

# Update: A glossary of drying terms

---

**Drying is one of the most complex and energy-intensive technologies in bulk materials processing. To ensure you understand the terminology used by drying equipment suppliers, consultants, and users, read the terms defined in this drying glossary, updated from one in Powder and Bulk Engineering's April 1993 issue.**

---

**Agitated bed dryer.** Continuous, direct-heat dryer with a vertical drying chamber; chamber has a bottom heated-air plenum and a center rotor with blades that agitate the wet material, thus eliminating a need for back-mixing dry product into the feed to improve fluidization. Commonly used for high-solids feeds such as pastes and filter cakes.

**Agitated pan dryer.** Pressure or vacuum batch dryer that consists of a pan inside a heat-jacketed, round cabinet with a conical top and flat bottom. Unit's stirrer agitates the material, exposing it to the heat conducted through the cabinet walls. Commonly used to dry sticky or viscous materials.

**Back-mixing.** Process of mixing some dry material (usually from the dryer discharge) into an overly wet feed or a feed that goes through a sticky phase during drying. By altering the feed consistency, back-mixing allows the dryer to properly handle the feed.

**Band dryer.** See *Conveyor dryer*.

**Batch drying.** Method in which material is manually loaded into the dryer one batch at a time and unloaded when the drying cycle is complete, in contrast to continuous drying.

**Belt dryer.** See *Conveyor dryer*.

**Belt flaker-dryer.** Processor that dries or cools material on an endless belt.

**Calciner.** Batch or continuous, direct- or indirect-heat processor that usually operates at high temperatures.

**Closed-cycle drying.** Drying in which all of the drying gas — most often nitrogen or another inert gas — is recirculated rather than exhausted. Method minimizes gaseous or powder emissions, recovers the solvent and gas, and reduces explosion and fire risks; method is sometimes used to reduce material oxidation or decomposition. Also called *closed-circuit* or *closed-loop drying*.

**Cocurrent drying.** Direct-heat drying in which the material and hot gas flow in the same direction. Incoming moist material contacts the hot gas and thus is protected from the heat by evaporation.

**Compartment dryer.** See *Tray dryer*.

**Conduction drying.** See *Indirect-heat drying*.

**Constant-rate drying.** Initial drying stage when the rate of moisture removal (evaporation) per unit of drying surface and the material temperature remain constant.

**Continuous drying.** Method in which material is continuously fed into and discharged from the dryer, in contrast to batch drying.

**Convection drying.** See *Direct-heat drying*.

**Conveyor dryer.** Continuous, direct-heat dryer with a rectangular housing that encloses a moving belt. Wet material is fed onto the moving belt, and hot gas blows through or across the material. Feed is often preformed into briquettes or other shapes. Also called a *belt*, *band*, *apron*, or *through-circulation dryer*. Also see *Multiple-conveyor dryer*.

**Countercurrent drying.** Direct-heat drying in which the material flows counter to the gas flow, so that the hot gas contacts the material just before discharge, providing maximum product temperature.

**Desiccant.** Drying agent consisting of a soluble or insoluble chemical substance that draws water from many moist materials; often enclosed in packaging to keep solids dry

during transport and storage. Soluble desiccants are calcium chloride and glycerol; insoluble desiccants are bauxite and silica gel.

**Dielectric drying.** Using dielectric (radio frequency) energy to preheat wet material and achieve falling-rate drying for dyes, pigments, and foundry molds; method reduces energy use and drying times.

**Diffusion drying.** Drying caused by moisture that's trapped firmly in the material and requires a long exposure time to be released; occurs during the falling-rate period, and the heat transfer rate is low. See *Falling-rate drying*.

**Direct-heat drying.** Method in which hot gas directly contacts the wet material, causing evaporation and carrying off the vapor. Examples of direct-heat drying equipment include flash, fluidized bed, rotary, and spray dryers. Also called *convection drying*.

**Disk dryer.** Continuous, indirect-heat dryer with a horizontal trough that houses a rotating shaft mounted with one (or more) hollow, heated disk. Disks transfer heat to the material while mixing it. Commonly used for drying coal, corn germ, soybeans, and polypropylene; unit can also cool material.

**Double-cone tumbler dryer.** Vacuum, batch, indirect-heat dryer with a heat-jacketed chamber shaped like two cones joined at their wide ends. Trunnions support the chamber as it rotates. Rotation deagglomerates the wet particles and exposes them to the heat conducted through the chamber walls. Commonly used for drying pharmaceutical powders and heat-sensitive materials. Also called double-cone tumble dryer and rotating indirect-heat batch dryer. Variation is the extended-surface batch dryer, which also has baffles or tubes that extend the vessel's surface to provide a greater surface-to-volume ratio.

