

Update: Glossary of agglomeration terms

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The growing use of new agglomeration methods is creating a corresponding rise in the number of agglomeration terms we use — many of them confusingly similar to other terms. To help us all speak the same language, *Powder and Bulk Engineering* presents the latest edition of the author's agglomeration glossary. Since its last publication in February 1990, this glossary has been expanded to include 33 new or updated agglomeration terms and their definitions.

General terms

Agglomerate. (Noun form.) The product of size enlargement, such as a pellet, ball, granule, or briquet.

Agglomeration. Size enlargement; the process of gathering fine particles into permanent larger shapes in which individual particles can still be distinguished.

Binder. An additive to the material being agglomerated that provides bonding strength in the final product. A binder can be a liquid or solid that forms a bridge, film, or matrix filler or that causes a chemical reaction.

Bonding. The forces of cohesion between particles, as in agglomerate bonding or bonding strength. See **Strength**.

Capping. The rupturing and breaking of a tablet (formed by a tableting press) due to internal stress and imperfect particle packing.

Clustering. Loose bonding of particles by pendular and funicular bridges in the presence of moisture.

Clamshelling. Splitting of an imperfect, poorly formed briquet.

Coalescence. Growing or joining together into one form or group.

Coldbonding. A hydrothermal process performed at ambient or low temperatures that uses the cementitious characteristics of a binder (such as lime, silica, or magnesia) to induce a high-strength bond in pellets or briquets. Often used with ore fines, steel mill waste, and coal.

Density. The mass per unit volume of a material under specified conditions of pressure. Also called *apparent density*, *bulk density*, or *true density*.

Porosity. The property of containing pores; the total volume of pores in a solid.

Strength. The power to resist force, strain, or stress.

Agglomeration methods

Agitation. Particle size enlargement without the use of pressure, either by tumbling, coalescence, or particle growth. Also called *agitative agglomeration* or *tumble agglomeration*.

Ammoniation-granulation. The formation of small fertilizer pellets from a mixture of minerals and chemicals in combination with a chemical reaction such as ammoniation.

Balling. The formation of spherical agglomerates (such as balls or pellets) with moisture. Applications include the formation of iron ore fines into greenballs.

Beading. The formation of small pellets in drum and pin-mixer pelletizers. Used by the petroleum industry and in the production of carbon black.

Briquetting. Pressure agglomeration that forms shaped agglomerates called *briquets*. Usually refers to double-roll press (or roller press) briquetting.

Coating. Applying a layer of material, a film, or a finish to a substrate. Applications include coated ceramics, medicinal tablets, fertilizers, and foods.

Compaction. Densification or compression of solids that firmly joins particles together.

Compaction-granulation. A type of briquetting where pressure is used to form a compacted sheet of material; the

sheet is then milled (granulated) and screened to produce small agglomerates. Typically used for fertilizer production. Also called *dry granulation*.

Conditioning. The tumbling, mixing, and dedusting of fine material for dustless disposal or for feeding to a second processing stage.

Dry granulation. See *Compaction-granulation*.

Encapsulation. Enclosing powder or small granules in a protective membrane or capsule.

Extrusion. The formation of cylindrical agglomerates (such as pellets or extrudates) by forcing a plastic mass through a perforated die, then cutting the extruded material or allowing it to break off.

Fluid-bed granulation. See *Spray granulation*.

Globulation. Drop-formation of solutions, slurries, or melts. See *Prilling*, *Spray drying*, and *Spray granulation*.

Granulation. The formation of small granules by growth-tumble agglomeration.

Growth-tumble agglomeration. See *Agitation*.

Heat bonding. Using heat to fuse fine particles into solid shapes, as in sintering, calcining, or induration. Also called *thermal agglomeration*.

Hot-melt granulation. Pan granulation of concentrated hot melt, such as urea or ammonium nitrate.

Induration. In geology, the hardening of a mass or rock. In iron ore processing, heat-hardening iron ore pellets (taconite) on a grate, in a shaft, or in a rotary kiln. See *Sintering*.

Instantizing. The formation of loosely held agglomerates that have “instant” solubility in liquids. Applications include instant drink mixes, instant coffee, and instant milk.

Isostatic pressing. The compaction of powdered material into a predetermined shape by using a liquid or gaseous medium as the pressure-transmitting force.

Micropelletizing. The formation of small pellets — usually no larger than -6 mesh (3.3 millimeters) — by tumbling, growth agitation, or mixing. See *Conditioning* and *Granulation*.

Mixer granulation. Agitation and growth agglomeration in a mixer.

