



Cryogenic Grinding of Spices

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Outline of the Presentation

- I. Cryogenic Grinding of Spices
- II. Advantage of Cryogenic Grinding
- III. Schematic of Cryogenic Grinding system
- IV. Examples of Cryogenic Grinding
- V. Parameters required for Cryogenic Grinding
- VI. Time schedule

Problems in conventional grinding process

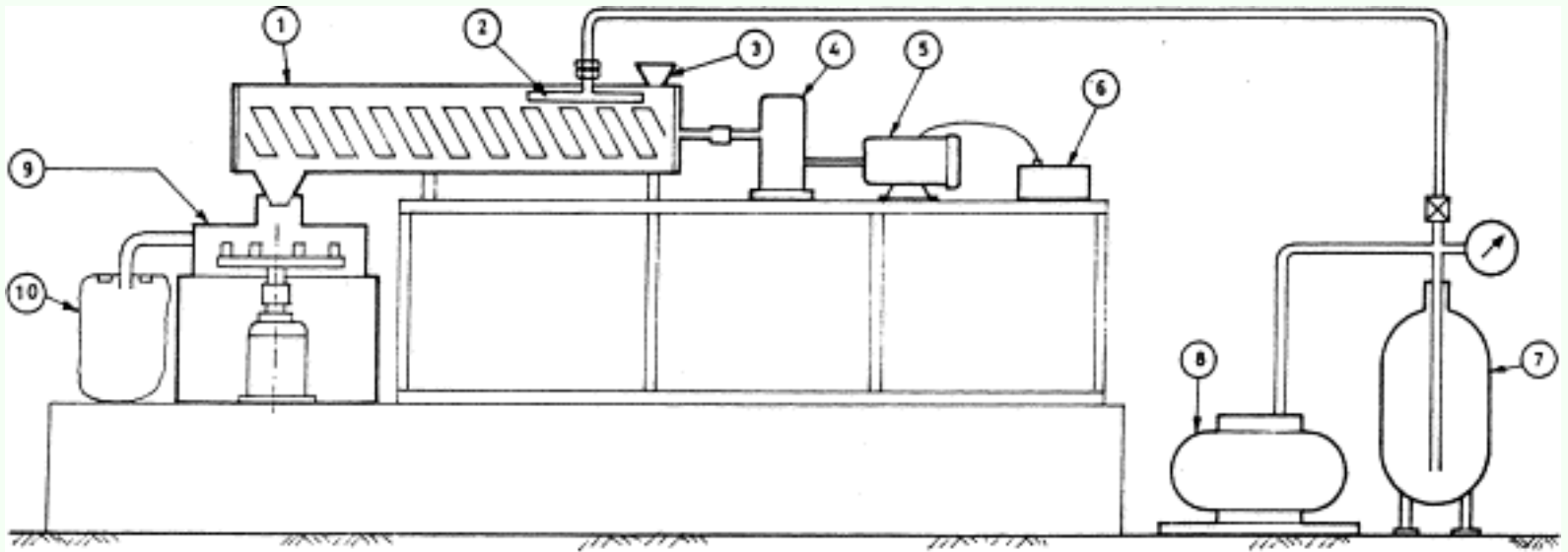
- High heat generation
- Introduction of tensile residual stress
- Clogging and Gumming of the mill
- Oxidation
- Loss of Etheric oil in Spice grinding

Advantage of Cryogenic Grinding

Cryogenic grinding involves cooling a material below its embrittlement temperature with cryogenic fluid. Typically Liquid Nitrogen/ saturated Vapor Nitrogen or in certain applications, liquid Carbon Dioxide is used.

- Increased throughput & power saving, Approx. 2 - 3 times higher grinding capacity
- Finer particle size
- More uniform particle distribution
- Lower grinding cost
- No heat generation
- Provides an inert atmosphere
- Reduced grinding force
- Provide clean and pollution free environment
- Prevent oxidation
- Possibility of fine grinding of difficult spices
- Maintains Aroma, Taste and quality.

Schematic of Cryogenic Grinding of Spices



LEGEND:

