BALL MILLING / HIGH-ENERGY BALL MILLING

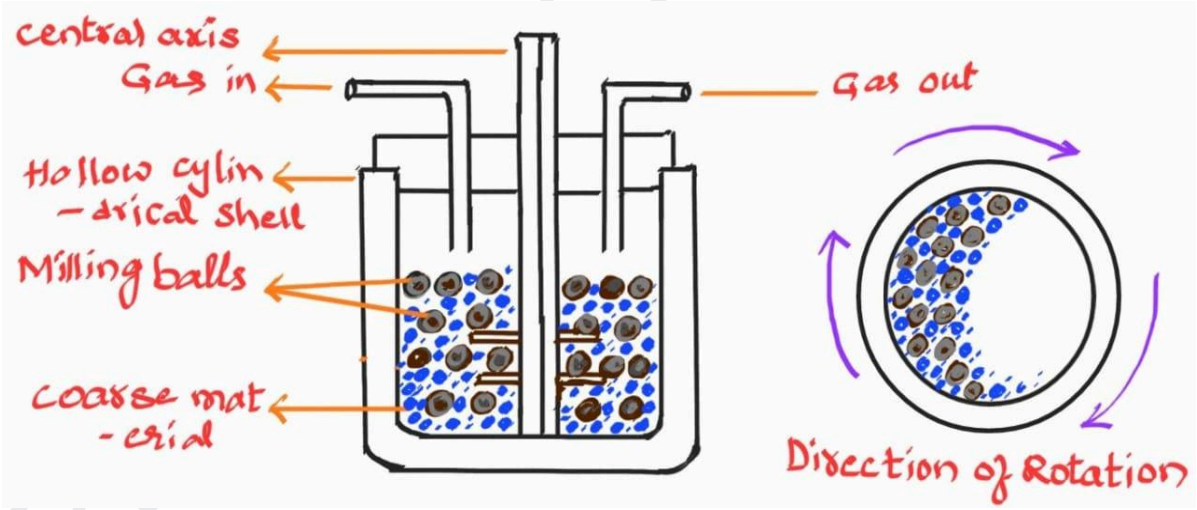
Ball milling :

- Ball milling is a mechanical process of grinding a material into a very fine powder by using a cylindrical device (ball mill) filled with both balls & material.

Principle:

- It works on the principle of Impact & Attrition. Impact force occurs during collision between balls and materials. Attrition force occurs during material grinding which helps in size reduction of material.

Construction:

- It consists of a hollow cylindrical shell rotating about its axis (with horizontal or some angle). This hollow cylindrical shell is filled with balls, made up of steel / tungsten carbide.
- This hollow cylindrical shell is lined with a resistant material such as manganese steel/rubber.
- 

Working process:

- The steps involved in this working process are as follows:

Material Selection and Analysis:

- The first step is to carefully select the material to be milled and understand its properties(such as hardness and abrasiveness). The desired characteristics of the final product, like particle size, shape, and purity.

Ball mill loading:

- Place a desired material of any size along with balls in a cylindrical shell in the ratio of 2:10 and close it with lids.

Process of milling:

- The shell is rotated through a drive gear with speed 60-100 RPM around their own axis as well as around some central axis.
- The speed rotation causes differential moments between the ball & there is a collision between balls and material.
- During this process of impact & attrition coarse material is crushed and reduces its size.

Process Monitoring and Optimization:

- The ball milling process is often monitored to assess the particle size and distribution of the milled material.
- The process can be optimized by adjusting factors like milling speed, duration, and the type of grinding media.
- Ultimately, nanoparticles are formed in the form of fine powder.

Post- treatment:

- The resulting powder may undergo additional treatments such as drying,sieving or surface modification to enhance its properties.

Advantages:

- It is not a time-consuming process.
- Low cost of installation and production
- Grinding medium is cheap/low cost.
- Suitable for both batch & continuous operations.
- It is suitable for materials of all degrees of hardness.
- This method is operated on a large scale.

Disadvantages:

- Low working efficiency and Loud noise.
- Large electricity consumption and Mill feed size
- Contamination by the milling tools & atmosphere can be a problem.