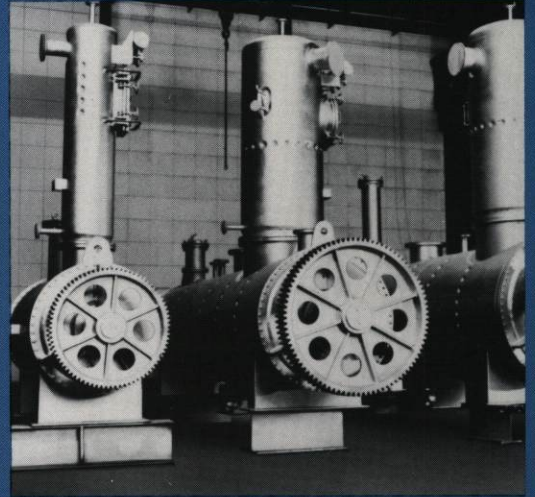
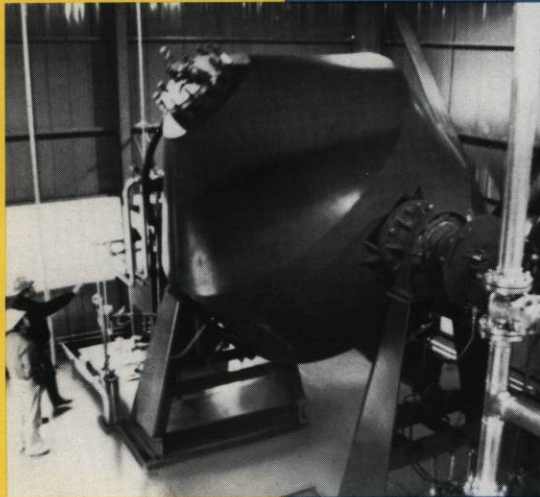
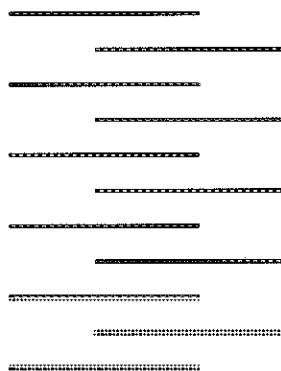


PAUL O. ABBÉ INC.

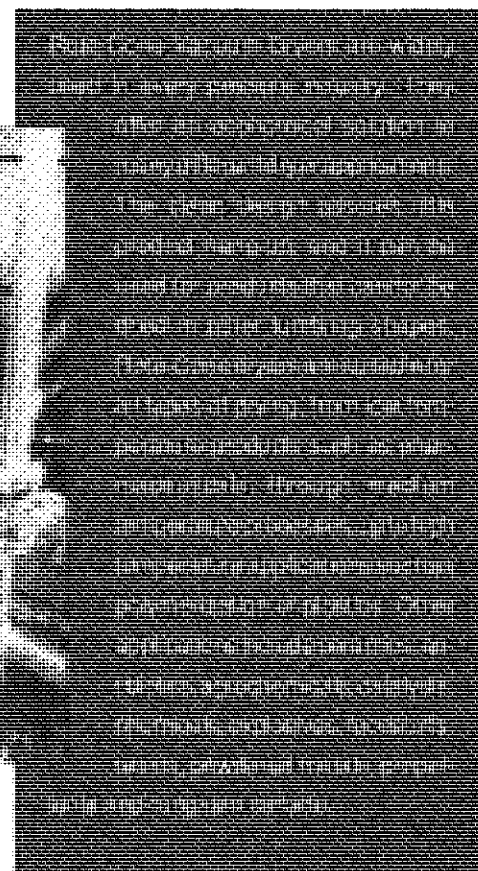
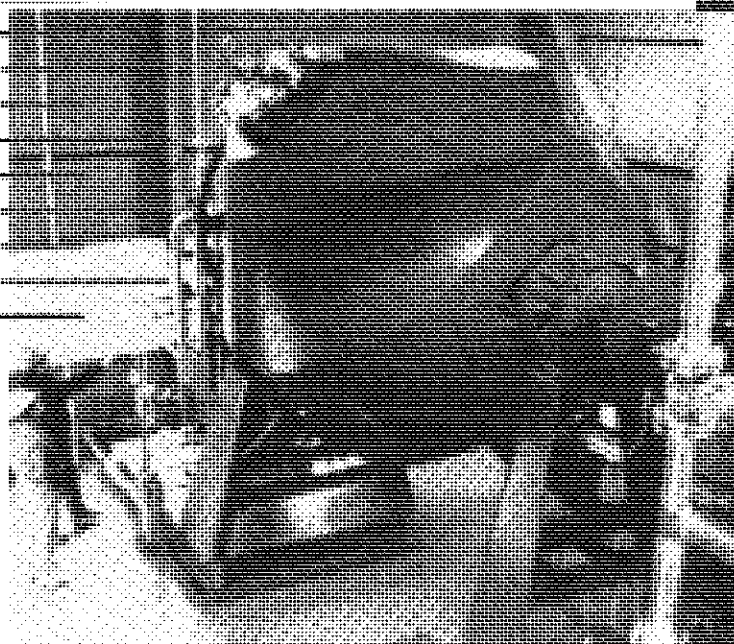


DRYERS AND DRYING SYSTEMS

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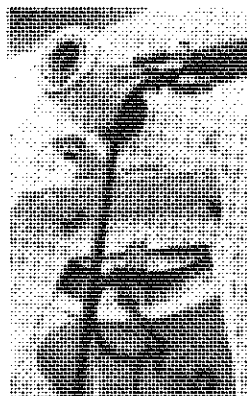
The double cone design is the first and most widely used form of tumbling vacuum dryer. It consists of two 45 degree cones joined by a cylindrical center band. The dryer rotates end over end around the axis of this center band causing material to gently tumble and slide into contact with the heated surfaces. The Rota-Cone Dryer combines rugged construction with high quality workmanship to produce one of the most versatile vacuum dryers available.