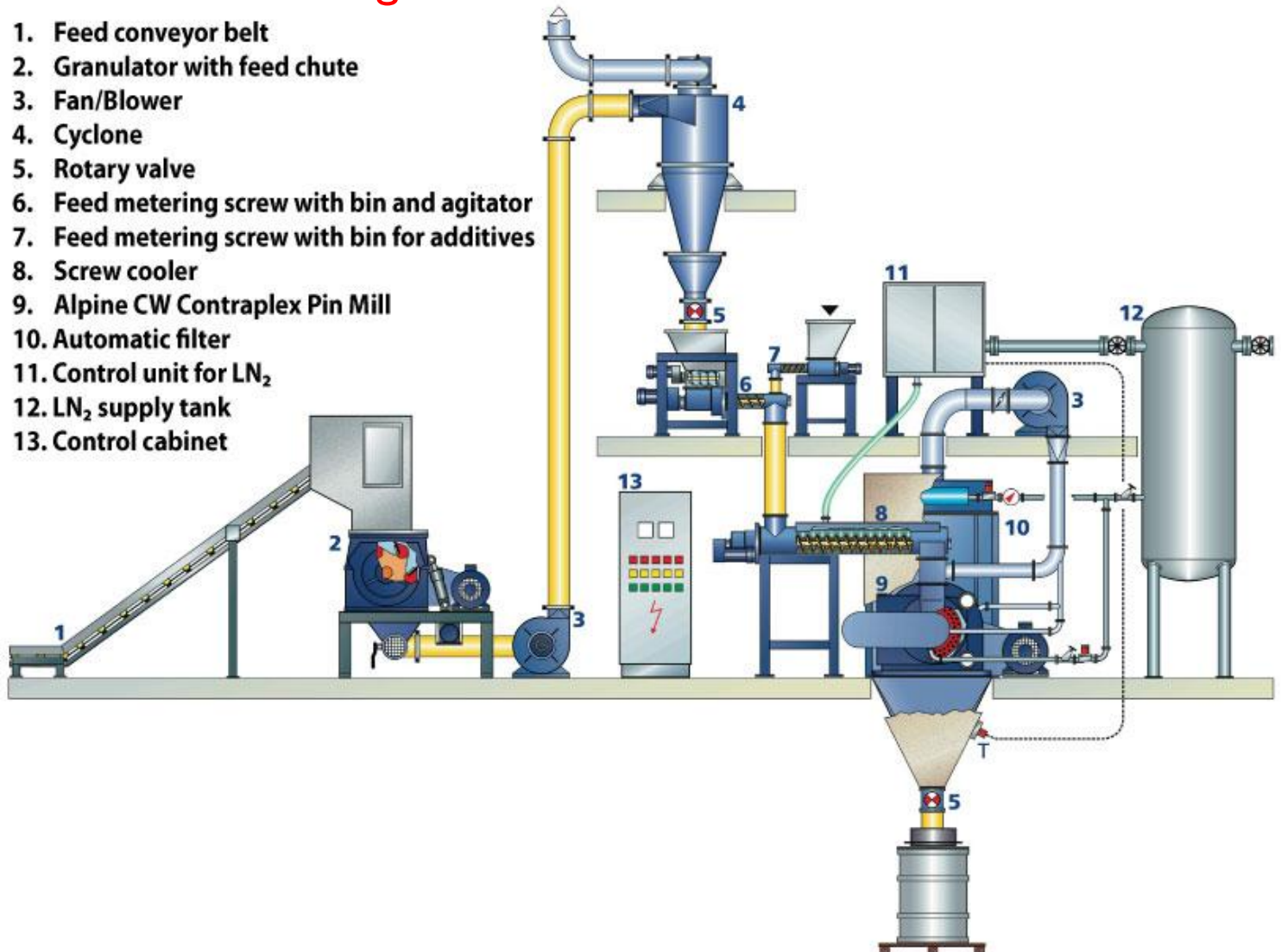
1. SCREW CONVEYOR ; 2. LN₂ DISTRIBUTOR ; 3. HOPPER ; 4. REDUCTION GEAR BOX ; 5. MOTOR ; 6. RECTIFIER ; 7. LN₂ CYLINDER ;
8. COMPRESSOR ; 9. GRINDER ; 10. COLLECTING BAG .



Schematic of Cryogenic Grinding of Spices

Amount of liquid nitrogen required ~0.6-0.8 kg/kg of Spices!!

Cost of LN₂ ~ Rs. 8/ kg



Volatile oil content & flavor component

I. Pepper

SL No.	Components	Cryoground(%)	Conventional ground(%)
1	Moisture	13.00	11.00
2	Volatile oil	2.61	1.15
3	Flavour compounds (relative concentration)		
	Alpha pinene	1.40	0.29
	limonene	8.30	1.18

2. Clove

AMOUNT OF VOLATILE OIL PRESENT IN CLOVE POWDER GROUND CRYOGENICALLY AND AMBIENTLY, mL/100 g OF POWDER ON DRY BASIS

	Cryogenic grinding, °C				Ambient grinding, °C			
	-110	-90	-70	-50	55	65	75	85
Mean	13.3	13.3	13.2	13.2	11.0	10.3	9.9	9.3

In ambient grinding, the volatile oil decreased from 11.0 to **9.3 mL/100g** as grinding temperature increased from **55 to 85C**

The clove could be successfully ground at temperatures below -50C without any deposition over the sieve surface. An increase in temperature in the cryogenic range (-110 to -50C) had no significant effect on volatile oil content,

whereas temperatures in the range of 55 to 85C significantly reduced the volatile oil content from 11.0 to 9.3 mL./100g. Thus, cryogenic grinding resulted in 29.5% more volatile oil in comparison to that of ambient grinding.

Product size control

SPICES



AMBIENT GRINDING



CRYOGENIC GRINDING



Parameters required for Cryogenic Grinding

- Feed in grinder: ~1000kg/hr
- LN2 consumption. ~ 0.5-0.8 kg/kg of spices
- Retention time:
 - Depend upon the moisture content
 - Glass transition temperature for embrittlement
 - Specific heat, Thermal conductivity and thermal diffusivity
- Particle size. We may need to introduce multiple stages of grinding to achieve desired final product. And introduction of cryogenic level in second or third stage.
- Power consumption
- Cost: capital and operational

Projects by INDUS for Cryogenic Grinding

Cryogenic Grinding Machine LIN distribution systems
Capacity: 500-2000 kg/Hr. We supplied the SIVL, Liquid Nitrogen Distribution System and accessories for the supply of LN2 to Cryogenic Screw Conveyer. We also offer LN2 Tanks on demand.

- SATVAM Nutrifoods Pvt. Ltd., Himmatnagar, Gujarat
- NRV foods Pvt. Ltd., Bangalore, for Cryogenic Grinding Machine LIN distribution systems Capacity: 300 kg/Hr.
- Hathi Masala, Rajkot, Gujarat, Capacity 1000 Kg/Hr
- Rakesh Masala, Kanpur, UP, Capacity 2000 Kg/Hr
- Patel Retail Pvt. Ltd, Kutch, Gujarat, Capacity 2000 Kg/Hr
- And many more.....



THANK YOU