Nodulizing. The formation of irregular or spheroidal agglomerates by tumbling particles at elevated temperatures in a dryer or kiln.

Pelleting. A form of the word *pelletizing*, used mainly in the compound animal feed industry to describe the extrusion of feed material into cylindrical pellets in a pellet mill or pellet press. See *Pelletizing*.

Pelletizing. The formation of pellets, balls, or granules by growth agitation and rolling of fines with moisture, generally in a rotating disc or drum pelletizer. The process usually refers to the green-pelletizing and drying of pellets, sometimes followed by firing, calcining, or induration.

Prilling. The formation of spherical agglomerates called *prills* from a melt by droplet dispersion in a chamber (prill

tower) and free-fall cooling. Also called *globulation* or *shotforming*. Common applications include ammonium nitrate, urea, and sulfur.

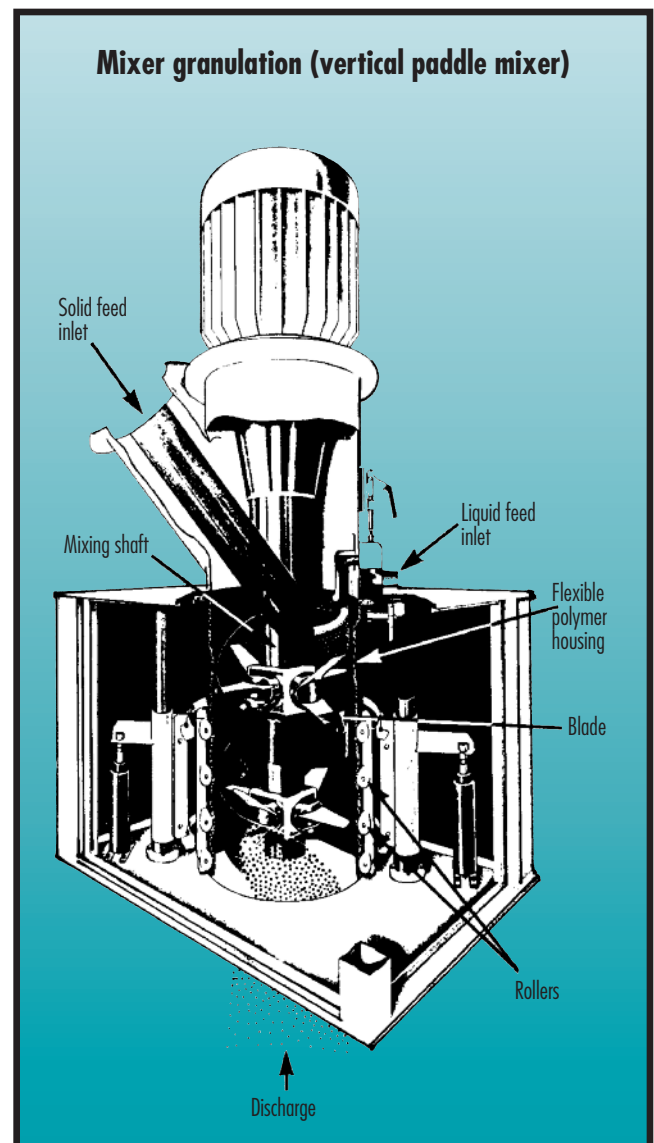
Roll pressing. See *Briquetting*.

Selective agglomeration. The agglomeration of fine particles in liquid by adding a bridging agent during agitation. Also called *immiscible liquid wetting*, *spherical agglomeration*, and, particularly in coal preparation, *oil agglomeration*.

Shotforming. The agglomeration of a liquid into small balls or pellets; occurs in a spray tower where liquid falls through a cooling medium.

Sintering. High-temperature treatment of a mineral mixture (such as iron ore, carbon, and flux) by inducing a draft on a traveling grate device to form a hard clinker, called *sinter cake*. See *Induration*.

Spheronization. The rounding of moist, soft, cylindrical pellets in a spheronizer. Also called *spheronizing*.



Spray drying. The formation of fine, granular solids or bead-like agglomerates by dispersing a liquid or semiliquid suspension or slurry in droplet form in a chamber in the presence of drying gases that evaporate moisture. Applications include food, pharmaceutical, and ceramic products.

Spray granulation. The formation of small, spherical agglomerates in a bed of spouted or circulating seed particles by spraying a solution, slurry, or melt into a chamber in the presence of drying air; can be batch or continuous. Applications include food products, chemicals, and minerals. Also called *fluid-bed granulation*.