**Drum dryer.** Continuous dryer with one or two rotating, internally heated drums. Liquid feed is applied to each drum's exterior by rolls or sprays or by dipping; dry material is scraped off by a doctor blade. Commonly used to dry chemical liquid suspensions and fluids, slurries, and pastes. Also called *thin-film dryer*.

**Extended-surface batch dryer.** See *Double-cone tumbler dryer*.

**Falling-rate drying.** Drying stage when the drying rate is no longer constant but falls off continuously and the moisture has to migrate from the particle's interior to the surface.

**Flash dryer.** Continuous, direct-heat dryer that conveys the material in a hot gas stream inside a vertical tube, providing a very short residence time. Commonly used for drying granular, free-flowing materials that can be readily dispersed in the gas stream. Also called *pneumatic conveying dryer*.

**Fluidized bed dryer.** Continuous, direct-heat dryer that consists of a vertical, cylindrical housing. Hot gas blows upward through a perforated plate, ceramic grid, or set of nozzles in the housing's base to fluidize and dry a static bed of wet materials. Commonly used to dry free-flowing particles. Also called *fluid bed dryer*. Also see *Vibratory fluid bed dryer*.

**Forced-convection tray dryer.** See *Tray dryer*.

**Freeze drying.** Freezing a material under high vacuum so that ice or another frozen solvent sublimates and a porous solid remains.

**Heat transfer drying.** Drying caused by moisture at the material's surface that evaporates readily at a constant rate at a high heat input.

**Indirect-heat drying.** Drying without gas flow by applying heat to the wet material through a metal wall. Also called conduction drying. Most indirect-heat dryers have agitators mounted on a shaft; the agitators and shaft can be heated and the dryer can also be heat-jacketed. Examples include agitated pan, double-cone tumbler, disk, paddle, and screw conveyor dryers. Drum dryers and some rotary dryers are also indirect.

**Microwave drying.** Using electromagnetic energy in or just below the microwave spectrum to preheat wet material and achieve falling-rate drying; method reduces energy use and drying time. Often used with direct heat and in vacuum and freeze dryers and atmospheric food dryers.

**Multiple-conveyor dryer.** Continuous, direct-heat dryer with three to seven mesh- or perforated-belt conveyors stacked inside one enclosure; material drops gently from the end of one belt onto the next as hot gas flows through the belt to dry the material.

**Multistage drying.** 1) Drying in more than one drying stage, such as in a conveyor dryer with several, usually identical, stages. 2) Drying in a system that includes more than one dryer type, often applied to effect both heat transfer and diffusion drying.

**Nodulizing.** Creating spherical lumps from dust or powder either by heating or drying a liquid-solid mixture or by chemical reaction; frequently accomplished in a rotary dryer.

**Paddle dryer.** Some models of this dryer have agitators (or paddles) mounted on two or four rotating shafts; agitators can be intermeshing or separated. Agitators and shafts can be heated, and dryer can also be heat-jacketed. Other models have paddles that throw the material onto the vessel wall, and a small flow of hot gas aids drying.

**Pan dryer.** Batch, indirect-heat dryer with a horizontal, stationary heat-jacketed vessel and a flat agitating pan; the pan vibrates or rotates to help transfer heat from the vessel wall. Commonly used for drying large batches of free-flowing powders, granules, and crystals.

**Plate dryer.** Dryer with hollow, heated plates that is typically applied as in indirect-heat unit, using little or no gas flow. Unit is similar to the rotary tray dryer, a direct-heat dryer with unheated trays.

**Pneumatic conveying dryer.** See *Flash dryer*.

**Pulse combustion.** Firing a fuel intermittently at 30 to 200 hertz in a chamber shaped like a Helmholtz resonator, producing high-frequency pressure pulses and gas flow reversals. Can be applied in a dryer that uses sound or high-frequency pressure pulses, or both, to disperse pumpable feed to handle waste, food, chemical, pharmaceutical, or mineral products.

**Ribbon dryer.** Rotary, indirect-heat dryer fitted with a spiral ribbon agitator to provide gentle mixing during drying to improve heat transfer. Also called a *spiral ribbon dryer*.

**Rotary dryer.** Continuous dryer that consists of a rotating, horizontal cylinder and uses hot gas or steam to apply direct heat, indirect heat, or a combination of the two to dry the wet material. Examples are a steam-tube rotary dryer and ribbon dryer.

**Rotary tray dryer.** Continuous, direct-heat dryer with vertical, cylindrical chamber containing circular stacked trays or plates (which can rotate or be stationary). Material feeds from the top of the chamber onto the top tray or plate and is scraped by a wiper onto the next tray or plate; hot gas can circulate through the chamber, or heat can be conducted through the trays or plates. Also called *tray* or *plate dryer*. Also see *Plate dryer*.