Custom Engineering

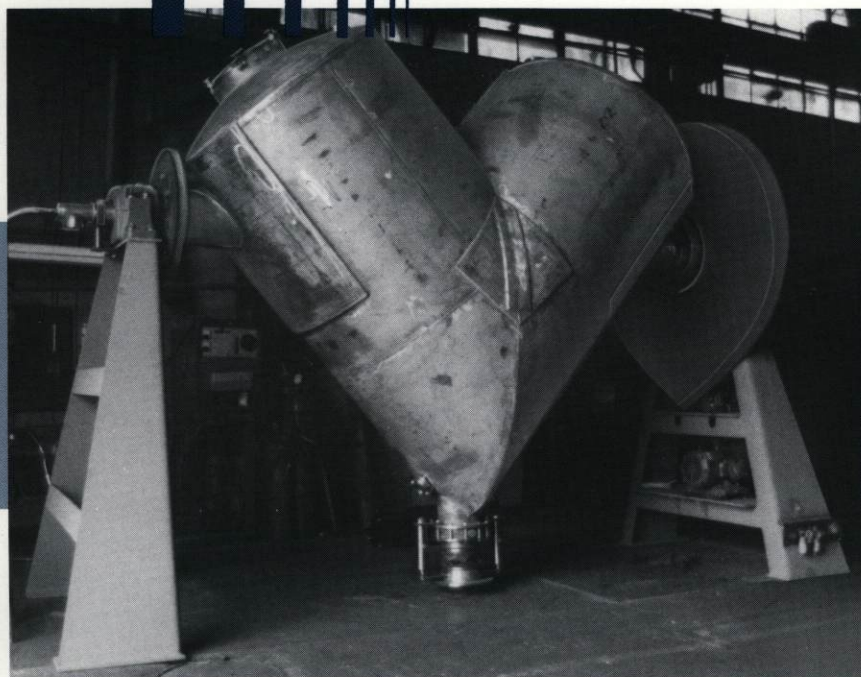
Paul O. Abbe Inc. specializes in custom-engineered solutions to customer drying problems. Every dryer in this brochure can be tailored precisely to the requirements of the process and the space available. Specialized requirements such as high temperature, sanitary operation, fragile product and hazardous operation are handled on a regular basis. All custom-engineered designs are built to the same exacting quality as our "standard" designs and can be packaged for your particular requirement (see page 9 for packaged designs).

Loading and Unloading



Tumble dryers can be stopped in pre-selected positions for loading and unloading, or for access for cleaning or maintenance. Sensors on the positioning disc spot the dryer to the preselected position. Actuated, retractable sleeves can be mounted for dust-tight loading and unloading operations, or for automated operation.

The Rota-Vee dryer is a V-shape design made by joining two cylindrical legs with approximately an 80 degree angle between them. The continual splitting and rejoining of the material as the vessel rotates gives a folding and mixing action which can also lead to more contact with the heated surfaces and potentially faster drying times than a Rota-Cone Dryer.



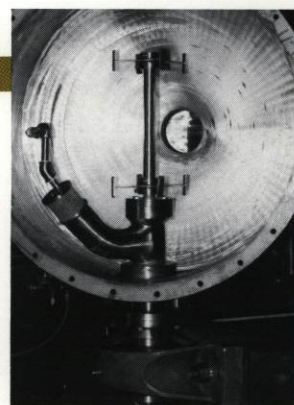
The Rota-Vee is best suited for materials which are "free-flowing" and therefore benefit most from the splitting and rejoining action as the dryer rotates.

Formulation

The Rota-Vee Dryer is most widely used in the pharmaceutical industry due to its efficient mixing action. The most sophisticated design includes a high-speed intensifier with liquid addition capability. This allows it to be used for formulation of pharmaceutical preparations by mixing various ingredients while adding binders in liquid form, and using the intensifier to control agglomerate size. The material is then dried prior to tabletting.

Agitators

All tumble dryers can be fitted with agitators or intensifiers. Agitators are available in many different forms, including pin bars, discs, T-bars and blades from slow to fast tip speeds. The more deagglomeration is required, the higher the speed used. Agitators are most commonly used when adding liquids to the solids prior to the drying step. The liquid can be added through the agitator shaft or via a separate spray nozzle(s). Liquid spraying systems range from standard full cone and fan spray nozzles to airless sprays.



The Rota-Master is a cylindrical design especially suited to high temperature drying of granular materials or uniformly shaped particles such as polymers and resins. The trunnions are mounted to the cylinder heads such that the axes of rotation of the two "ends" of the vessel are offset. This causes movement of the material about the horizontal axis and the vertical axis as obtained in other tumble shapes.



