BOND BALL MILL WORK INDEX TEST LABORATORY PROCEDURE

Ball Mill Grindability Test

The standard feed is prepared by stage crushing to all passing a 6 mesh sieve, but finer feed can be used when necessary. It is screen analysed and packed by shaking in a 1000-cc graduated cylinder, and the weight of 700 cc is placed in the mill and ground dry at 250 per cent circulating load.

The mill is 12 in. x 12 in. with rounded corners, and a smooth lining except for a 4 in. x 8 in. hand hole door for charging. It has a revolution counter and runs at 70 rpm.

The grinding charge consists of 285 iron balls weighing 20,125 grams. It consists of about 43-1.45-in. balls, 67-1.17-in. balls, 10-1.0-in. balls, 71-0.75-in. balls and 90-0.61 in. balls with a calculated surface area of 842 sq. in.

Tests are made at all sieve sizes below 28 mesh. After the first grinding period of 100 revolutions, the mill is dumped, the ball charge is screened out, and the 700 cc of material is screened on sieves of the mesh size tested, with coarser protecting sieves if necessary. The undersize is weighed, and fresh unsegregated feed is added to the oversize to bring its weight back to that of the original charge. Then it is returned on to the balls in the mill and ground for the number of revolutions calculated to produce a 250 per cent circulating load, dumped and rescreened. The number of revolutions required is calculated from the results of the previous period to produce sieve undersize equal to 1/3.5 of the total charge in the mill.

The grinding period cycles are continued until the net grams of sieve undersize produced per mill revolution reaches equilibrium and reverses its direction of increase or decrease. Then the undersize product and circulating load are screen analysed, and the average of the last three net grams per revolution (Gbp) is the ball mill grindability.

When F is the size in microns which 80 per cent of the new ball mill feed passes, P is the microns which 80 per cent of the last cycle sieve undersize product passes, and P_1 is the opening in microns of the sieve size tested, then the ball mill work index Wi is calculated from the following revised (1960) equation:

$$Wi = \frac{44.5}{(P_1)^{0.23} \times (Gbp)^{0.82} \left(\frac{10}{\sqrt{P}} - \frac{10}{\sqrt{F}} \right)}$$

The average value of P at 100 mesh is 114 microns, at 150 mesh it is 76 microns, at 200 mesh it is 50, and at 325 mesh it is 26.7. These values of P are to be used in this equation when P cannot be found from size distribution analyses.

The Wi value from this equation should conform with the motor output power to an average overflow ball mill of 8 ft. interior diameter grinding wet in closed circuit.

For dry grinding the work input should normally be multiplied by 1.30. However, ball coating and packing can increase the work input in dry grinding.

The accompanying procedure and table can be used to shorten the calculations required with the new formula. The values of $44.5/(P_1)^{0.23}$ are listed for each mesh size, and the values of $(Gbp)^{0.82}$ can be found by interpolation from the table. The average P values are listed in the last column and should be used for tests whenever the actual P value is not available from screen analyses.

BOND BALL MILL GRINDABILITY LABORATORY PROCEDURE

1. Prepare sample to -6 mesh by stage crushing and screening.

2. Determine Screen Analysis

3. Determine Bulk Density Lbs/Ft^3

4. Calculate weight of material charge

$$\text{Material Charge (gms)} = \frac{\text{Bulk Density } (Lbs/Ft^3)}{62.4\ Lbs/Ft^3} \times 700\ cc$$

$$\text{Material Charge} = \frac{\text{Bulk Wt. (gm/lit.)}}{1000} \times 700\ cc$$

5. Calculate IPP (Ideal Potential Product) for 250% Circulating Load

$$\text{IPP (grams)} = \frac{\text{Wt. Material Charge (gms)}}{3.5}$$

6. Split feed sample to obtain 8 to 12 samples slightly smaller than IPP. Also split out sample for Material Charge.

7. Place Material Charge and Ball Charge in Mill Run $\underline{x}$ revolutions

   x = number of revolutions based on estimate of work index; usually 50, 100, 150 or 200 revolutions

8. Dump Mill, separate balls and Material Charge. Screen all the material at Mesh of Grind - Weigh Product.

9. Product = weight of Material Charge - weight of Screen Oversize.

10. Net Product = Product - weight of undersize in Mill Feed

11. $$\text{Net grams of product per revolution} = \frac{\text{Net Product}}{\text{No. of Rev.}}$$

12. Add new feed to Screen Oversize (circulating load) to bring up to original weight of Material Charge using split samples.

13. Calculate No. of Revolutions for next period.

$$\text{No. Rev.} = \frac{\text{IPP (gms) - Wt. undersize in feed}}{\text{Net grams/rev. for previous period}}$$

14. Repeat steps 8-14 until net gms/rev. comes into equillibrium (May be steady or jumping, minimum of 5 periods)

$$\text{Circulating Load} = \frac{\text{Material Charge - (Last 2-3 periods) Average Product}}{\text{Average Product (Last 2-3 periods)}}$$

ALLIS-CHALMERS BALL MILL

GRINDABILITY TABLE II

$$Wi = \frac{44.5}{(P_1)^{0.23} \times (Gbp)^{0.82} \times \left(\frac{10}{\sqrt{P}} - \frac{10}{\sqrt{F}}\right)}$$

Gbp	Gbp$^{.82}$	Gbp	Gbp$^{.82}$	Gbp	Gbp$^{.82}$	Mesh Test (Tyler)	44.5/$P_1^{.23}$	Ave P
0.10	0.151	1.75	1.583	4.00	3.120			
0.20	.267	1.80	1.620	4.1	3.180	Feed	-	2100
0.30	.373	1.85	1.655	4.2	3.245			
0.40	.472	1.90	1.692	4.3	3.310	28	10.25	431
0.45	.520	1.95	1.730	4.4	3.370			
0.50	0.566	2.00	1.765	4.5	3.435	35	11.10	323
0.55	.612	2.05	1.800	4.6	3.495			
0.60	.659	2.10	1.837	4.7	3.555	48	12.00	235
0.65	.703	2.15	1.873	4.8	3.620			
0.70	.746	2.20	1.910	4.9	3.680	65	13.00	165
0.75	.790	2.25	1.944	5.0	3.745			
0.80	.833	2.30	1.980	5.2	3.865	100	14.07	114
0.85	.875	2.35	2.015	5.4	3.985			
0.90	.9175	2.40	2.050	5.6	4.110	150 (US 140)	15.23	76
0.95	0.9588	2.45	2.085	5.8	4.225			
1.00	1.0000	2.50	2.120	6.0	4.345	200	16.50	50
1.05	1.0408	2.60	2.190	6.2	4.46			
1.10	1.0811	2.70	2.259	6.4	4.58	270	17.80	32.3
1.15	1.1212	2.00	2.325	6.6	4.70			
1.20	1.161	2.90	2.391	6.8	4.81	.325	18.61	26.7
1.25	1.201	3.00	2.460	7.0	4.93			
1.30	1.240	3.10	2.528	7.2	5.04			
1.35	1.279	3.20	2.598	7.4	5.16			
1.40	1.318	3.30	2.660	7.6	5.28			
1.45	1.356	3.40	2.730	7.8	5.39			
1.50	1.394	3.50	2.793	8.0	5.50			
1.55	1.432	3.60	2.860	8.5	5.78			
1.60	1.470	3.70	2.920	9.0	6.07			
1.65	1.507	3.80	2.990	9.5	6.33			
1.70	1.545	3.90	3.050	10.0	6.60			