Tableting. A punch-and-die procedure that compacts powdered or granular solids. Applications include pharmaceuticals, food products, and chemicals.

Tumble agglomeration. See *Agitation*.

Wet granulation. Agitative agglomeration with moisture, used to form pellets or granules. Applications include fertilizer granulation in a rotating disc or drum pelletizer.

Agglomeration equipment

Axial extruder. An auger- or screw-type extruder where the extrusion die is at the end of an extrusion shaft and screw; shaft may be single or double.

Basket extruder. A low-pressure forming device with a basket-shaped perforated extrusion chamber and wiper blades.

Blunger. A vat or trough that contains a rotating shaft with knives, arms, or paddles for mixing clay and water into a slip. Used mainly in the ceramic and fertilizer industries. See *Pugmill*.

Briquetter. Usually refers to a double-roll press with pockets that shape fine materials (such as ore, coal, flue dust, or metal powders) into larger forms, sometimes with the use of a binder.

Coating pan. A bulb-shaped or conical mixing vessel that applies a material layer (or coating) on small granules, usually in the presence of a liquid, heat, or both. Typically used in the pharmaceutical and food industries.

Countercurrent mixer-granulator. A rotating mixing vessel, also used for granulation, that produces agitation using countercurrent rotating paddles, arms, or plows. Can be used for blending only or for forming pellets in the presence of moisture.

Die. A device for cutting, forming, or stamping material.

Dome extruder. An axial auger extruder with a dome-shaped die rather than a flat die.

Drum granulator. See *Pelletizer*.

Exter press. (German origin.) A piston extruder that forms brick-shaped briquets in a channel. Used predominately in Europe for briquetting brown coal.

Falling-curtain agglomerator. (US origin.) Rotary drum with internal bar cage and spiral ribbon to create a constant-density falling curtain of material during liquid application and granulation. Sometimes called *O'Brien drum*.

Gear briquetter. A double-roll briquetter with two intermeshing gears; material is squeezed through the perforated inner part of the gears to form cylindrical briquets.

Marumerizer. (Japanese origin.) Trade name for a spheronizing device.

Muller. Originally a device that used a stone or other hard tool to grind and mix drugs, paints, and similar materials. Today, the device is a blender with two large metal wheels that knead (mull) material; often used for preconditioning or binder-mixing prior to briquetting. Also called a *mix-muller*.

Paddle mixer. See *Pugmill*.

Pan granulator. See *Pelletizer*.

Pellet mill. An extrusion (pelletizing) device that consists of a rotating ring with perforations and rollers inside it. Used to extrude fines into cylindrical pellets. Typical applications include compound animal feeds.

Pelletizer. Usually describes a rotating disc, drum, or cone device that uses layering, particle growth, or agitation with the addition of water, binders, or both to form spherical pellets from fine dust and powder.

Pin mixer. A stationary-shell mixing and granulating machine with a single-shaft pin agitator for blending, preconditioning, granulating, and pelletizing.

Piston press. A mechanically or hydraulically actuated reciprocal piston that compacts dry or moist particles into brick- or puck-shaped pieces within a large cylindrical die. Also used for chips, borings, turnings, and other metallic particles. Also called a *ram extruder* or *ram press*.

Plow mixer. A mixing and granulating machine with a stationary chamber and agitator fitted with plowshare-shaped tools.

Press. Any device that applies pressure to a workpiece or material for the purpose of cutting, shaping, or forming under pressure. Typical agglomeration presses include the briquetter, extruder, tableting press, piston press, ram press, compactor, and punch-and-die press.

Pugmill. A paddle-type mixer, usually with double shafts, that has a trough-shaped chamber. Used for wetting, dedusting, cake forming, and granulation. Applications include clay, ceramic mix, flue dust, and mixed fertilizer.

Punch and die. Parts of a tool set that mold and form powders into compressed shapes, as in a piston press or tableting press.

Radial extruder. An extruder with a perforated screen in the circumference of the extrusion barrel; wiping blades and arms force the material through the screen die.

Ram extruder or ram press. See *Piston press*.

Ring-die extruder. A device that uses a rotating, perforated die press and rollers to force a wetted mass of particles through holes, where they're cut into cylindrical pellets. Also called a *pellet mill*.

Roll press. Another name for a briquetter or double-roll briquetter. Also called a *roller press*.

Schugi mixer. (Dutch origin.) Trade name for a high-speed, vertical-shaft paddle mixer used to mix or agglomerate (or provide both to) powder and liquid.

Zig-Zag blender. (US origin.) Trade name for a continuous, multiple-cone blender that mixes or agglomerates (or provides both to) fine materials with liquid by agitation.