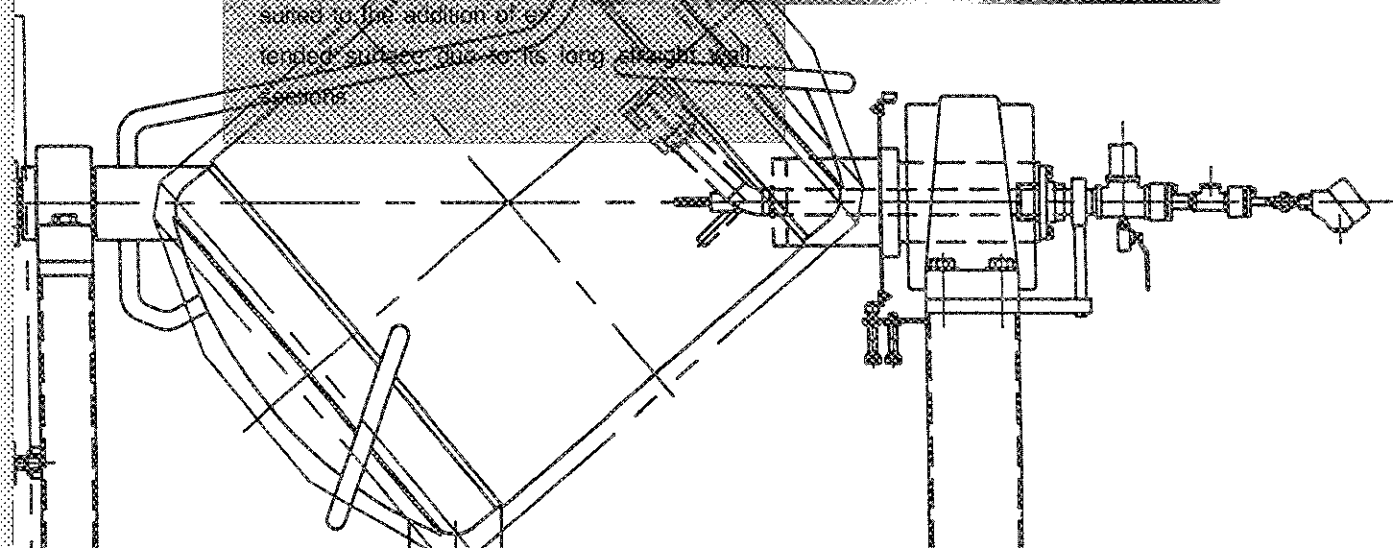
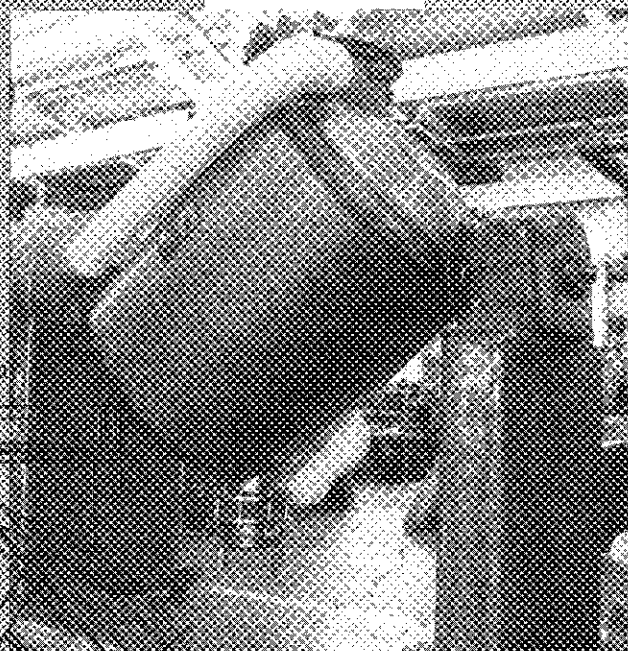
Extended Surface

When processing polymers and other high temperature products, the process time can be constrained by the amount of heat transfer surface available. The heated surface is normally limited to the vessel jacket. Both the Rota-Cone and Rota-Master Dryers can be fitted with extra heating surface (extended surface) inside the dryer. This extended surface is usually provided by coils or panels linked to the jacket. Extended surfaces can effectively double the heat transfer surface of the dryer and thus have the temperature dependent portion of the process. The Rota-Master is especially well suited to the addition of extended surface due to its long straight wall sections.

