WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Cryogenic Grinding

[1]P. Durga prasad, [2]B. Vivek

#Department of Mechanical Engineering GMRIT, rajam, Andhra Pradesh, India
[1]Rollnumber 22345A0315; Email: Vivekbollina@gmail.com
[2] Roll number 22345A0313; Email: Pathivadadurgaprasad9407@gmail.com
DOI: https://doi.org/10.55248/gengpi.5.0324.0795

ABSTRACT:-

This effort aims to optimize the grinding process for elastic materials including plastic, rubber, metal, waxes, and composites. Nowadays, many of these resources are squandered. Certain materials, such as plastic and synthetic rubber. Composites carry considerable environmental dangers. This study emphasizes the importance of using the cited pollutants responsibly. Milling small thermoplastic particles at room temperature can be problematic. Because of their softness, they can clog screens and form lumpy masses. Cryogenic grinding requires cooling thermoplastics. Using liquid nitrogen, carbon dioxide, or dry ice, they can be pulverized to a powder suitable for electrostatic spraying and other powder operations by cooling with dry ice or liquid carbon dioxide.

Keywords:- Cryogenic grinding, thermoplastic,liquid and gases.

I. INTRODUCTION

The name 'Cryogenics' comes from the Greek phrase for creating or producing anything through cold temperatures. It is the investigation of the creation and behavior of Materials are at extremely low temperatures. Scientists assume cryogenics begin at or below -150 0C (123 K; -2380C), while the exact temperature range is unclear.Cryogens such as liquid helium (3.19K), liquid hydrogen (20.27K), liquid neon (27.09K), liquid nitrogen (77.36K), liquid air (78.8K), liquid argon (87.24K), and liquid oxygen (90.18K) are used to produce extremely low temperatures. The most common is liquid nitrogen, which is inert in nature. Cryogens are housed in Dewar flasks. Low-pressure tanks use venting, insulation, or refrigeration to keep their contents in liquid phase. They are huge..This work explores how changing material behavior may be used to grind them into tiny particles.

Cryogenic grinding technique allows for efficient grinding.

Suitable for cryogenic recycling of multi-component materials and scrap. This procedure addresses common issues with traditional grinding, such as heat generation, tensile stresses, shorter tool life, mill blockage and gumming, and oxidation. The procedures are described as:

1) Cryogenic grinding involves cooling or chilling materials and reducing them to smaller particles. Because practically all materials are fragile when exposed to cold temperatures. Cryogenic size reduction uses cold energy from cryogenic fluids to chill, embrittle, and stabilize materials before or during grinding. This method addresses the challenges of grinding elastic materials at ambient temperatures, which can generate lumpy masses and clog the screen.

2) A solenoid is used in freezer milling, a form of cryogenic milling, to grind samples. The sample is ground to analytical fitness by the solenoid's back-and-forth movement of the grinding medium inside the vial. Since the sample is arc milled at liquid nitrogen temperature (-1960C), this kind of milling is particularly helpful for temperature-sensitive materials.

3) A type of mechanical milling known as cryomilling involves milling metallic powder or other samples—like volatile samples that are sensitive to temperature—in a cryogenic slurry or at a cryogenic temperature while adhering to specific processing guidelines in order to produce microstructured particles. The cryomill's grinding jar oscillates radially in a horizontal orientation. The material sampled at the rounded ends of the grinding jar is pulverized by the high-energy impact of the grinding ball due to its inertia. Throughout the process, liquid nitrogen is used to continually cool the jar. Conventional grinding has a number of drawbacks, including excessive heat generation, the creation of tensile residual stresses, a decrease in tool life, and mill clogging and gumming as well as related deterioration.

2. How cryogenic grinders operate

The material to be ground is manually cleaned before being added to the hopper. The material enters the vibratory feeder through the hopper's outlet and is able to regulate the feed rate. It is positioned with a slight inclination toward the helical screw conveyor's entrance. The screw conveyor is sprayed with liquid nitrogen that is drawn from the storage container; the conveyor drive's speed can be adjusted to control how long the material remains in the conveyor.

