Jet Mill Grinding

JET mill grinding is a mechanical method of comminution used for reduction of particles into superfine subsieve sizes of particle range. By this is meant maximum sizes of 20–10–5, or less, microns diameter of the particles. The possibility of producing, on a commercial scale, very small particle sizes depends, of course, on the friability of the materials. In general, rubbery, some fibrous, or very resilient materials cannot be handled. Agglomerates of certain materials, such as metal powders, can only be dispersed.

One of the first jet mills for commercial use, the Micronizer, was introduced in the early thirties and has since found widespread use in the grinding of minerals, pigments, and foodstuffs, and even such antibiotics as penicillin and streptomycin. Later types included the Reductionizer and Fluid Energy Reduction Mill, and a new type, the Jet T-Mill. All these mills grind and classify within a continuous chamber.

The older mills use the same principle, passing the material past a series of jets, which introduce fluid streams of high energy into the pulverizing chamber. The applied fluid is transformed into velocity head when it expands to atmospheric pressure within the grinding chamber. Application of the fluid jets causes high-speed rotation of the contents of the chamber, which consist of a relatively small circulatory load of material being acted upon and entrained in the gaseous fluid. No heat is generated in the mill during the grinding process.

The velocity of the gas emitted from the jets may be as high as 2000–3000 feet per second at the nozzle tip, and the load velocities within the mill chamber may vary from 150 to over 400 feet per second. The fluid energy is usually compressed air or superheated steam. Air consumption varies between 15 and 20 cfm to 1500–2000 cfm at pressures of 50–150 psi gauge. Superheated steam may vary between 100 and 5000 lbs/hr, usually at pressures of 75–225 psi gauge. Superheat of air or steam will dry the materials processed.

Except for the new Jet T-Mill, which is a simplified but efficient mill using only two opposed nozzles, which meet head on in a small tubular grinding chamber, the mills employ from four nozzles, in small types, to sixteen in the larger mills.

Methods of controlling particle size are basically dependent upon (1) rotational speed, (2) gas flow, (3) flow of feed material within fairly close limits, and (4) shape and proportions of grinding and classification chambers. Control of the first and second factors is usually accomplished by adjusting the rate of feed or gas pressure and the temperature. Flow of feed material depends on the type of feeder mechanism used. The fourth factor is usually varied experimentally, to adapt mill construction to the processing of a particular product.

In general, the energy cost of grinding to very low micron sizes will range from $1.00 for precipitates or claylike materials, up to $10.00 per ton, and higher, for the less grindable materials. Other materials, such as limestone, will cost about $3.00–$5.00 per ton, but even on some one type of material the range may be wide, depending upon the requirements with regard to the maximum permissible particle size. These figures are energy costs, not over-all grinding costs. Other items of expense are dependent upon scale of operation and local factors, hence gross cost figures cannot be given.

With today's increasing demand from industry and from science for finer particle sizes, jet mills will be widely used in superfine grinding, and their potential importance in the chemical industry has just begun to be appreciated.

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SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948.

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Annual subscriptions, $7.50; single copies, $.25; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, $.50. Special rates to members of the AAAS.

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