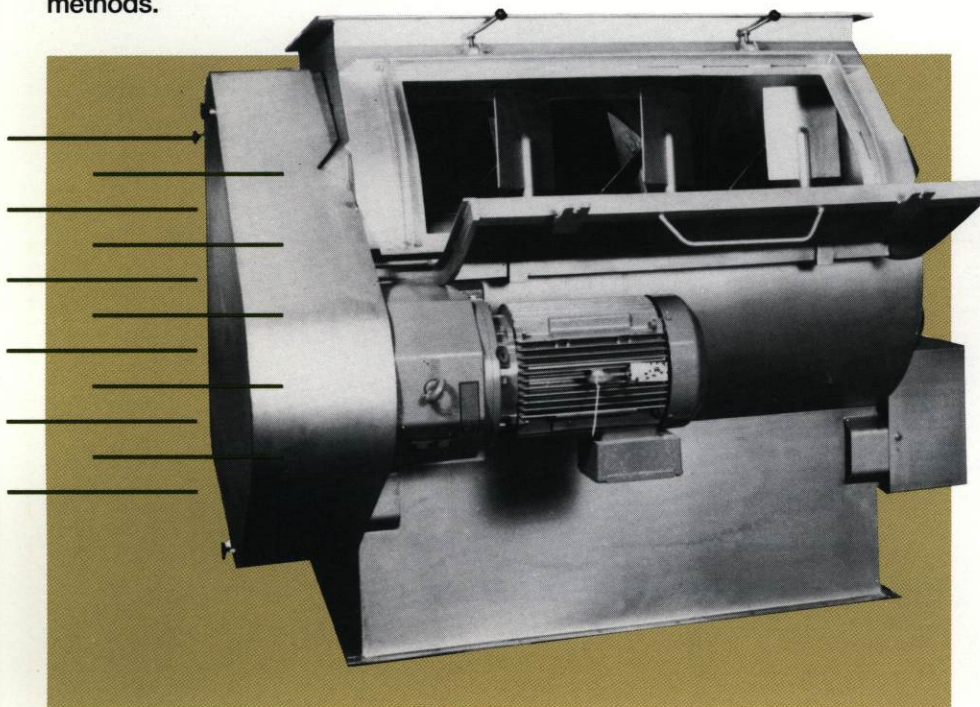
High Temperature

Tumble vacuum dryers are extensively used for high temperature, solid state polymerization of certain types of polymers, including PET, PBT and Liquid Crystal Polymers. These processes are lengthy, involving temperatures up to 600°F and very high vacuum. The Rota-Master is especially well suited for high temperature polymerization. It can support the

large diameter vacuum lines which are necessary for the high vacuum used. It lends itself to the addition of extended heat transfer surfaces, and the all-rounded shape with no sharp angles minimizes product attrition during the long process cycle.

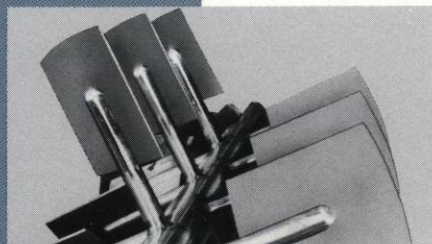


The "Forberg II" Drying System is a uniquely effective convection dryer. It works by mechanically fluidizing the material to be dried while bringing it into contact with a heated gas stream. The air passes through the material at a much lower pressure than a conventional fluid bed dryer. The mechanical action allows the dryer to handle many materials that cannot be handled in conventional fluid bed dryers including pastes and slurries. The result is a truly revolutionary dryer capable of drying materials impossible to dry by other methods.

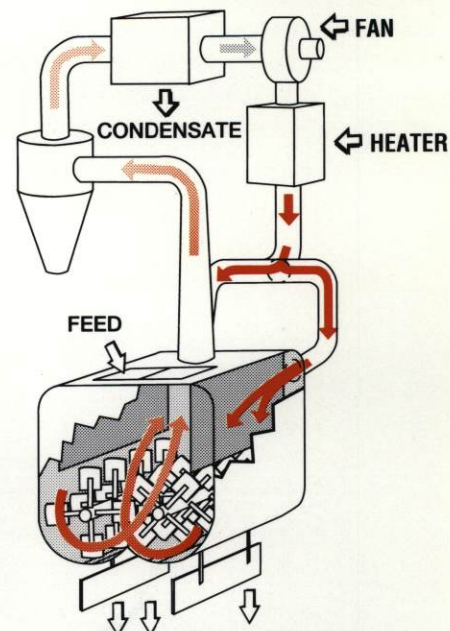


Fluidized Zone

The "Forberg II" Drying System is based on the ZERO GRAVITY FLUIDIZED ZONE created by synchronized, counter-rotating mixing paddles. In this zone all the particles are fully fluidized and able to move independently of all other particles. Dry heated gas is fed into the mixing chamber in the direction of paddle rotation so that it rises with the fluidized particles. Every particle, irrespective of size or density, is equally exposed to the heated gas stream so that the moisture of each particle evaporates at the same rate resulting in near 80% adiabatic efficiency. This allows higher gas temperatures and shorter drying times without any risk of overheating the product. The "Forberg II" dryer is therefore suitable for the widest range of products, and the high efficiency results in a low direct cost of drying. The shortened cycle times often result in a smaller unit and a lower installed cost compared to other fluid bed dryers.