Types of agglomerates

Bead. Any round object of wood, glass, metal, or ceramic.

Briquet. An agglomerate that consists of fine material pressed into the shape of a block, puck, cylinder, pillow, wafer, nugget, or log. The most common example is the commercial charcoal briquet. A derivation of the French term *brique*, meaning small brick. Also called *briquette*.

Densified refuse-derived fuel (dRDF). The briquetted or extruded lightweight, combustible portion of processed solid waste.

Granule. While *pellet* is typically used to describe mineral (such as iron ore) agglomerates, *granule* commonly describes chemical (such as fertilizer) agglomerates. See *Pellet*.

Greenball. Any moist, uncured pellet formed by agitative agglomeration, such as occurs in a rotating disc or drum pelletizer. Most frequently used in iron ore processing to distinguish the green, moist ball from the fired, indurated pellet.

Hot-briquetted iron (HBI). Briquetted metallized iron from direct reduction of iron ore fines or ferrous waste.

Nodule. In geology, a small hard mass or lump of mineral that is of contrasting composition and greater hardness than the surrounding sediment or rock matrix. In ore processing, a formed spherical or spheroidal agglomerate.

Pastille. Typically a small medicated or flavored tablet, usually formed by solidification of drop-forms on cooling belts.

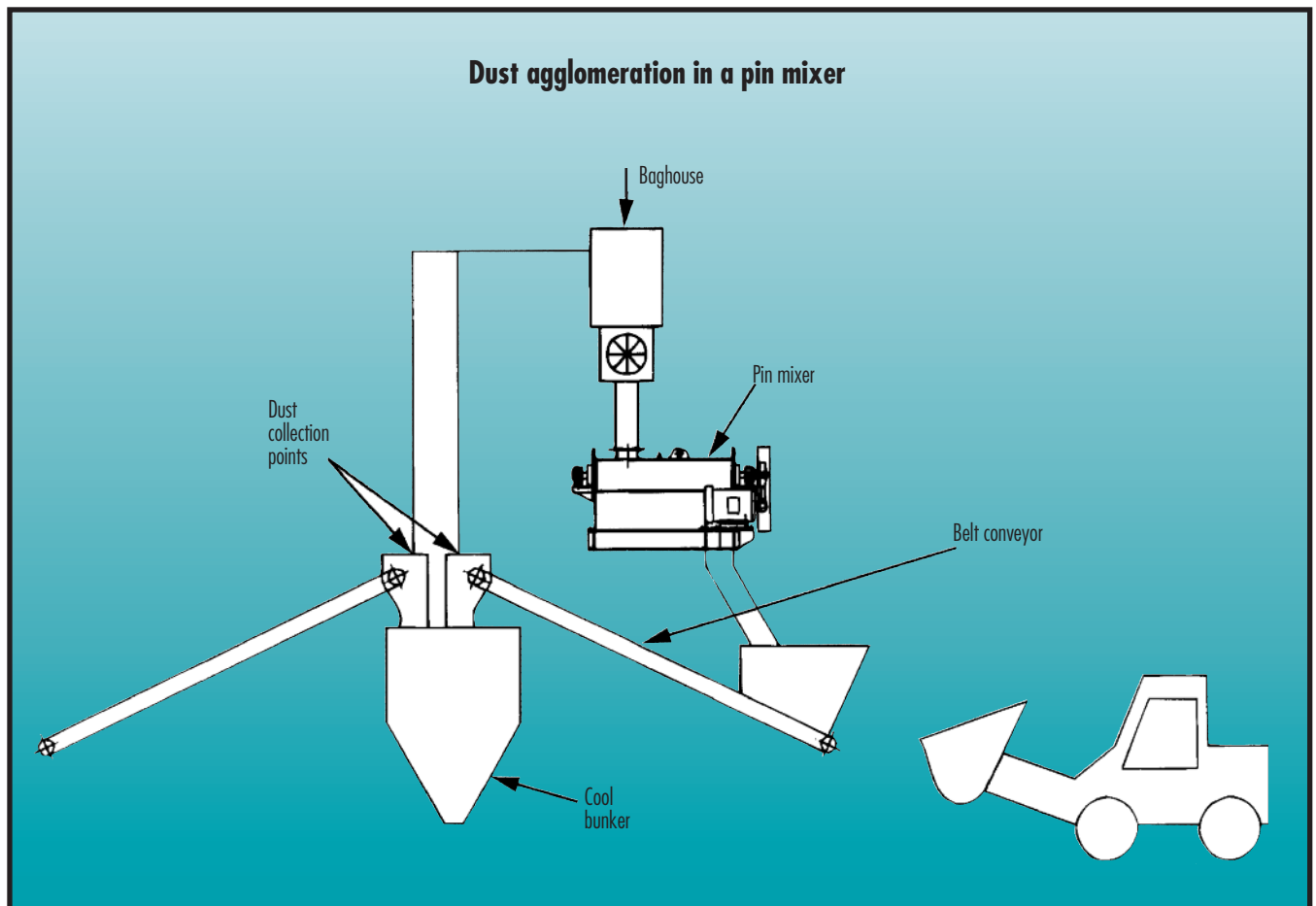
Pellet. In mineral, iron ore, and coal processing, a spherical agglomerate; in compound animal feed and industrial catalyst processing, a cylindrical body; in pharmaceutical processing, a small pill.

