PRESENTATION ON

CRYOGENIC GRINDING AND IT'S APPLICATIONS

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INTRODUCTION

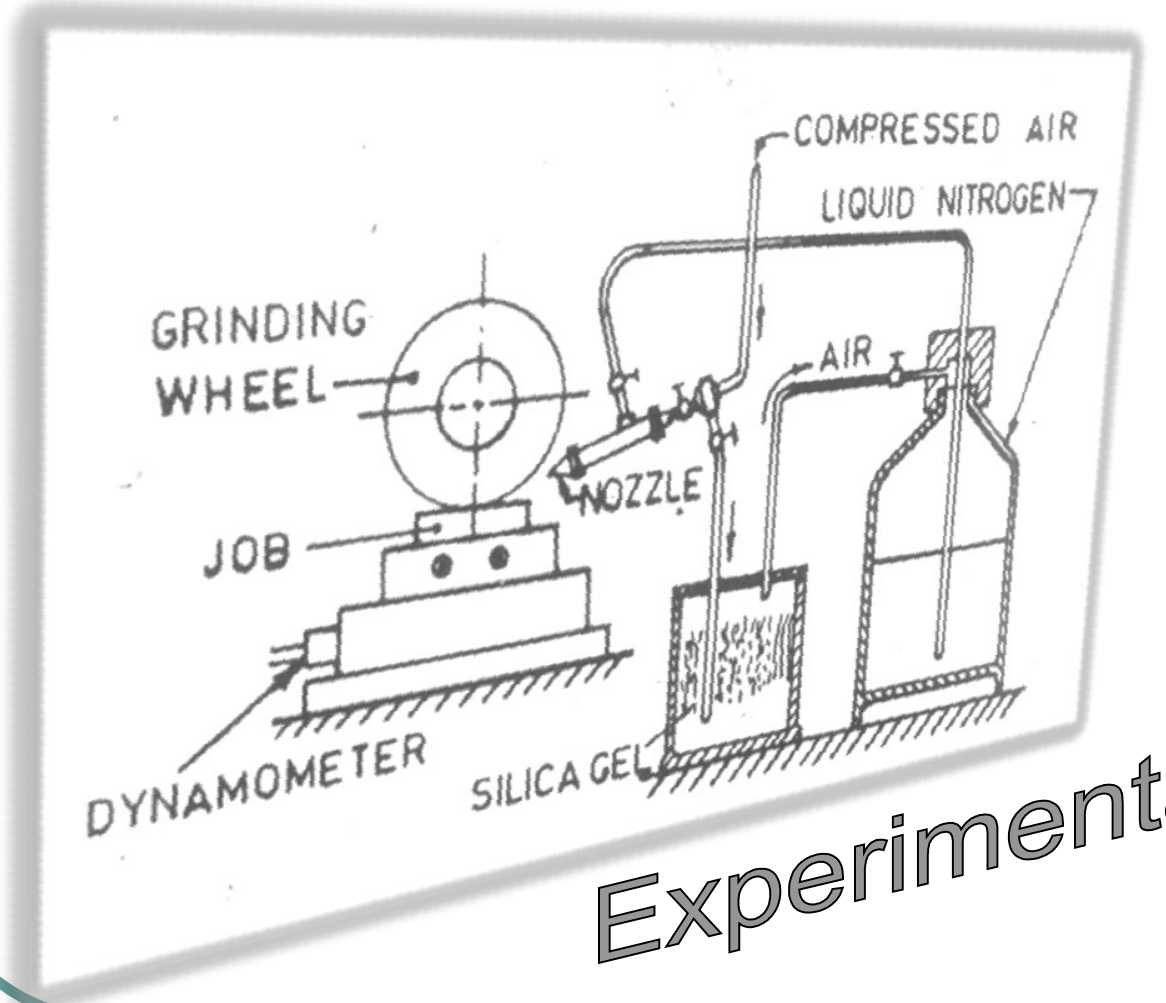
- The word ‘cryogenics’ originates from Greek word ‘cryo’,which means cold.
- Temperatures as low as -180ºC are attained in cryogenic systems.
- The extremely low temperature are produced by using substances called ‘cryogens 'such as liquid nitrogen and liquid helium.
- Cryogens are stored in vessels called as Dewar flask which provides good insulation.

CRYOGENS AND IT'S APPLICATIONS

1. Cryogenic fuels such as liquid hydrogen are used as rocket fuels and propellants.
2. Cryogens are used to achieve superconductivity in metals such as tin and aluminium.
3. Cryogens are used for the preservation of bodies of animal and humans. This process is called as cryopreservation.
4. Cryogens are used in food industry for food handling and processing.
5. Cryogens are used in various machining operations such as cryogenic deburring, cryogenic deflashing, cryogenic tempering and cryogenic grinding.
6. Cryogens like liquid nitrogen are used in special chilling and freezing applications.