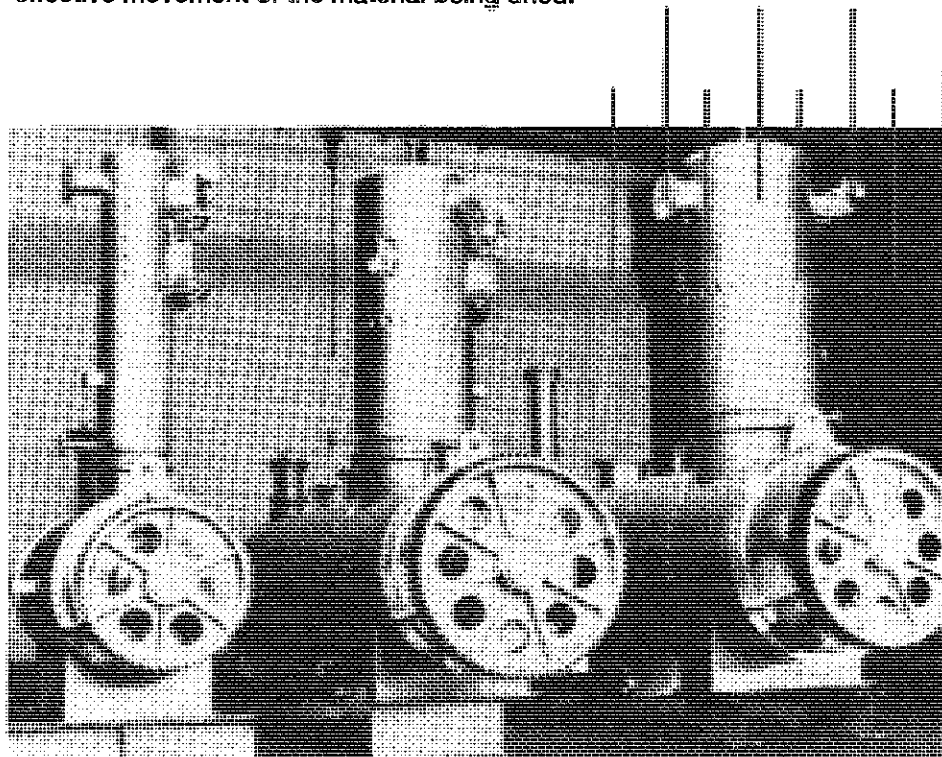
Closed Loop System



MASS FLOW DISCHARGE

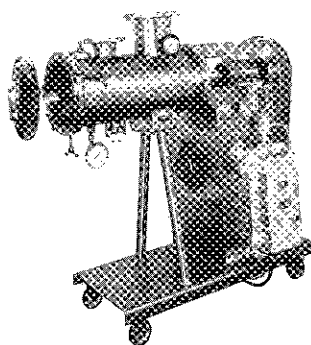
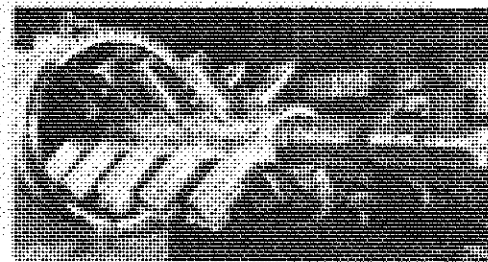
The "Forberg II" Drying System can be configured as a closed loop with a continually circulating gas stream. This arrangement is suited to processes where once-through gas cannot be used due to considerations of purity, hazardous materials, cleanliness, economics, pollution or where solvent recovery is required.

For less free-flowing materials it is best to use a stationary dryer with a rotating agitator. Rotary vacuum dryers are the most common form but are limited in heated surface area. The Rota-Blade Dryer is a state-of-the-art vacuum paddle dryer designed to give the optimum amount of heat-transfer area within a given volume, while providing effective agitation. The Rota-Blade Vacuum Dryer has specially designed, profiled paddle arms with angled blades at the ends for effective movement of the material being dried.



The Rota-Blade Dryer heat transfer area includes the agitator shaft plus the agitator arms as well as the jacketed cylinder and cylinder heads. The slow-moving, profiled arms mix and displace the material, ensuring continual contact with new heating surface. Compared to equivalent-

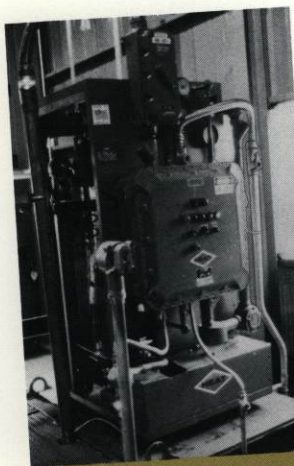
volume tumble dryers, the Rota-Blade offers twice the heated surface area, which combined with a better heat transfer coefficient results in much shorter drying times – in many cases, half the time. And the specially profiled arms are very effective in handling a wide range of feedstocks, including filter cakes and slurries as well as the more free-flowing wet materials. This can translate into a smaller dryer than, say, a tumble dryer for a given production requirement.



Testing

Drying of solids is still an empirical process. Therefore, any dryer being considered for a new product or process should be tested at the laboratory pilot-scale first. Paul O. Abbe offers both the testing capability and the expertise to scale up from the test data to the production machine. A full range of laboratory and pilot test machines are available for use, either at our Test Facility or for on-site rental. Before selecting any dryer, talk to the experts first!

Ribbon Mixer Dryers are "U" trough design ribbon or paddle mixers which are jacketed. They are suitable for both atmospheric and vacuum operation. A Ribbon Mixer Dryer can be used as a continuous dryer, where the long narrow design gives the necessary residence time, or as a batch dryer. Various ribbon and paddle configurations are available in this type of dryer.

