Issue 1 vol 4 ISSN: 2321-8134

IJFEAT

INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY

TITLE: CRYOGENIC GRINDING

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Abstract

The title consisting the Two words has their specific meanings, here the word "Cryogenic" means the creation or production by means of cold. And the word "Grinding" means to convert raw materials into very tiny particles or in the powder form. This process is very useful in different industries. In todays date the prices for energy and raw materials is rising continuously. So, for reusing the materials and recycling them the Cryogenic Grinding process is very much efficient. Cryogenic grinding can efficiently grind the most tough materials. The Cryogenic grinding technology cools down the raw materials to 0 to minus 70°F, and then the materials or herbs are powdered. Normal grinding processes other than cryogenic grinding reach up to 200°F, but this may lead to heat up sensitive constituents in the herb, and also can reduce the volatile components. Liquid nitrogen is used in the cryogenic grinding for cooling. For grinding whenever the cooling method is used then the chemical composition does not get damage in case of the herbs. For some materials like rubber and plastic this method is very useful as this can harden the rubber or plastic and then can embrittle it to convert into powder form. Also, at room temperatures there are many materials which are either very soft or very tough. When these get cooled in cryogenic grinding by the use of liquid nitrogen, these may be embrittled and can be converted into the powder form for further processing.

Index Terms: *Cryogenic Grinding, Working, Cryogenic Grinding Experimental Setup, Advantages, Disadvantages, Applications, etc.*

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1.Cryogenic Grinding

It is also known as Freezer milling, Freezer grinding, and Cryomilling, is the act of cooling or chilling a material and then reducing it into a small particle size or in the powder form. For example, thermoplastics and rubber are difficult to grind to small particle sizes at room temperatures. When chilled by dry ice, liquid carbon dioxide or liquid nitrogen, the thermoplastics can be finely ground or to be converted into powders suitable for different powder processes. Cryogenic grinding of plant(herbs) and animal tissue is a technique used by microbiologists. Samples that require extraction of nucleic acids must be kept at −80 °C or lower during the entire extraction process. For samples that are soft or flexible at room temperature like plastic and rubber, cryogenic grinding may be the only capable and successful technique for processing samples.

1.1 Cryogenic Grinding Experimental Setup

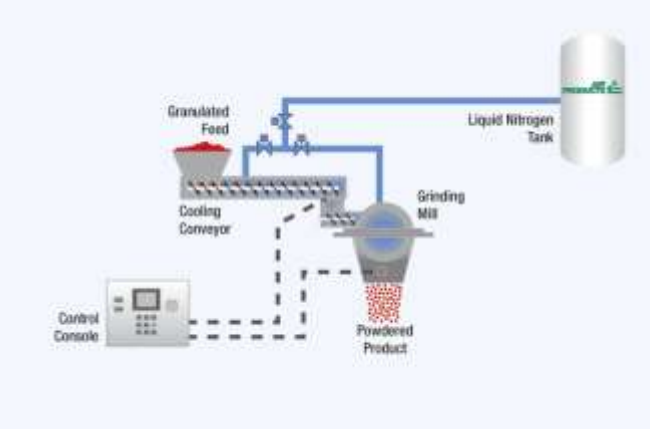


Fig-1: Cryogenic Grinding Experimental Setup

The Cryogenic Grinding system consist of the following equipment's, cooling conveyer, grinding mill, liquid nitrogen tank, control console, gauges etc.

The Cooling Conveyer is placed inside a proper casing which is totally leak proof. It is used because the cooling process occurs in this casing. A liquid nitrogen cylinder is kept near the casing and is connected to the casing with the help of pipes. The casing from other end is connected to the grinding wheel case. The grinding wheel

case is then connected to the blower and it is connected back to the Casing of the screw conveyer.

1.2 Working:

- Raw material is transferred inside the conveyer casing from the upper opening on the conveyer. Sometimes the vibratory motion is also given to the opening of the casing for smooth conveying of the raw materials.
- The casing is continuously cooled using the liquid nitrogen gas. And the raw material is cooled at minus temperature to embrittle it.
- Then the frozen or extremely cooled raw material is then sent to the Grinding wheel by the lower opening of the casing.
- The grinding wheel converts the frozen material into the ground or the powder form.
- The ground wheel casing gives the powder form of the raw material.
- Also, the blower is connected to the screw conveyer casing so that the complete system stays cool without any discharge. And the temperature is maintained throughout the process.
- In this way the Cryogenic grinding system or frizzing milling or freezer grinding work.