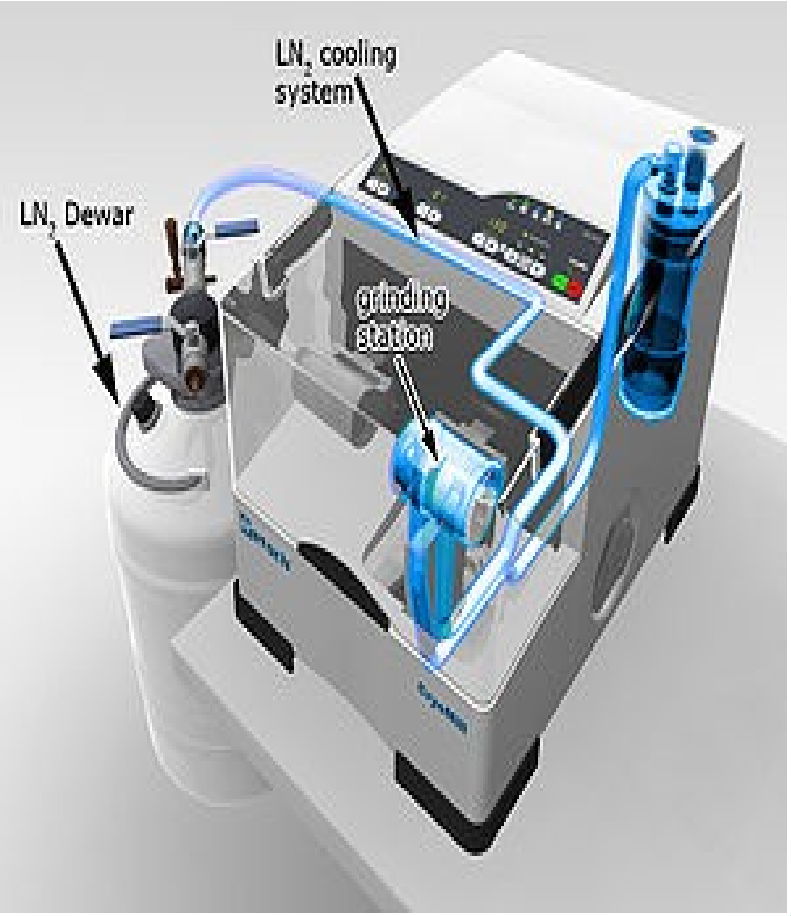
CRYOGENIC GRINDING PROCESS

- Cryogenic grinding , also known as freezer milling/ freezer grinding/ cryomilling is the act of cooling or chilling a material and then reducing it to smaller particle size.
- Almost all materials embrittle when exposed to low temperature. Cryogenic size reduction utilizes the cooling effect of liquid nitrogen to embrittle materials prior to and or during the grinding process.
- Materials which are elastic in nature, which have low melting points, which have low combustion temperatures and which are sensitive to oxygen can be ideally machined by cryogenic grinding process.



Experimental set-up

- A cryogen like liquid nitrogen is applied mostly in the form of a jet. At a low temperature of -196ºC of the cryogen,the temperature is effectively controlled and embrittles the work piece. This enables the grinding of the work piece.



ADVANTAGES OF CRYOGENIC GRINDING

- Higher material removal rate can be achieved.
- Tool wear and tear is minimized to a great extent.
- Grinding forces are reduced.
- Cryogens act as coolant and hence the effects of overheating of the tool and work piece are reduced.
- Materials which are soft and elastic in nature such as rubber can be easily machined with this process.
- Smaller particle size can be achieved.
- Better surface finish and dimensional accuracy can be achieved.

APPLICATIONS OF CRYOGENIC GRINDING

- Cryogrinding of steel :-The large amount of heat generated during grinding at high speed raises the temperatures at cutting zones excessively. Cryogens such as liquid nitrogen will help in reducing the effect of heat on tool and work piece, thereby increasing the life of the tool.
- Thermoplastics :-Nylon, Pvc, Polyethylene, Polypropylene are usually machined using cryogenic grinding to form fine powders.
- Thermo sets :-Synthetic and natural vulcanized rubber and materials such as bakelite can be economically machined with cryogenic grinding and recycled.

- Adhesives and waxes :- Sticky materials such as adhesives and waxes are difficult to machine using the conventional grinding methods. By using cryogenic grinding , they can be embrittled easily and machined into fine particles.
- Explosives :- Explosive materials explode when their temperature increases to ignition temperature in the presence of oxygen. By using cryogens the ignition temperature can be reduced effectively and then be machined.
- Spices :- Spices like pepper ,cinnamon can be powdered by cryogenic grinding which helps in the preservation of the taste and aroma.

DISADVANTAGES OF CRYOGENIC GRINDING

Cryo-grinding do have distinctive advantages over the conventional cooling processes, but…

- 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.
- Economic considerations should be solved.

EXPERIMENTAL STUDY

Best practices in scrap tires and rubber recycling (Conventional versus Cryogenic grinding)

- There are several processes that can be used to produce ground rubber crumb. Two of the most common are conventional grinding using various types of grinding mills and cryogenic grinding of rubber by chilling with liquid nitrogen. The ambient process often uses a conventional high powered rubber cracker mill set with a close nip and vulcanized rubber is sheared and ground into a small particle. Any fiber and extraneous material must be removed using an air separation facility.

Metal is separated using a magnetic separator. The process produces a material with an irregular jagged particle shape. In addition the process generates a significant amount of heat in the rubber during processing. Excess heat can degrade the rubber and, if not cooled properly, combustion can occur upon storage.

- Cryogenic grinding usually starts with chips or a fine crumb. This is cooled using a chiller. The final product is a range of particle sizes which are sorted and either used as is or passed on and further size reduction performed .The cryogenic process produces fairly smooth fracture surfaces. Little or no heat is generated in the process. This results in less degradation of the rubber.

- In addition, the most significant feature of the process is that almost all fiber or steel is liberated from the rubber resulting in a high yield of usable product and little loss of rubber.

Physical Property (rubber)	**Ambient Ground**	**Cryogenic Ground**
Specific gravity	Same	Same
Particle shape	Irregular	Regular
Fiber content	0.5%	nil
Steel content	0.1%	nil

CONCLUSION

- Cryogenic grinding improves product quality by controlling thermal effects.
- Oxidation and surface burning are eliminated.
- Surface damage is eliminated.
- Finer particle size is achieved.
- Material removal rate is high.
- The process is economical in the long run.

THANK YOU