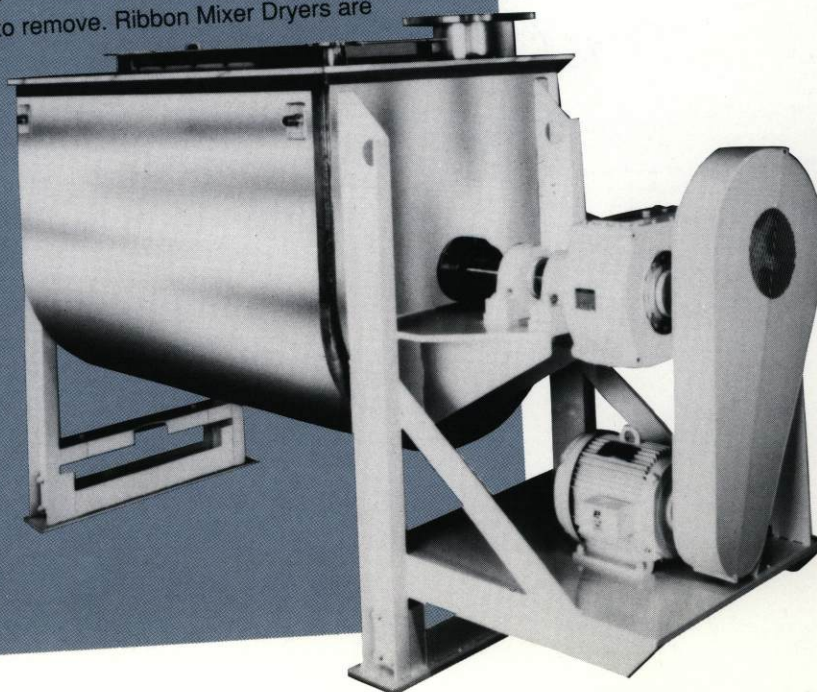


Heating Systems

All Paul O. Abbe vacuum dryers (jacket and agitator) can be heated by any one of a variety of methods. These include steam, hot water, hot oil, and other heat-transfer fluids.

Packaged heating systems based on any of these fluids can be supplied for any size or type of dryer. They are normally complete with all controls and can be skid-mounted or free-standing as required.

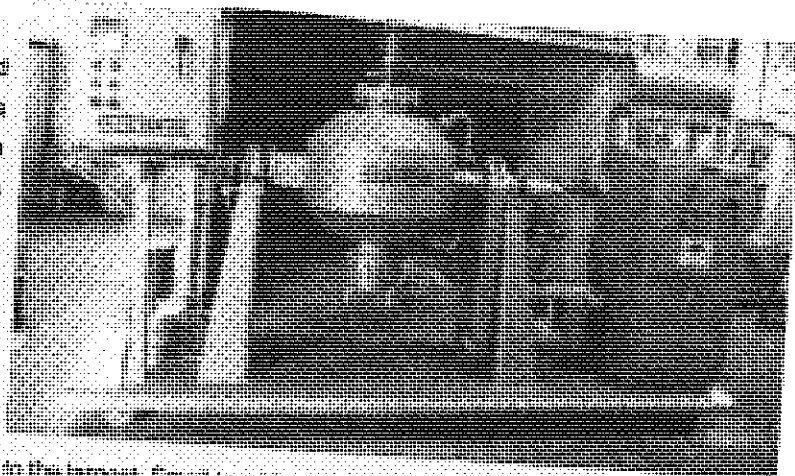
The Ribbon Mixer Dryer is a low-cost relative of the Rotary Vacuum Dryer. It normally uses a smaller diameter, compared to the Rotary Vacuum Dryer, as the material is charged to cover the agitator, rather than the maximum 60% fill in a cylindrical design. Cleaning of a trough design dryer can be easy, as the cover is simple to remove. Ribbon Mixer Dryers are used extensively in the food industry because of this ready access for cleaning. Paul O. Abbe Ribbon Mixer Dryers incorporate lathe-turned agitator shafts and a machined seal housing, whether operating atmospherically or under vacuum.



Packaging of a system offers many advantages including reduction in the overall cost due to the reduced site work involved in installation of the equipment. Also, the opportunity to functionally test the system before it leaves the factory is an important consideration for many users. Most important is the comfort of having the specialists at Paul O. Abbe specify the correct equipment and ancillaries for your process.

All dryers in the Paul O. Abbe line lend themselves to being packaged into a self-contained system. Depending on the dryer type, a packaged system can include a wide variety of options: various types of heating systems, solvent recovery systems, vacuum systems, gas recirculation systems, controls, automation and instrumentation. Packaged systems can be built for any size

of Paul O. Abbe dryer, from the smallest to the largest. Small to mid-size units can be built onto a common baseplate or as single modules. Larger units are skid mounted or containerized.



Vacuum Systems

Vacuum dryers can be used with an array of vacuum systems. These can be based on liquid ring pumps (water, oil or solvent sealed), rotary vane pumps, rotary piston pumps or other vacuum sources. Vacuum systems are available to operate from a few inches Hg to microns absolute. They can be built to the process requirement, with one or more precondensers, condensate receiver, transfer pump, seal fluid circulation and cooling pumps (liquid ring systems), separator tanks, aftercondensers and any level of instrumentation and control that is desired.

Controls and Instruments

Controls can range from simple manual systems to sophisticated, fully programmable options. Instruments are provided as appropriate to the level of control. Systems are available to meet all NEMA and NEC classifications.