**Screw conveyor dryer.** Continuous, indirect-heat dryer with one (or more) rotating screw inside a horizontal, cylindrical heat-jacketed vessel. Material is pushed by the screw flights through the dryer as the vessel wall (and, in some cases, the screw flights) transfers heat to the material. Commonly used for nonsticky, low-moisture-content granules and free-flowing powders. Also called *screw flight dryer*.

**Spiral dryer.** Continuous vibratory dryer consisting of a vertical, cylindrical chamber and a rotating spiral deck. Material feeds onto the deck, which moves upward as hot gas blows over the material and dries it. Deck can also be heated. Commonly used for chemicals and foods.

**Spray dryer.** Continuous, direct-heat dryer with a usually vertical, cylindrical chamber. Liquid feed is sprayed into a hot gas stream and is converted to small, generally spherical, dry particles. Commonly used for drying solutions or slurries to produce free-flowing powders.

**Spray granulation.** Forming small, spherical agglomerates in a bed of spouted or circulating seed particles by spraying a solution, slurry, or melt into a chamber containing hot gas; method can be batch or continuous.

**Steam-tube rotary dryer.** Continuous, indirect-heat dryer with a horizontal, cylindrical shell and internal ring (bundle) of steam-heated tubes. Shell or tube bundle (or both) rotates. Unit can also operate as a direct-heat dryer by using some hot gas flow. Commonly used to dry fibers and free-flowing powders.

**Superheated steam drying.** Using steam or high-humidity gas as the drying medium. Steam or gas recirculates after moisture removal, thus reducing the heat required and the amount of exhaust. Also called superheated vapor drying.

**Tray dryer.** Rectangular batch, direct-heat dryer with trays on fixed racks; trays are manually loaded and unloaded. Hot gas blows through the housing to dry the material. Also called a forced-convection tray or shelf dryer. Variations are a truck dryer, a larger unit with trays on wheeled trucks, and a tunnel dryer, a large rectangular oven into which wheeled trucks are rolled and that can operate semi-continuously.

**Tumble dryer.** See *Double-cone tumbler dryer*.

**Tunnel dryer.** See *Tray dryer*.

**V-cone dryer.** Variation of a double-cone tumbler dryer that consists of a cylindrical chamber cut and welded into a V-shape. Unit speeds drying by providing more contact with the dryer's heated surfaces.

**Vacuum dryer.** Dryer that operates under vacuum to prevent the escape of potentially hazardous vapors and materials when drying toxic chemicals, explosives, or solvents. Unit can also prevent damage to heat-sensitive materials and protect materials that can be damaged by air or humidity. Examples are a vacuum shelf dryer, vacuum rotary dryer, and vacuum double-cone tumbler dryer.

**Vibrating tray dryer.** Continuous, indirect-heat dryer consisting of a rectangular, heat-jacketed vessel containing one (or more) heated metal tray. Material is moved forward by the tray's vibration. Commonly used for free-flowing powders as well as granules, crystals, and fibers that can be conveyed by vibration.

**Vibratory fluid bed dryer.** Variation of fluidized bed dryer in which a combination of pneumatic and mechanical forces fluidizes the material in the hot gas. Also called a *vibratory dryer*. **PBE**

### Acknowledgment

The editors thank Harman D. DuMont and Ed Cook of DuMont Drying Consultants, Whitehouse Station, N.J., for their assistance in reviewing this article. They are the coauthors of the book *Process Drying Practice* and conduct dryer technology seminars at the University of Wisconsin-Madison.

### Sources

Glossary information was adapted from these articles previously published in *Powder and Bulk Engineering*:

Thomas S. Chirkot, "Maximizing surface-to-volume ratio: Rotating indirect-heat dryers," April 1994, pages 53-59.

David Cox, "Using a batch vacuum dryer to protect workers, the environment, and heat-sensitive materials," April 1991, pages 40-46.

Katherine Davich, "Choosing a dryer: Dryer types and selection steps," April 1990, pages 26-35.

William H. Engelleitner, "Glossary of agglomeration terms," February 1990, pages 44-48.

Stewart G. Gibson, "Drying high-solids feed with an agitated flash dryer," April 1993, pages 49-55.

Paul Y. McCormick, "Answers to 10 questions about drying," April 1992, pages 43-49.

Britton Miller, "Drying fragile or friable materials in a multiple-conveyor dryer," April 1995, pages 67-76.

Ben Root, "Using moisture control agents to ensure the integrity of packaged products," June 1988, pages 17-19.

George Svonja and Colin Crankshaw, "Ring dryer: A tool for transforming waste for reuse or disposal," April 1996, pages 87-98.

Brian M. Trudel, "What you should know to select a vibratory fluid bed dryer," April 1989, pages 38-42.

David Vetere and Jeffrey Morris, "How a conduction dryer works and how to select one," Part I (September 1997, pages 23-28) and Part II (October 1997, pages 35-41).