The material is crushed between the studs and comes out as a ground product through an optional sieve when the mill is operating.The material is crushed between the studs and exits the mill as a ground product through an optional sieve while the machine is operating.The ground product is gathered in a collecting bin located at the base of the mills.The cyclic process is maintained by sucking the vaporized nitrogen from the mill via the filler assembly in the feed back mill using a centrifugal blower.A schematic illustration of a different kind of liquid nitrogen-powered cryogenic grinder is displayed. This provides a thorough understanding of the parts of a standard cryogrinder. It is made up of a liquid nitrogen container, a pressure gauge, a pressure valve, a flexible pipe, a nozzle, a cover for the grinding wheel, a dynamometer, and a grinder

Feed quantity: 8 g

Material specification(s): elastic, temperature sensitive

Configuration(s): Grinding jar stainless steel 50 ml for CryoMill; grinding ball stainless steel 25 mm, Frequency 25 Hz

Time: 5 min. (for grinding, 10 min pre-cooling) Achieved result(s): 500µm

3.Data on Performance

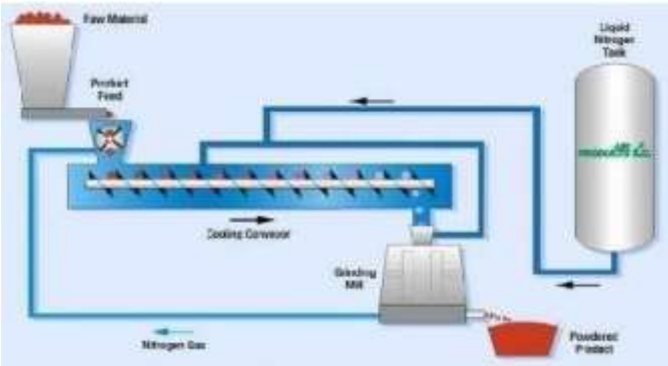


FIG NO 1

B] Application field: Cu + 10 % Nb

Feed size: 0-200 µm Feed quantity: 7 g

Material specification(s): Ductile Configuration(s): Grinding jar stainless steel 50 mm; Grinding ball (stainless steel) 25mm; Grinding ball stainless steel 10 mm Frequency: 25 Hz

Time: 3 x 20 min. (grinding, sampling every 20 min, 10 min precooling)

Achieved result(s): 200µm Remark(s): After > 40 min a pressure increase inside the grinding jar has to be expected

Cryogenic grinders produce more at a faster rate and with a more even distribution of particles. The experimental data fluctuate depending on the size and type of feed material used as well as any modifications made to the cryogenic grinding machine's design

.4. Analyzing the Outcomes

The polyethylene or polyamide plastic pellets are weighed and fed into the mill using a dosing wheel. The thermoplastics would typically melt at the grinding heat, making fine-particle grinding impossible.

Cryogenic gases, on the other hand, stop this from happening by embrittling the material in a cooling conveying screw. Both the gas and the plastic that has been cryogenically ground are gathered in a bin. A cellular wheel sluice is used to further process the ground product. After being filtered, the mill gas is expelled after being cleaned. For heat integration, the leftover gas is recycled back into the mill.Thus, the experimental outcome for polyamide utilizing the Linde cryogenic grinding equipment is provided below.Specialized for cryogenic grinding is the Cryomill. Before and during the grinding operation, liquid nitrogen from the integrated cooling system is continuously poured into the grinding jar. As a result, volatile components are maintained and the sample becomes embrittled. Liquid nitrogen is continuously pumped through the system and refilled in precisely the right amount via an auto fill system in order to maintain the system's temperature at -1960C. A strong impact ball mill produces flawless grinding efficiency. Because the auto fill method keeps LN2 out of direct touch, cryogenic grinding is extremely safe. Because of its adaptability (wet and dry grinding at ambient temperature, cryogenic grinding), the CryoMill is the best grinder for small amounts up to 20 milliliters.Utilizing RETSCH cryomills, processed data for Plastic and (Copper + 10%Nb) is noticed.

A] Application field: Chemistry / Plastics Material:

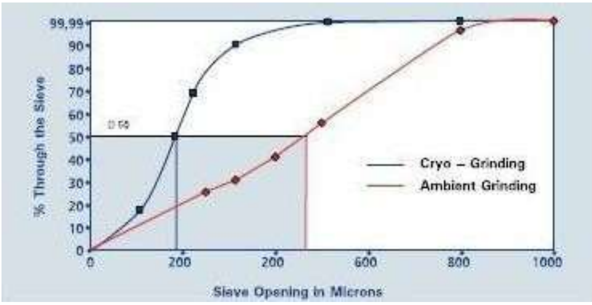
Mixture of plastic granules. Feed size: 0-5 mm

5. A comparison of the conventional and cryogenic grinding processes

The ambient method typically grinds the given material into tiny particles using a traditional, high-powered mill set. Using this rather cheap approach, it is customary to manufacture 10 to 30 mesh material in order to make a relatively large crumb. It is common to employ many cracker mills in sequence. For 10–20 mesh, typical yields are 2,000–2,200 pounds per hour, and for 30–40 mesh, they are 1200 pounds per hour. The longer the material is allowed to run on or in the mill, the finer the desired particle. Moreover, the particle size can be decreased by using several grinds.