Temperature Control

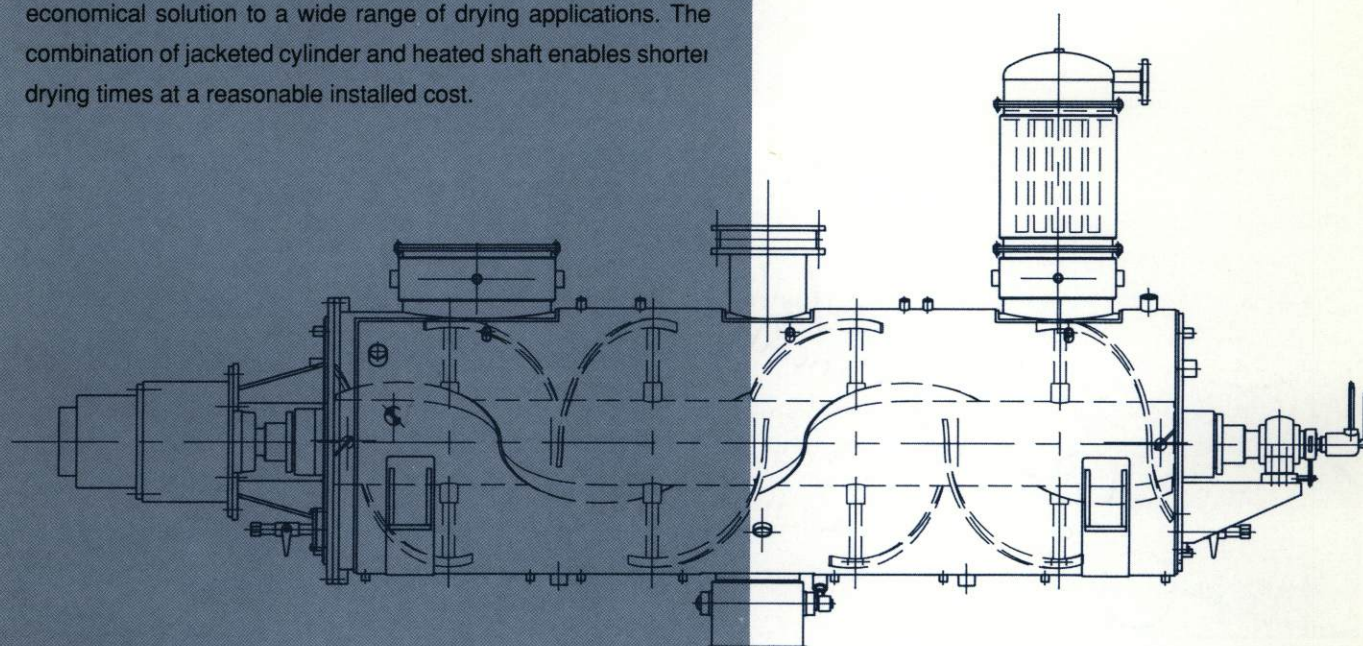
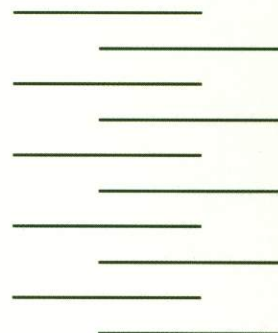
Operating up to 600°F, heating packages are sized to meet the maximum system heat load. In many batch vacuum drying systems, integral cooling is built into the heating package.

Gas Circulation

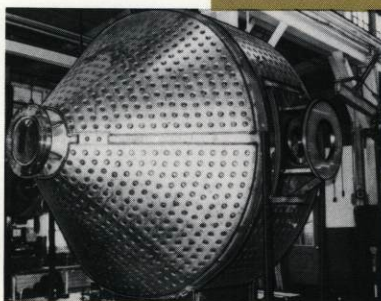
Can be set up for once-through or closed-loop recirculation, with or without bleed-off and makeup gas as needed. Ductwork can be pre-fabricated or site installed, depending on the size and scope of the installation.

The Vacuum Rotary Dryer is a vacuum dryer based on a stationary, horizontal cylinder fitted with a ribbon or paddle-type agitator. The simple, yet robust design makes the Vacuum Rotary Dryer a popular design for many different applications. It is well suited to pastes and filter cakes that break up readily during the drying cycle.

In general, the Vacuum Rotary Dryer is used for drying the full range of chemicals. It is well suited to processes where tumble dryers cannot be used, either because rotating-vessels are not practical, or because a fixed installation is required due to process or environmental considerations. The Vacuum Rotary Dryer offers an economical solution to a wide range of drying applications. The combination of jacketed cylinder and heated shaft enables shorter drying times at a reasonable installed cost.