Fig-2: Cryogenic Grinding System

2.1 Advantages of cryogenic grinding:

- Production rate is high.
- Lower energy consumption.
- Particle size is finer.
- More uniform particle distribution.
- Grinding cost is low.
- There is not at all the heat generation during the process.
- Due to inert atmosphere the possibility of oxidation is eliminated.
- We get the improved pouring properties due to finely ground material.

2.2 Disadvantage of cryogenic grinding:

- The application of cryogen in moist atmosphere may cause formation of ice around the delivery nozzle and the piping system carrying the cryogen. This may cause a possible blockage in the delivery system of liquid nitrogen.
- The process has Economic considerations, that should be solved.
- It is difficult to fill the Conveyer.
- Maintenance cost high.
- Operation cost is high.

3. Applications of Cryogenic Grinding:

- By adopting Cryogrinding technology, the leading spice industries of our country will earn considerable foreign exchange by exporting more value-added processed spices, in place of exporting whole spices.
- The technique can be easily extended to processing of PVC and industrial waste plastics in view of recycling of non-biodegradable materials.
- Gas Industry - in air separation. The volume of production of nitrogen and Oxygen by cryogenic seperation of air is the important of the separation of air, refrigeration and separation. In the separation column, the difference in the boiling points of the constituents of air is used to separate them out.
- Cryogrinding of steel: the large amount of heat is generated during machining at high speed and feed rate raises the temperature at the cutting zones excessively.
- Adhesives and Wax – To avoid the pliable and sticky of certain materials which is not possible in conventional grinding.
- Explosives: to grind the explosive materials below their ignition temperature.
- Spices: To overcome the volatility of etheric oils (gives the taste and smell of Spices)

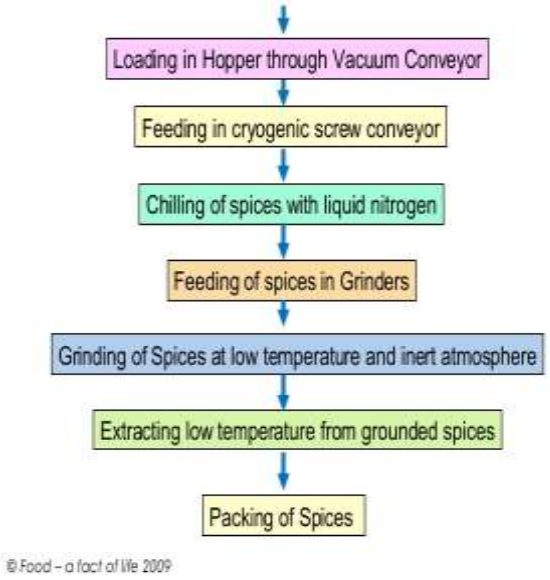
4.Volatile oil content and flavour components:

Table 1: Volatile oil content and flavour components

Sr. no.	Components	Cryoground %	Conventional ground (%)

1	Moisture	13.00	11.00
2	Volatile oil	2.61	1.15
3	Flavour Compounds (relative concentration) α- Pining Limonene	1.40 8.30	0.29 1.18

5.The Flow Chart related to Cryogenic Grinding: Spice Processing Flow Chart:



6.CONCLUSION

From this presentation we have concluded that, the Cryogenic Grinding process is useful to us in many ways. It is an efficient way for recycling and reusing of the tough and hard materials. Also, this process is great for the products like rubber or the other soft materials. This method does not let the raw material to loss its chemical properties unlike the conventional grinding. Due to the day by day increase in the costs of materials, this method is far better for recycling and reusing the waste scrap. It uses liquid nitrogen for cooling purpose. There is other method for grinding like long cycle times which uses high energy and gives less productivity and increases cost unnecessarily which is of no use. So, the cryogenic grinding is the most efficient way for Grinding, for tough as well as soft materials.

7.Acknowledgement:

Every seminar big or small is successful largely due to the effort of a number of wonderful people who have always given their valuable advice or lent a helping hand. I sincerely appreciate the inspiration; support and guidance of all those people who have been instrumental in making this project a success.

I wish to express my sense of gratitude to my Guide Ashish Choube. Jawaharlal Darda College of Engineering and Technology, Yavatmal and The S.G.B.A.U. to give me guidance at every moment during my entire paper presentation and giving valuable suggestions in all the needed ways.

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