TECHNICAL BULLETIN - DDR02

SUBJECT: ATMOSPHERIC DOUBLE DRUM DRYERS, PRINCIPLES OF OPERATION AND FOOD PRODUCTION

General

Atmospheric double drum dryers are used in the food industry to produce products such as precooked infant cereals, dry fruit flakes and powders such as apples, peaches and bananas; dry vegetables such as tomatoes, beans, and squash; meat powders, instant grits, toasted cereals for gruels and drinks; dry formulations used as ingredients for other products; fish and animal foods, precooked starches for instant puddings, and so on.

The drying process for products on an atmospheric double drum dryer includes three phases:

Phase 1: The formulation and processing of the ingredients to be dried with water in a slurry form and metered to a double drum dryer for drying.

Phase 2: The drying process, which includes the evaporation of water from the slurry on steam heated drums and the removal of the dried product from the drums with a doctor knife.

Phase 3: The dry processing of the product produced on the dryer includes conveying the material, removal of out of specification materials from the product stream, flaking and grinding of the dry product to specification, screening to specification, and blending the dry product with other ingredients to form a final product.

This bulletin will describe the operating principles and characteristics of an atmospheric double drum dryer used for the production of food products under sanitary conditions.

A. Basic Double Drum Dryer Configuration

An atmospheric double drum dryer consists of the following basic components:

1. Drums and Bearings
   Two hollow drums are fabricated with cast iron or welded steel with large end shafts. The drums rotate on sleeve or roller bearings and include a metered oiling system. The drums are mounted on a frame and parallel to each other. One drum is in a fixed position and the other drum can be adjusted in or out to set the clearance between the drums to a very close tolerance. The drums are fabricated for operation under steam pressure and should conform to pressure vessel codes.

2. Gap Adjustment System
   One dryer drum is adjustable with relation to the fixed drum. The adjustable drum can be moved closer or further away from the fixed drum to control the gap (NIP) between the drums to very close tolerances. The adjusting screws are usually used to change the position of the dryer drum bearings, which carry the drums. Springs or pneumatic cylinders keep the drum in position and allows the drum to move if a foreign object should get between the drums.

3. Frames
   A structural frame of cast iron, steel, or stainless steel supports the drums on their bearings and provides a mounting surface and alignment for the other dryer components.

4. Drum Drives
   The dryer drums are usually driven by synchronized gearing or chains and sprockets mounted on the dryer drum shafts and powered by a variable speed drive motor. An alternative drive includes a motor and compact planetary gearbox

mounted directly to each dryer drum drive shaft with speed control provided by an electric variable frequency motor controller.

5. End Dams
   An end dam is positioned in the upper quadrants at each end of the drums and is held tightly to the ends of the drums to provide a dam, which retains slurry in a puddle above the close fitting drums. An air cylinder or manual tightener provides pressure against the end dam to seal it against the ends of the drums to prevent leakage of the slurry from between the drums.

6. Steam and Condensate System
   Steam controls, valves, and piping supply steam to the interior of each drum through a rotary steam joint attached to the shaft of each dryer drum. Steam condensates generated by the drying process are removed from the interior of the drums and siphoned through the rotary joints to condensate traps for return to the steam boilers.

7. Vapor Hoods, Splash Shields and Ducts
   Steam vapors generated by the drying process are captured by the hoods and ducts mounted above and below the dryer drums. The vapors are removed from the dryer room through ducts to an exhaust fan and discharged to the outside atmosphere. Sometimes the vapors must be scrubbed to remove entrained particles of slurry and dry product prior to discharging the vapors to the exterior. Splash panels to contain the violently boiling slurry between the drums are mounted and supported in conjunction with the vapor hood. A single tight fitting hood can be mounted to remove vapors and also contain the violently boiling slurry. The hood is hinged and raised by a pneumatic cylinder to expose the interior of the close fitting hood for cleaning.

8. Doctor Knives and Holders
   A heavy support runs parallel to each drum and supports a holder to mount a flexible sharp knife which contacts the drum to remove dry product from the rotating drum surface. The knife support pivots to raise the knife from the drums or to press the knife tightly to the drum surface. Movement and pressure of the knife holder is controlled by an air cylinder or manual screw adjustment.

9. Dry Product Conveyor
   Dry product removed from the dryer drums by the doctor knives fall into a conveying system for removal and transfer to the dry product processing area. Conveyors used include screw conveyors, belt conveyors, and pneumatic conveyors or a combination of conveying systems.

10. Slurry Delivery System
    Slurry is pumped to the dryer for drying and is distributed uniformly in the puddle between the dryer drums and retained in the puddle by the end dams. The slurry is evenly distributed along the length of the dryer drums by a parallel pipe with several outlets spaced along the length of the pipe. An alternative system used is a long pipe or several shorter pipes moving in a pendulum motion along the length of the puddle between the drums. The slurry feed system is integrated with the vapor hood used above the dryer drums.

11. Slurry Level Control System
    The rate of delivery of slurry to the dryer puddle is controlled by sensing a predetermined operating level of slurry in the puddle and then to modulating a pump or valve to control the rate of flow of slurry to the puddle. Various probes or sensors are used to detect the depth of slurry. A control instrument measures the sensed level of slurry and compares it to the set point of the desired level. The instrument modulates the rate of feed to a valve or pump until the desired slurry level is reached and the level is maintained.

