



STANDARD DUTY

Transferring Heat with a Vibrating Fluidized Bed

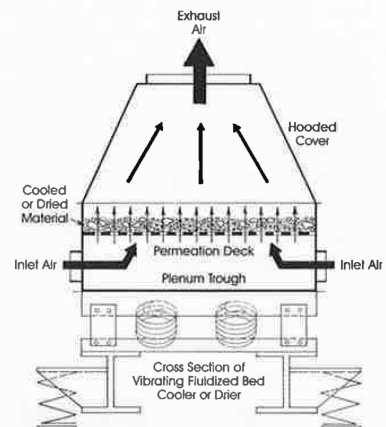


HEAVY DUTY

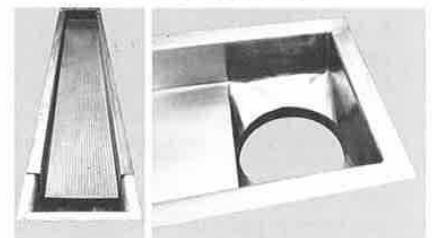
A vibratory conveying action reduces "inter-particle" friction. Consequently, the material tends to reflect the characteristics of a fluid as it is gently "induced" to move. Add air that is simultaneously forced up openings in the conveying surface so it permeates through the mat depth of material. The result is a vibrating "fluidized" bed of dynamically active particles that can efficiently exchange heat energy. The reason is the intimate contact the air makes with their individual surfaces. Therefore, the incoming air can cool or heat the conveyed bulk solid (or unit pieces) by convection on a "continuous" basis. Further, heating and then cooling can be accomplished in the same unit when it is needed.

Thermodynamically, it is a constant heat process which makes it adiabatic, and it typically occurs at atmospheric pressure.

A reasonably steady feed of material is provided to the unit by an upstream supply source. It is slowly conveyed over the length of the permeation deck. Underneath, either cooled or heated air is ducted to a series of inlet ports spaced along the side of the plenum trough. This air passes up through the mat depth of conveyed material. It is then collected by a hooded cover for discharge to the air exhaust circuit. The plenum trough and the hooded cover can be sectioned to permit different air flow zones which improves thermal efficiency.



AIR FLOW SCHEMATIC



PERMEATION DECK

FOOD GRADE FINISHES

By making the drive angle steep, an extensive stroke can be imparted without the material advancing very far. Thus, the applied vibration is "effective" without sacrificing retention. The material's conveying speed is adjustable by a simple method of electrical control. To better contend with the unexpected or to provide greater operating flexibility, the Kinerdy Drive System enables automatic "pulsing" of the unit's operating stroke and frequency. Perforated plate, wedge bar, or woven wire are used to make up the permeation deck. When a more precise air distribution is needed, a specifically designed "drilled plate" is provided.

The width of the unit is established by the needed mat depth moving at a given conveying velocity to achieve the required capacity (TPH). Its length is determined by the required retention. Standard and heavy duty units are available. Sanitary designs for food, pharmaceutical, cosmetic, and munition type applications can be provided. So can the needed inside and outer surface finishes. The flexible connections utilized will correspond to the operating temperatures needed. Counter-balanced units are always recommended, but non-balanced designs can be supplied when they are wanted.

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While testing at the site of actual use or at Kinerdy's plant is always beneficial, many applications can be accomplished without it. Well known heat balance calculations combined with previous experience factors make this possible.

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Cooling

When cooling with forced air through a vibrating fluidized bed, every effort should be exerted to take advantage of the evaporation of water. Therefore, the inlet air is made to be as near to 100% relative humidity as is practical. The wet air cools the hot material by absorbing heat to "boil" or fully vaporize the tiny droplets of water it contains. Ambient or recirculating air flowing through a chamber, equipped with atomizing nozzles to produce a water mist or spray, is the least expensive method of "wetting" the applied cooling air. However, if hot, dry air can be used for some other purpose such as heat recovery to help fire a boiler or kiln, ordinary ambient air becomes the better choice for a cooling medium. Other alternates include the use of chilled water coils with the inlet air passing over them. When it is needed, a refrigeration unit is employed to make the air more cold. These options are used when the incoming air must have a larger amount of "temperature difference" with respect to the substance being cooled.