Jackets

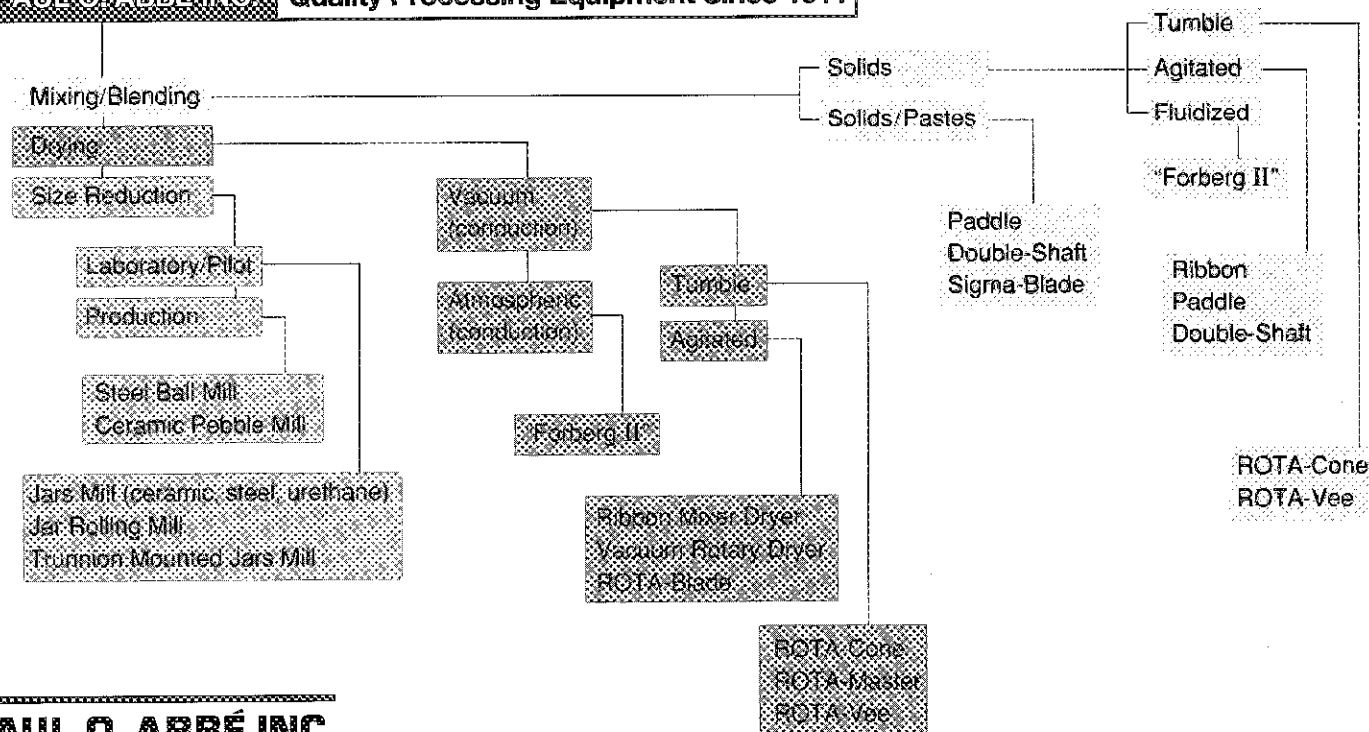


Either standard open jackets or dimple jackets are available on all Paul O. Abbe Vacuum Dryers. They can be fabricated from any of the common steels or corrosion-resistant materials. On tumbling vessels jacket designs can range up to 100 psig in the open design to 150 psig for the dimple design. For stationary dryers the jackets can be built up to 200 psig or higher. All pressure jackets above 15 psig are built and stamped per the ASME Code. Jackets are usually baffled for optimal heat transfer. On all designs the jackets can be fully insulated with a variety of different insulation materials.

Abbe Dryer Model	Design	Heating	Operation	Advantages
Rota-Cone Dryer	Tumble type design, cone-shaped, vertical shaft.	Indirect jacket	Batch, up to 500 cu ft.	Simple design & operation. Easy to clean. Minimal vibration. Full discharge.
Rota-Vee Dryer	Forced convection design, double discharge ports.	Indirect jacket	Batch, up to 250 cu ft.	Simple design & operation. Easy to clean. Full discharge.
Rota-Master Dryer	Tumble type design, indirect, vacuum-dry.	Indirect jacket	Batch, up to 500 cu ft.	Simple design & operation. Easy to clean. Minimal vibration. Full discharge.
"Forberg II" Dryer	Mechanical fluidized bed, fine particle sizes, atmospheric only.	Direct contact heated gas, once thru or closed loop.	Batch, up to 500 cu ft. Continuous.	Rapid drying times. High throughput. Extremely versatile. Temperature breakthrough. Full discharge.
Rota-Blade Dryer	Horizontal cylinder, double shafts, vacuum-dry.	Indirect jacket, heated shaft & paddles.	Batch, up to 500 cu ft. Continuous.	Large heated surface area. Medium speed rotation. Easy particle control.
Vacuum Rotary Dryer	Horizontal cylinder, vacuum for particle control, vacuum-dry.	Indirect jacket, heated shaft.	Batch, up to 500 cu ft. Continuous.	Low speed rotation. Easy to operate. Dries fines, powders, cakes.
Ribbon Mixer Dryer	Horizontal trough, ribbon mix, vacuum-dry, vacuum-dry.	Indirect jacket	Batch, up to 500 cu ft. Continuous.	Easy to operate. Dries pastes, powders, cakes.

PAUL O. ABBE INC.

Quality Processing Equipment Since 1911



PAUL O. ABBÉ INC.

139 Center Ave., Little Falls, NJ 07424
 Tel:(201) 256-4242 • Fax:(201) 256-0041
 1-800-524-2188