Recycle. Material that is returned to the beginning of a process system after being separated from the product by screening. Examples include the undersize portion of pelletized, granulated, or compacted fertilizer.

Slug. The puck-shaped briquet formed by a piston press or ram press. In the pharmaceutical industry, the preform made in a punch-and-die press prior to tableting.

Tablet. A compressed, molded form of material, usually shaped like a wafer or disc, such as a pharmaceutical tablet.

Water-dispersible granule (WDG). Granular herbicide or pesticide consisting of carrier and active ingredients.



Physical characteristics tests for agglomerates

Attrition (abrasion). Determines the resistance of an agglomerate to surface abrasion. Performed by subjecting an agglomerate to tumbling — in a rotating drum, laboratory tumbler, or laboratory sieve shaker — and measuring the percentage of abraded fines to provide an abrasion index. Abrasion media can be used to apply surface-attrition action.

Caking. Determines the tendency of agglomerates, like fertilizers or foods, to cake in containers or during bulk storage or transport. Measured by applying pressure to a mass of agglomerates during controlled cycles of time, temperature, and humidity.

Crush strength. Determines the agglomerate's resistance to crushing and breaking during handling. Measured by crushing a pellet, briquet, or extrudate between plates and recording the total pound crush force required to break or crack the agglomerate.

Dispersibility. The ability of agglomerated solids to quickly and uniformly disperse in a liquid or solid (such as carbon black pellets dispersing in rubber compounding).

Homogeneity. Determines possible demixing of ingredients due to handling, storage, or the agglomeration process itself. Measured by comparing the homogeneity of a multicomponent material (such as fertilizer, glass batch, or sinter mix) before and after agglomeration.

Impact strength. Determines the maximum number of drops or impacts an agglomerate can survive before breaking or shattering. Can also be measured with a shatter test, where a weighed quantity of agglomerate is dropped en masse to simulate actual handling conditions.

Porosity. Determines the specific void volume of agglomerates. Used as a measure of densification — for example, to determine the relative porosity of pellets versus briquets.

Product end use. Evaluates the performance characteristics of agglomerates in actual or simulated end uses. Examples include determining the combustion rate of coal pellets and briquets; the melting rate of glass batch agglomerates; the grindability of fuel, carbon black, or mineral agglomerates; the reducing index of metal oxide agglomerates in furnaces; the pressability of micropellets in tablet and compacting presses; and the bulk factor of consumer goods (such as foods and detergents) in packaging.

Strength. Determines the ability of an agglomerate to withstand destructive force, as in crush strength or tensile strength. Measured by crushing, dropping, impacting, shearing, abrading, or tumbling the agglomerate. One model, developed by H. Rumpf, determines the tensile strength of agglomerates as a measure of strength and is defined as the tensile force at failure divided by the cross-section of the agglomerate. See **Crush strength**.

Weatherability. Determines the stability of an agglomerate during exposure to the elements, particularly during outside storage and transportation. For example, a waterproof index can be measured by immersing agglomerates in water for long periods, spraying them with water, or assessing their strength after rain or freeze-and-thaw cycles.

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Sources

For a selected bibliography of agglomeration resources refer to page 48 in the author's February 1990 glossary in *Powder and Bulk Engineering*.

More information is available from the Institute for Briquetting and Agglomeration, 179 Riverview Acres, Hudson, WI 54016, 715/549-6342, fax 715/549-5678 (iba@pressenter.com); Ralph W. Weggel, executive director.

For further reading

Find more information on agglomeration equipment and methods elsewhere in this issue and in articles listed under "Agglomeration" in *Powder and Bulk Engineering's* comprehensive "Index to articles" (in the December 1999 issue and on PBE's Web site, www.powderbulk.com).

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