Ambient Versus Cryogenic Grinding

Material: Recycled Rubber from Tires, Industrial Scrap Rubber, and Post-Consumer Scrap Rubber Products

Issue: *There are several processes that can be used to produce ground rubber crumb. Two of the most common are ambient grinding using various types of grinding mills and cryogenic grinding of rubber by chilling with liquid nitrogen. This section will review the attributes and properties of crumb rubber produced by both methods.*

Best Practice: Vulcanized scrap rubber is first reduced to a 2" x 2" or 1" x 1" chip. This can then be further reduced using ambient ground mills, or frozen and "smashed," or ground into fine particles while frozen using cryogenic grinding. This best practice will compare the two methods.

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. It is common to produce 10 to 30 mesh material using this relatively inexpensive method to produce relatively large crumb. Several cracker mills are often used in series. Typical yields are 2,000-2,200 pounds per hour for 10-20 mesh and 1200 pounds per hour for 30-40 mesh. The finer the desired particle, the longer the rubber is let run on or in the mill. In addition multiple grinds can be used to reduce the particle size. The lower practical limit for the process is the production of 40 mesh material. Any fiber and extraneous material must be removed using an air separation or an air table. Metal is used using a magnetic separator. The resulting material is fairly clean.

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.

Implementation: Cryogenic grinding usually starts with chips or a fine crumb. This is cooled using a chiller. The rubber, while frozen, is put through a mill. This is often a paddle type mill. The Best Practice on Cryogenic Grinding covers this process in detail. 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 (e.g., using a wet grind method). A typical process generates 4,000 to 6,000 pounds per hour.

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. The price of liquid nitrogen has come down significantly recently and cryogenically ground rubber can compete on a large scale with ambient ground products.

Benefits: The following chart compares the properties and benefits of ambient and cryogenically ground rubbers.

Physical Property	Ambient Ground	Cryogenic Ground
Specific gravity	Same	Same
Particle shape	Irregular	Regular
Fiber content	0.5%	nil
Steel content	0.1%	nil
Cost	Comparable	Comparable

The following chart shows the particle size distribution for two typical 60 mesh ground rubbers. One was prepared ambiently and the other cryogenically.

Amount Retained	Ambient	Cryogenic
30 mesh	2%	2%
40 mesh	15%	10-12%
60 mesh	60-75%	35-40%
80 mesh	15%	35-40%
100 mesh	5%	20%
Pan	5-10%	2-10%

Application Sites: For cryogenic grinding see the Best Practice on Cryogenic Grinding. Ambient grinding is practiced at many locations. Some of the larger ones are Rondy, Spartan, ACM, BAS, National, and many others.

Contact: For more information about this Best Practice, contact the CWC at (206) 443-7746, email info@cwc.org.

References:

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