Typically, most of the cooling is accomplished in the unit's first half of length. A large amount of air is consumed and its exhaust will be relatively dry. Since applying cold, damp air to something hot is a form of "quenching", the cooling rate may need to be slowed if the particles' surfaces are adversely affected by their temperature being reduced too quickly.

The effective vibration enhances the cooling. The adjustable retention time and automatic "pulsing" are inherent because the Kinergy Drive System is powering the unit.

Drying

A vibrating fluidized bed has the advantage of providing "continuous" drying. It is second in thermal efficiency to only a vacuum type dryer which often is a "batch" type operation. The objective is to use hot, dry air to absorb moisture from a slowly conveyed solid. Before drying, it is good practice to remove as much liquid as possible by a mechanical means such as a filter or a deliquifying screen.

The incoming wet material is sensibly heated from its entering temperature (usually ambient) to the wet bulb temperature of the drying air. From there, the removal of liquid portrays the three "classic drying phases". The initial "constant rate" portion is rapidly drying up or vaporizing most of the surface moisture on the particles. During this step, a large amount of air is required and exhausted to carry away the resulting vapor. The material's temperature stays about the same. After this is accomplished, the "critical moisture content" point has been reached. In the second or "falling rate" stage, the remaining surface moisture evaporates. The particles more steadily diffuse internal moisture to their surfaces as their temperature gradually rises. Even so, the drying rate slows because diffusion is more difficult to achieve. The final stage is solely at a liquid "diffusion rate" from the interior of the particles to their surfaces. If the solid is sensitive to a higher temperature, it becomes necessary to reduce the amount of drying air to prevent damage to the particles. Otherwise, the highest permissible temperature is used to keep the drying time to a minimum.

Drying with a vibrating fluidized bed typically involves removing surface moisture and some internal or inherent moisture by diffusion. Therefore, in many applications, the "constant rate" and "falling rate" phases of drying will only be required. If any portion of the "diffusion rate" stage is necessary, it could markedly add to the time for retention.

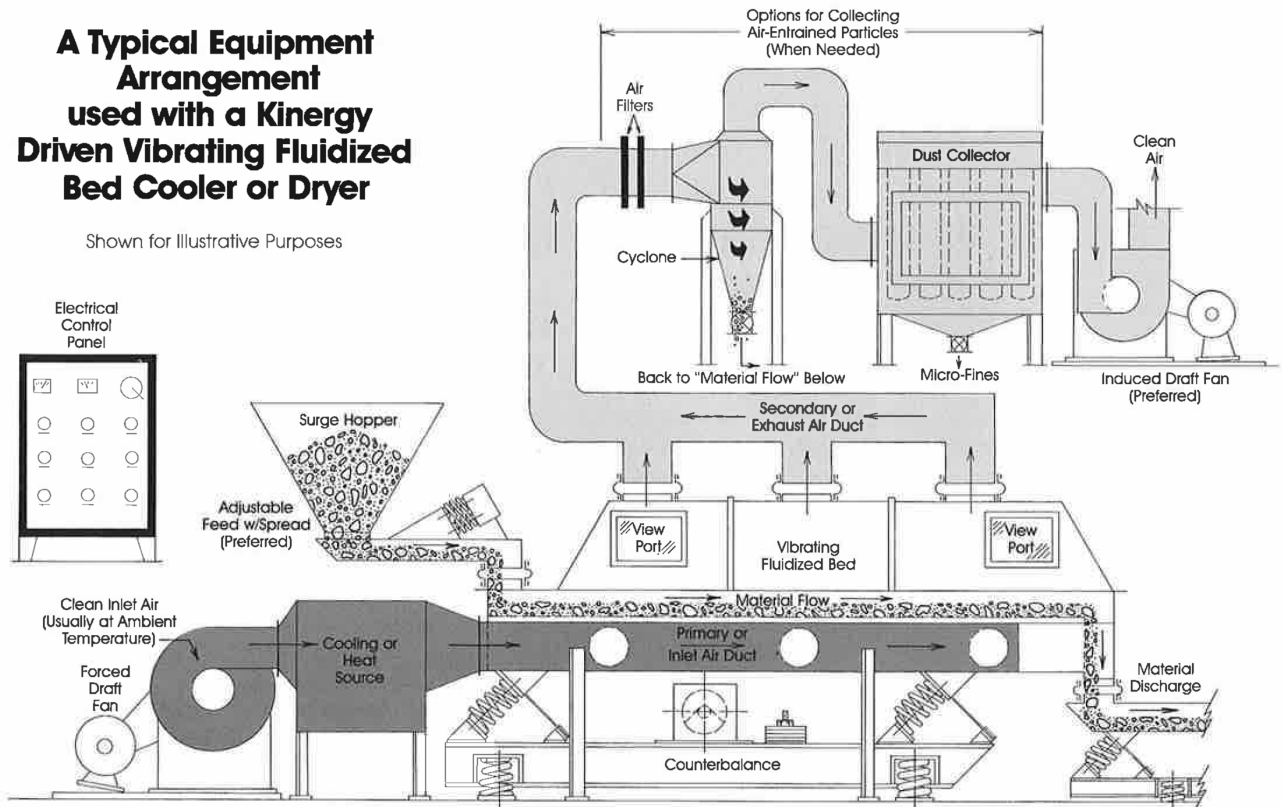
Materials being dried often change in their physical characteristics which can affect their conveyability over the fluidized bed. For example, the incoming wet material may be sluggish in its response to a given vibratory conveying action. Conversely, when it is relatively dry, it may respond very well and move faster near the discharge

