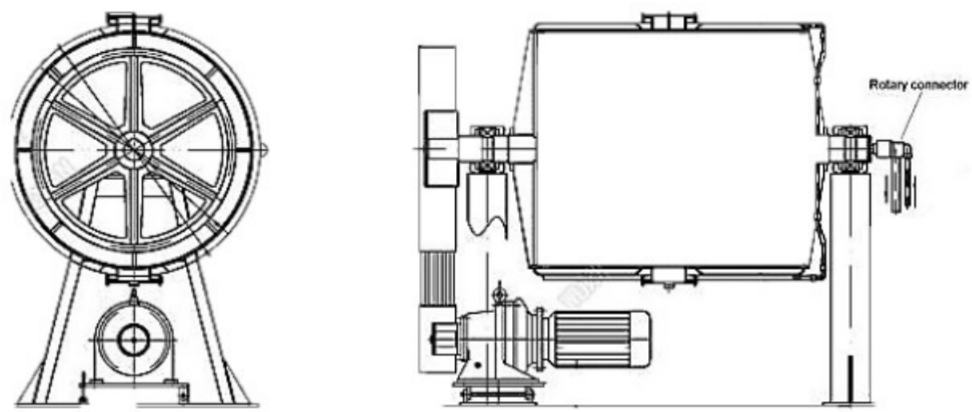
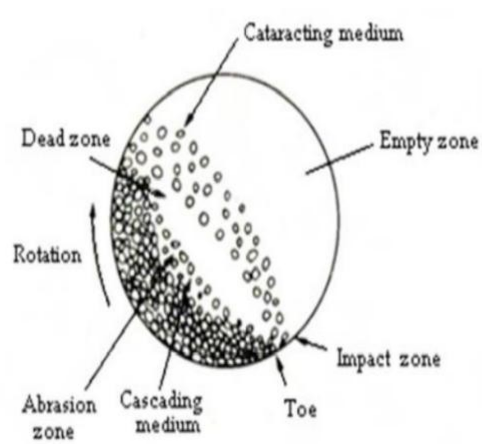
Experiment No. 1

Aim: To determine reduction ratio and critical speed of a ball mill and also determine the energy required for crushing the given feed and thus obtain the work index for the same.



Theory: Action of the grinding is based on impact and attrition. The shell is lined with silica rock and rubber. Centrifugal force keeps the ball in contact with the wall.

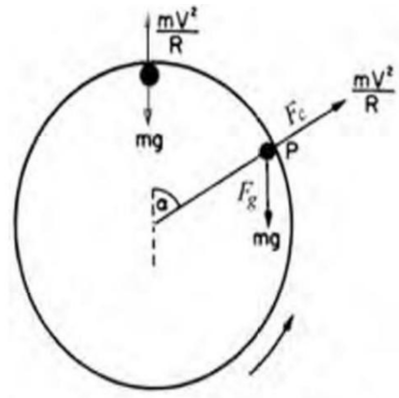


The grinding process is attributed to three different stages of a ball mill:
1. Cascading
2. Cataracting
3. Centrifuging

If the speed of the ball mill is too low then only cascading occurs, and the particles lead to rolling down of the balls and limiting grinding will occur. On the other hand, if the speed of the ball mill is very high (greater than the critical speed) centrifuging occurs leading to little or no grinding. So the mill is to be operated between two extreme speed i.e. below the critical speed of the mill.

Critical Speed: The critical speed is the speed at which centrifuging takes place. In order to do effective grinding, speed should be less than critical speed.

Feed size should be proportionate to the square root of the size of the balls.



Apparatus and materials required:

1) Ball mill experimental setup
2) Sample and sieves (according to feed size)
3) Energy meter
4) Stopwatch

Formulae Used:

1. Energy required for crushing

$$E = \frac{N-n}{m \times EMC} \quad \text{kWh/tones}$$

2. Work Index

$$W_i = \frac{W}{10}\left(\frac{1}{\sqrt{P}} - \frac{1}{\sqrt{F}}\right)^{-1}$$

Where W = predicted mill energy consumption

P, F = 80% passing sizes in μm of feed (F) and product(P)

3. Reduction ratio = Feed Size / Product Size

4. Critical speed of the ball mill

$$N_c = \frac{1}{2\pi}\sqrt{\frac{g}{R-r}}$$

Procedure:

1. The grinding elements are placed in the mill and the mill is allowed to run under no load condition.
2. Time taken for one revolution of the discs in the energy meter is noted for the operations of ball mill under no load conditions.
3. Mill is stopped and about 250 grams of the sample is charged in to the ball mill along with the balls. Before feeding the sample into the mill feed size (D_f) is measured either by volume displacement method or Feret's method.
4. The ball mill is started and allowed to run for 15 minutes.
5. Time taken for one revolution of the disc in the energy meter is noted for the operation of ball mill under on load condition.
6. The sample after crushing is transferred to the sieves and mechanically agitated for 10 minutes.
7. The quantity of sample retained on each sieve is weighed and tabulated as shown in the table below. The screen analysis data is used to determine the mass mean diameter of the product (D_p).

Tabulation:

S.N.	**Sieve Number**	**Sieve opening**	**Average particle size (Dpi)**	**Mass retained**	**Mass function**	**Cumulative mass function**	**Reciprocal of avarage particle size (1/Dpi)**

Observation:

Quantity of feed sample	=	Tones Feed size
D_f	=	mm
Time taken for 1 complete revolution (no load)	=	hr
Time taken for 1 complete revolution (on load)	=	hr
Total time the mill is put to operation	=	hr
Energy meter constants for ball mill	=	

(To be observed from the Experimental Setup)

Result:

Using the Ball mill experimental setup the following were determined:/

1. Energy required for crushing = ... kW hr / ton

2. Work index = ... kW hr mm/ ton

3. Reduction ratio = ...

4. Critical speed of the ball mill = ... rps

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