12. Electrical and Control System
    The drum dryer includes the following drives, drive systems, and control systems:
        1. Dryer Drum Drives – Variable Speed

2. Conveying System Drives – Variable Speed
3. Vapor Removal System Blower Drives
4. Oiler Metering System Drive
5. Slurry Delivery System Drive – Variable Speed
6. Slurry Level Control System
7. Slurry Pendulum Feed System
8. Steam Pressure Control System

The electrical hardware is usually located in a control cabinet. The cabinet is located in a dry central location close to the dryer operation. An operator's control panel is centrally located at the dryer. Operator controls for starting, stopping, and regulating speed of each control system are located in the operators control panel.

13. Accesses and Platforms
    Access to the various operating elements of the dryer and access to the dryer for cleaning and maintenance require platforms and accesses. The platforms should be designed to safety and sanitation specifications.

14. Exhaust Vapors Scrubber
    Environmental regulations may require that vapors removed from the dryer be scrubbed to remove droplets of slurry captured in the vapor stream above the puddle. Also, particles of dry product produced on the dryer may be captured in exhaust air and vapor streams. Exhausting these materials to the outside atmosphere may cause sanitary problems on roof areas and be in violation of regulations. A scrubbing system to clean the vapor stream and remove these materials is installed prior to discharging the vapors and captured air to the exterior atmosphere.

B. Principles of the Drying Operation

The purpose of double drum dryers is to remove the water from slurry of formulated or natural ingredients by evaporation of the water in the slurry on rotating steam heated drums. The final dry product (solids from the slurry) is retained on the drums and removed from the drum surfaces by sharp knives. The dry product is captured for packaging or further processing.

The mechanics of the drying process is as follows:

1. Slurry containing solids and water is fed to the dryer at a controlled rate of flow.

2. The slurry is deposited in a puddle between two rotating steam heated drums. The slurry is retained between the drums by end dams at each end of the drums.

3. The first phase of the drying process occurs in the puddle above the drums. Energy is transferred from the steam heated drums to the slurry. The boiling action converts water in the slurry to steam vapor in a violently boiling action above the drums and concentrates the slurry.

4. The second and final phase of the drying process occurs as the concentrated slurry from the puddle is deposited in a thin coating on the dryer drum surfaces at the "NIP" (tangent line of the two drums). This thin film dries on the hot drums as the drums rotate. The drying process is complete when the thin dry sheet reaches a knife in contact with the drums and the knife (doctor blade) removes the dry film from the drums and deposits the product into a conveying system for transfer to the dry processing area.

C. Variables Affecting Phase 1 Drying (Puddle Concentration)

1. The water content of the slurry being fed to the dryer. A higher percentage of water results in a lower rate of recovery of the solids in the slurry. A lower percentage of water in the slurry should be the objective.

2. The heat transfer rate of the materials of construction of the dryer drums and the thickness of the wall of the drums affect the water removal rate of a particular dryer. An efficient heat transfer rate should be the objective.
3. The size of the dryer drums in diameter and length. The more surface area exposed to the slurry the more water is removed. A dryer with the largest practical surface area should be the objective.

4. The slurry in the puddle should be in contact with as much heat transfer area as possible for maximum water removal. The higher the level of the slurry puddle the more drum area is exposed and the more water is removed. A high puddle level should be the objective.

5. The steam pressure inside the drums determines the temperature of the drum surface. The higher the steam pressure the hotter the drum surface. The temperature differential between the drum and the slurry is a factor in the boiling rate of the slurry. Since the boiling point of the slurry is fixed, an increase in steam pressure will increase the drum temperature, which increases the temperature differential, which increases the boiling rate. A high steam pressure should be the objective.

D. Variables Affecting Phase 2 Drying (Drum Surface)

1. The percent of moisture in the slurry concentrate from the puddle as it is deposited in a thick film on the drums at the NIP. The less water in the concentrated slurry the higher the production rate. A high level of solids in the slurry should be the objective.

2. The gap between the drums along with the depth of the slurry puddle, the concentration of slurry, and the speed of rotation of the drums balance to control the thickness of the thin film of slurry deposited on the dryer drum surfaces. This uniform film of slurry will dry uniformly if the variables are constant. The percent of solids is controlled in the formulation of the slurry, the operating level in depth of the puddle is controlled with a level sensor and controller, and the gap between the drums is set by positioning the adjustable drum.

3. The NIP gap is adjustable and should be easily changed during production.

4. The level control is easily adjustable and can be changed during production.

5. The internal steam pressure on the drums affects the evaporating (drying) rate of the thin slurry film on the drums. Also, the condensate removal efficiency from the drums affects the heat transfer rate. A steam controller maintains a uniform steam pressure and special traps efficiently remove condensate from the drums. Because of the metallic mass of the dryer drums, a change in temperature on the drums takes a long time. A production run should start with a preset steam pressure and uniform warm up temperature. Changes should not be made during production.

6. The saturated steam vapors, which collect in the valley beneath the drums, should be removed continuously to promote good drying efficiency.

7. The speed of the drums are adjusted to bring the dry product sheet to the doctor knife just as the sheet reaches the proper level of moisture content or dryness and is ready to be removed from the drums. Each drum has a different coefficient of heat transfer. To maximize productivity the rotation of each drum can be individually adjusted with separate variable speed drum drives.

Drum Drying Resources supplies new, rebuilt, and retrofitted Double Drum Dryers to the drying industry. Each dryer is configured to specific designs, specifications, and systems to produce your product at maximum quality, sanitation, and productivity levels.
Check our Technical Bulletin section often in order to learn more about how our products and services can help you become more productive.