Table 10.1 Selection of size reduction mills according to particle properties and product size required

Mohs' 'hardness'	Tough	Sticky	Abrasive	Friable
(a) Fine powder product (< 50 μm)				
1–3 (soft)	Ball, vibration (under liquid nitrogen)	Ball, vibration		Ball, vibration, pin, fuid energy
3–5 (intermediate)	Ball, vibration			Ball, vibration, fuid energy
5–10 (hard)	Ball, vibration, fuid energy		Ball, vibration, fuid energy	
(b) Coarse powder product (50–1000 μm)				
1–3 (soft)	Ball, vibration, roller, pin, hammer, cutter (all under liquid nitrogen)	Ball, pin		Ball, roller, pin, hammer, vibration
3–5 (intermediate)	Ball, roller, pin, hammer, vibration, cutter			Ball, roller, pin, vibration, hammer
5–10 (hard)	Ball, vibration		Ball, vibration, roller	
(c) Very coarse product (> 1000 μm)				
1–3 (soft)	Cutter	Roller, hammer	Roller, hammer	
3–5 (intermediate)	Roller, hammer			Roller, hammer
5–10 (hard)	Roller		Roller	

hardness, toughness, etc. The influences of various process and material variables on selection of a size reduction method are summarized in Table 10.1.

Introduction to size separation

Objectives of size separation

The significance of particle size and the principles involved in differentiating a powder into fractions of known particle size and in reducing particle dimensions have been considered in Chapter 9. Methods for achieving the required size range on a manufacturing scale has been discussed above. Here the methods by which size separation can be achieved are discussed.

Solid separation is a process by which powder particles are removed from gases or liquids, and has two main aims:

1. to recover valuable products or by-products
2. to prevent environmental pollution.

An important difference exists between the procedures known as *size analysis* and *size separation*. The former is designed to provide information on the size characteristics of a powder, whereas the latter is an integral part of a production process and results in a product powder of a given particle size range that is available for separate handling or subsequent processing. Thus, a particle size analysis method such as microscopy would be of no use as a size separation method. However sieving can be used for both purposes.

Size separation efficiency

The efficiency with which a powder can be separated into different particle size ranges is related to the particle and fluid properties and the separation method used. *Separation efficiency* is determined as a function of the effectiveness of a given process in separating particles into oversize and undersize fractions.

In a continuous size separation process, the production of oversize and undersize powder streams from a single feed stream can be represented by the following equation:

$$f_F = f_o + f_u \tag{10.7}$$