THE LINDE GROUP

Cryogenic Grinding. Fine-Particle Pulverization with Nitrogen or Carbon Dioxide.

Plastic, elastic, and heat-sensitive materials have properties that make fine grinding quite difficult, which can create additional process and performance difficulties. With cryogenic size reduction, Linde offers a process which economically pulverizes many different materials with low-temperature gases. This process can provide benefits such as reduced energy costs and increased production rates.

Cryogenic gases provide flexibility across a wide range of grinding temperatures. For example, carbon dioxide is traditionally used for cooling in the spice industry. The process usually utilizes fine impact mills, although other types of milling systems can also be applied.

Linde has decades of experience in the application of cryogenic grinding in customers' facilities. This expertise includes the selection, implementation, and optimization of suitable cryogenic grinding processes.

Advantages

- Increased productivity through optimized particle-size and increased throughput
- Elimination of caking product within the mill
- Decreased wear on grinding equipment
- Improved pouring properties due to finely ground material
- Increased protection from fire and product oxidation due to inert milling atmosphere
- Separation of composite materials within the mill

Numerous application possibilities

- Fine-particle size reduction for thermoplastics and elastomers
- The aroma from spices as well as heat-sensitive fats are preserved by utilizing low-temperature gases, which mitigate the effects from heat degradation
- Oxidizable materials, e.g. fine metal powder, are best protected in an inert gas atmosphere
- The treatment of production residues guarantees high product quality as well as the separation of individual components by recycling the composite

Linde offers a full service

- Consultation on technical application
- Experimentation and testing within laboratory and production mills
- Adaptation of present grinding systems for use in controlled temperature grinding
- Profitability analysis

Applications for cryogenic grinding include rubber, plastic, metal, composites, spices, pharmaceuticals, waxes, or other materials.

Process example for grinding spices

Cryogenic grinding of spices is a method of pulverizing the material at low temperatures. Traditional grinding processes generate heat that can degrade or reduce the volatility of a spice's heat sensitive constituents such as aroma and flavor. The spices are frozen with cryogen such as liquid nitrogen (LIN/N_2) or carbon dioxide (CO_2) as they are ground into a fine powder. This process preserves the quality of aroma and flavor within the product without damaging or altering the chemical composition of the spices.

Spices are fed through a hopper to a conveyor system. While moving along the conveyor, the spices are sprayed with the appropriate amount of cryogen. The material is then moved to a stainless steel auger that transports, grinds, and mixes the product and cryogen for an efficient cooling process. The cryogen absorbs the heat and is vaporized to a gaseous state, which is then expelled from the system through an exhaust system.

The results are high quality spices at controlled partial sizes with no evaporation of essential values and negligible loss of volatile components.

Cryogenic grinding data (e.g. pepper)

Particle Size	700 µm
Production Rate	1654 lb/h
Nitrogen Consumption	0.25 lb/lb pepper
Driving Power	35 kW (47 hp)

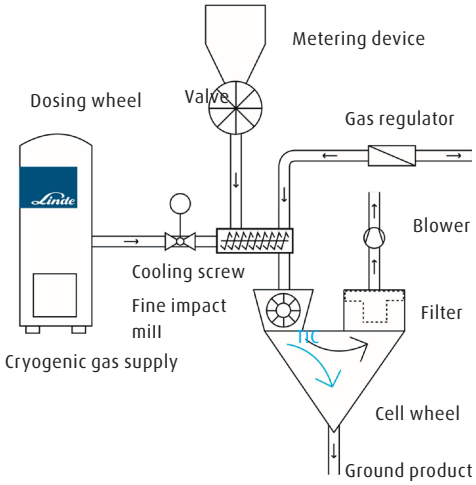
Process example for grinding thermoplastics

A dosing wheel meters the plastic pellets, e.g. polyethylene or polyamide, into the mill. The grinding heat would normally melt the thermoplastics, preventing the possibility of fine-particle grinding. However, cryogenic gases prevent this by embrittling the material in a cooling conveying screw. The cryogenically ground plastic and the gas are collected in a bin. The pulverized product is then further processed through a cellular wheel sluice. The mill gas is purified with a filter and is released. The remaining gas is recycled back into the mill for heat integration.

The results are finely ground thermoplastics that maintain the quality of the processing equipment by preventing melted material from impeding the system.

Cryogenic grinding data (e.g. polyamide)

Particle Size	80 µm
Production Rate	772 lb/h
Nitrogen Consumption	1.25 lb/lb polyamide
Driving Power	21 kW (28 hp)



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