The process's lower practical limit is the 40 mesh material is produced. Any type of fiber and An air tool must be used to remove any unnecessary material. a division or an air table. Metal is used with a magnetic division matrix. The final product is fairly tidy. Typically, cryogenic grinding begins with chips or A delicate crumb. This is chilled with a cryogenic chiller. A mill is used to process the frozen material. This often a mill with paddles. The finished result is a variety of sorted particle sizes that are utilized either exactly as is or continued and more size reduction was carried out. An Typical operations yield between 4,000 and 6,000 pounds each hour.

The 40 mesh material produced is the lowest practicable limit of the method. Any kind of fiber must be removed, and an air tool must be used to do so a table of divisions or air. When using a magnetic division matrix, metal is employed. The finished item is reasonably organized. Cryogenic grinding usually starts with chips or a thin crumb. A cryogenic chiller is used to cool this. The frozen material is processed in a mill. This is often a paddle- driven mill. A range of sorted particle sizes are the end product, which can be used just as is or further size reduction can be done. An the average process produces four to six thousand pounds in an hour Conversely, the process of cryogenic grinding results in fracture surfaces that are rather smooth. In the process, very little or no heat is produced. As a result, the material deteriorates less. The process's most important aspect is that it liberates nearly all of the steel or fiber from the rubber, producing a large amount of useable output.



6. Advantages of Cryogenic Grinding

Increased productivity through optimized particle-size and increased throughput. - Elimination of caking product within the mill.

Decreased wear on grinding equipment. Separation of composite materials within the mill. Higher production rate.

Lower energy consumption. Fine particle size.

More uniform particle distribution Lower grinding cost.

Decreased wear on grinding equipment. -

Improved

pouring properties due to finely grounded materials.

Reduction in microbial load.

7. Application of Cryogenic Grinding

Cryogrinding of steel

a) The large amount of heat generated during machining/grinding at high speed and feed rate raises the temperature at cutting zones excessively.

b) To overcome this problem liquid nitrogen is fed to the grinding spot.

c) Thermoplastics and Thermosets

d) To which nylon, PVC, polyethylene, synthetic rubber are commonly used in powder form , but not limited to ,a variety of applications such as adhesives, powdered coatings, fillers and plastic sintering and molding.

Adhesives and Waxes

e) To avoid pliable and sticky of certain materials which is unable in conventional grinding Explosives

f) To grind the explosive materials(TNT) below their ignition temperature

Other Application

g) Fine particle size reduction for thermoplastics and elastomers.

h) Oxidizable materials are best protected in an inert gas atmosphere.

i) The treatment of production residues guarantees high quality as well as the separation of individual components by recycling the composite.

j) Cryogenic grinding also used in microbiology

where plant or animal tissues are broken called method of cell disruption for protein extraction.

Conclusion

Based on the research, it can be said that fracture surfaces produced by the cryogenic grinding process are generally smooth. The method produces little to no heat. As a result, the material deteriorates less. Other than this This procedure achieves the necessary fineness and even distribution of a certain sized particle; it may be changed with the right arrangement of cryogenic grinders. The product is shielded against oxidation and rancidity since it is produced in an inert environment. In comparison, the energy consumption and cost of the cryogenic grinding process are lower. Also, the rate of production is increased.

References

Junghare, Hemantkumar, et al. "A Review on cryogenic grinding." Int. J. Curr. Eng. Technol 7.7 (2017): 420-423

Wilczek, Michael, Jürgen Bertling, and Damian Hintemann. "Optimised technologies for cryogenic grinding." International Journal of Mineral Processing 74 (2004): S425-S434.

Singh, K. K., and T. K. Goswami. "Design of a cryogenic grinding system for spices." Journal of Food Engineering 39.4 (1999): 359-368.

Murthy, C. T., and Suvendu Bhattacharya. "Cryogenic grinding of black pepper." Journal of Food Engineering 85.1 (2008): 18-28.

Singh, K. K., and T. K. Goswami. "Cryogenic grinding of cloves." Journal of food processing and preservation 24.1 (2000): 57-71.