of the migrated moisture. The system may, for example, have 25,000 to 200,000 lbs./hr. in circulation with an input and corresponding output of 5,000 lbs./hr.

Mixing of air and material is improved by drawing heated air up auxiliary duct **32** tangentially into ports **33** and **34** in the walls of column **2.**

The introduction of tangential air increases turbulence, mixing and retention time of heavier particles. Though air is preferred as a drying medium process, superheated steam, other gases or mixture of gases can be used.

I claim:

1. A method of drying moist stillage material composed of moisture and moist particles having moisture pervaded throughout the particles comprising

a. maintaining a rapidly moving gas stream emanating from a heat source and moving to one or more gas-stream and particulate-matter separator means which gas stream includes a columnar portion and is heated to a temperature sufficient to volatile moisture on and at the surface area of the particulate matter mixed therewith;

b. continuously introducing non-fluidized material into the columnar portion of the stream to cause the material to be mixed with it and heated by it;

c. causing the material to move a substantial distance along with the stream during which movement moisture on or at the surface area of the particulate matter is removed;

d. separating the material from the gas stream;

e. collecting the separated material;

f. conveying and handling the collected material for a sufficient time to permit moisture in the interior of the particulate to migrate to the surface area;

g. introducing a substantial quantity of the treated material in non-fluidized form back into the columnar portion of gas stream after said moisture migration; and

h. repeating the above steps until the material has been substantially dried,

whereby the stillage is progressively and incrementally dried at temperatures that avoid any substantial reduction in the nutrient value of the stillage and without emitting significant amounts of smoke or odors.

2. The method of claim **1** in which the gas stream has a temperature of from about 425°F to 150°F.

3. The method of claim **1** in which the gas is air;

4. The method of claim **1** in which the gas is superheated steam.

5. The method of claim **1** in which the gas is a mixture of gases.

6. Apparatus for drying spent stillage comprising

a. an elongated drying conduit;

b. gas pumping means for pumping a gas at high speed through the conduit;

c. non-fluidized stillage introducing means for introducing the non-fluidized stillage into the conduit as gas passes through the conduit;

d. heating means for heating the gas prior to its entering the conduit;

e. separator means associated with the conduit for separating the material from the gas after it has travelled a distance in the conduit; and

f. recirculating means for introducing a substantial portion of the material back to the stillage introducing means while diverting a portion of the material to a separate location.

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