Attrition methods

Size reduction range

This is indicated in Figure 10.11.

Roller mill

Roller mills use the principle of attrition to produce size reduction of solids in suspensions, pastes or ointments. Two or three porcelain or metal rollers are mounted horizontally with an adjustable gap, which can be as small as 20 μm. The rollers rotate at different speeds so that the material is sheared as it passes through the gap and is transferred from the slower to the faster roller, from which it is removed by means of a scraper.

Combined impact and attrition methods

Size reduction range

This is indicated in Figure 10.12.

Ball mill

A ball mill is an example of a comminution method which produces size reduction by both impact and attrition of particles. Ball mills consist of a hollow cylinder mounted such that it can be rotated on its horizontal longitudinal axis (Fig. 10.13). The cylinder contains balls that occupy 30–50% of the total volume, the ball size being dependent on feed and mill size. Mills may contain balls with many different diameters as this helps to improve the process, as the large balls tend to break down the coarse feed materials and the smaller balls help to form the fine product by reducing void spaces between balls.

The amount of material in a mill is of considerable importance: too much feed produces a cushioning effect and too little causes loss of efficiency and abrasive wear of the mill parts.

The factor of greatest importance in the operation of the ball mill is the speed of rotation. At low angular velocities (Fig. 10.13a) the balls move with the drum until the force due to gravity exceeds the frictional force of the bed on the drum, and the balls then slide back en masse to the base of the drum. This sequence is repeated, producing very little relative movement of the balls so that size reduction is minimal. At high angular velocities (Fig. 10.13b), the balls are thrown out to the mill wall, where they remain due to centrifugal force and no size reduction occurs. At about two-thirds of the critical angular velocity where centrifuging occurs (Fig. 10.13c), a cascading action is produced. Balls are lifted on the rising side of the drum until their

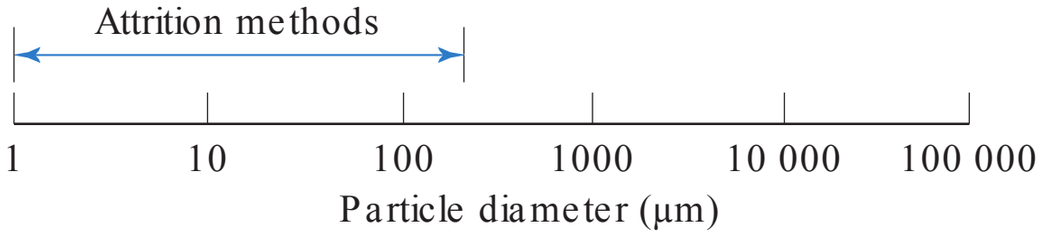

Fig. 10.11 • Size reduction range for attrition methods.

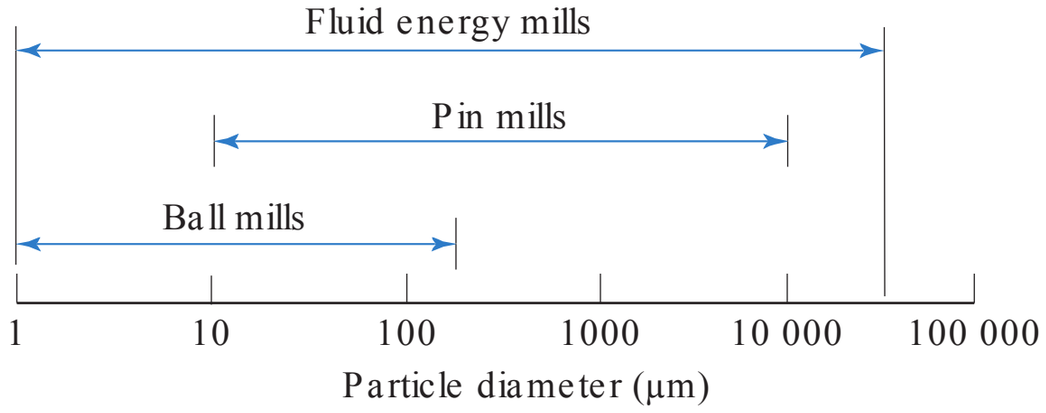

Fig. 10.12 • Size reduction range for combined impact and attrition methods.

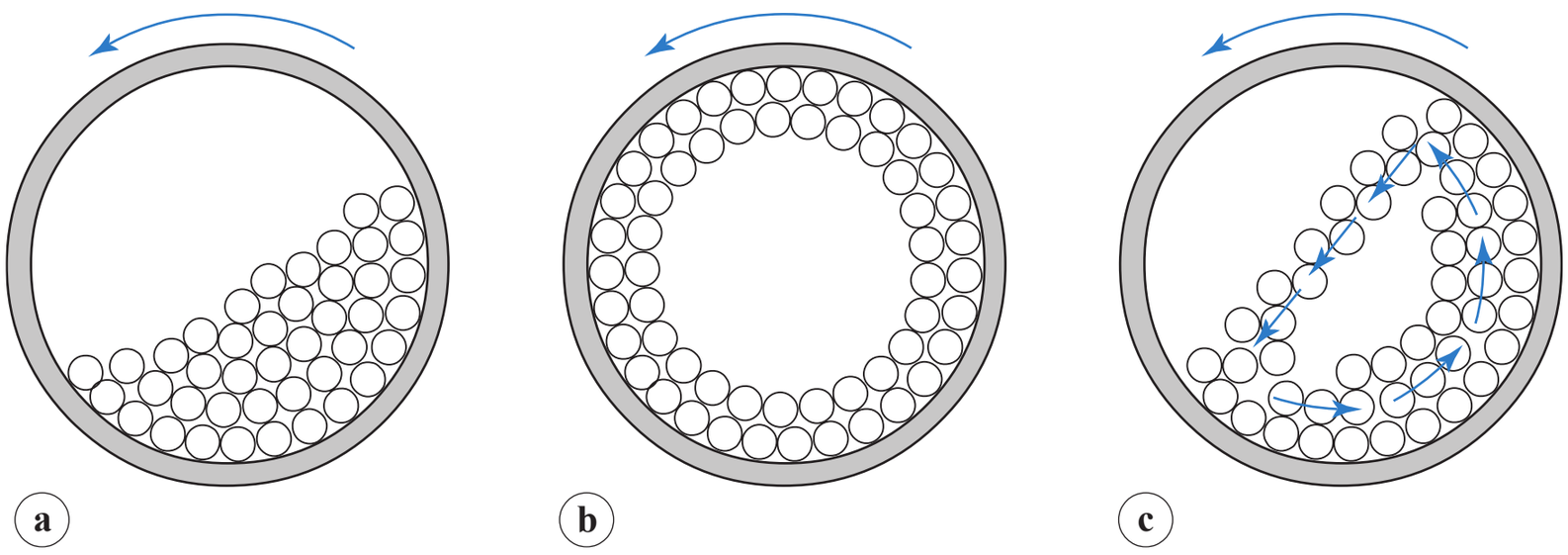

Fig. 10.13 • Ball mill in operation, showing correct cascade action **(c)**.