end. To contend with this practical situation, the Kinery Drive System enables the automatic "pulsing" of the operating stroke and frequency of the vibrating fluidized bed. The temporary, maximum vibration is established by the incoming wet material moving forward properly. The lower operating stroke and frequency correspond to the "steady state" movement of the drier material. The retention time can be changed by adjusting this conveying speed, which can be manually or automatically controlled. Inlet air temperatures to 550° F. are typical. Higher temperatures will require a special design. The ambient or recirculating air is usually heated by steam coils or an oil or natural gas-fired furnace equipped with modulating controls. Insulation to minimize heat loss is available.

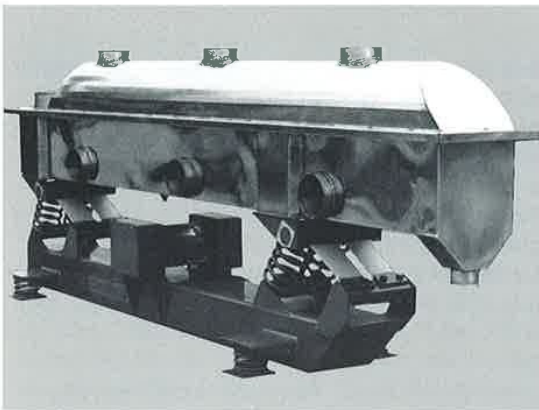
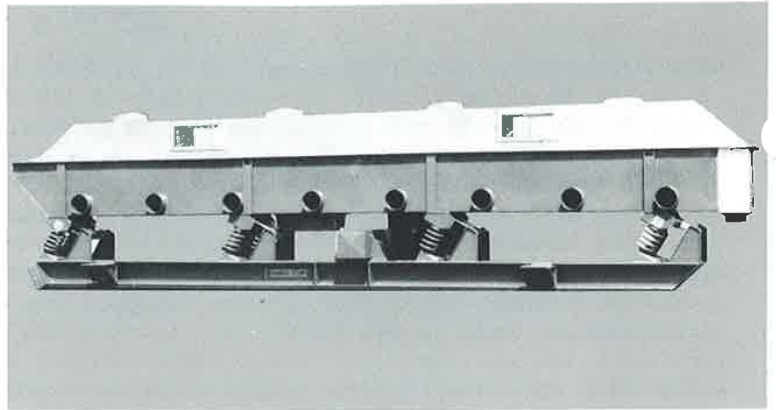
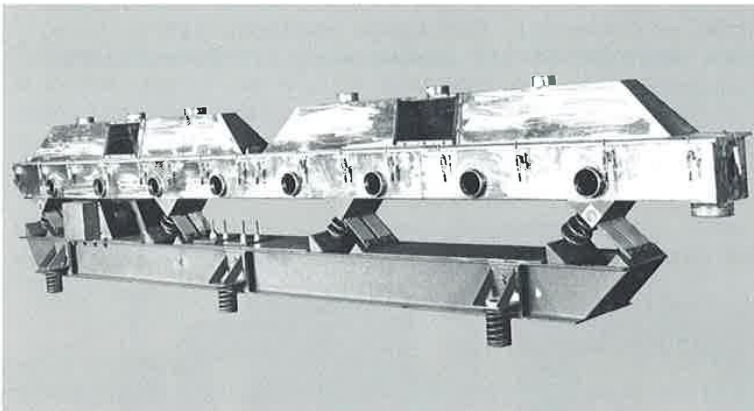
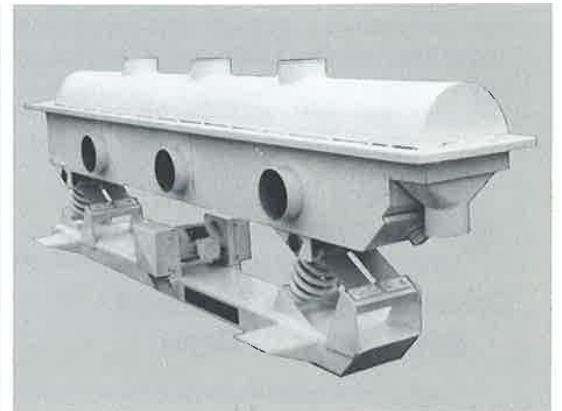
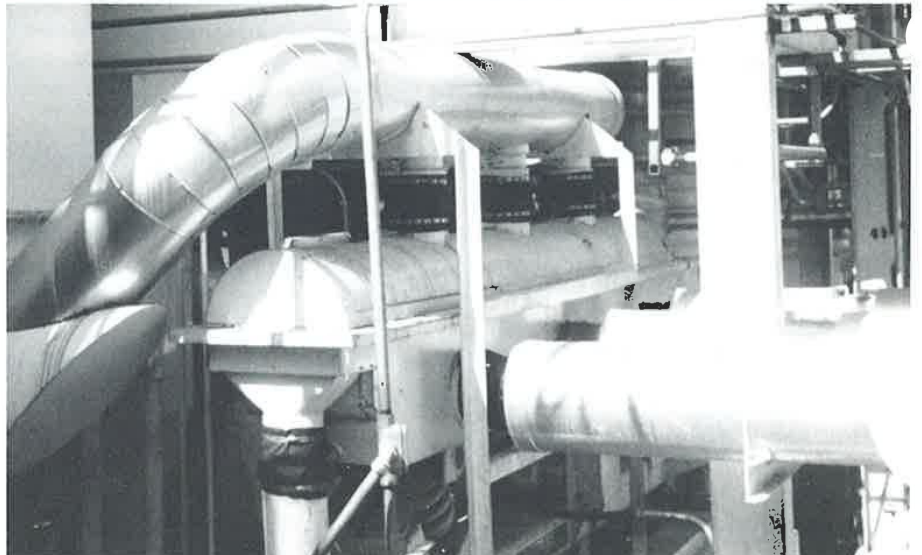
While this method of drying is reasonably predictable, practical factors such as the material's formulated process upstream of the dryer and the local climate conditions can ultimately affect the unit's thermal efficiency. For these reasons, extra capacity in the vibrating fluidized bed and some of its needed auxiliaries reflects good, prudent judgement and it is recommended.

A Typical Equipment Arrangement used with a Kinery Driven Vibrating Fluidized Bed Cooler or Dryer

Shown for Illustrative Purposes



Purchasing Options: Kinery's main interest is supplying the vibrating fluidized bed. When requested, Kinery will outline the essential information needed to enable the related auxiliaries to be procured from other sources. At "start up", a qualified engineer can be available to help coordinate all the auxiliaries even though they were not provided by Kinery. This approach has the lowest overall cost. If it is wanted, Kinery will supply any or all of the needed auxiliaries as a package. When appropriate, Kinery will accept the responsibility for the entire thermal function. Kinery's standard warranty will normally apply to the equipment it designs and manufactures. The warranty offered by the respective manufacturers of auxiliary units will be passed on to the purchaser.



Kinery Driven Vibrating Fluidized Beds

Testing: A vibratory fluidized bed, with its noted auxiliaries, is available for "on site" testing. At Kinery, the same trials can be conducted. This test unit normally has a 12" wide x 10' long air permeation deck or a fluidized bed area of 10 sq. ft. In either instance, a rental fee is charged. A portion of this cost can usually be applied to the purchase price of a production size unit.

