A Bond Ball Mill Index Test (BBMWI) is a standard test for determining the Ball Mill Work Index of a sample of ore. The BBMWI is a measure of the resistance of the material to crushing and grinding. It can be used to determine the grinding power required for a given throughput of material under ball mill grinding conditions.

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A BBMWI test is a standard test for determining the Ball Mill Work Index of a sample of ore. It was developed by Fred Bond in 1952 and modified in 1961. The BBMWI is a measure of the resistance of the material to crushing and grinding. It can be used to determine the grinding power required for a given throughput of material under ball mill grinding conditions. It is a ‘locked cycle’ test conducted in closed circuit with a laboratory screen.

The closing screen size is selected so that the product P80 from the test is as close as possible to the product P80 expected from the circuit under design.


A Bond Ball Mill Work Index test may be required for the design of a new mineral processing plant. Where possible, it is carried out on a sample of ore that is typical of the proposed feed to the plant.

The BBMWI is then used in the design calculations of the new grinding circuit. A BBMWI may also be used in the simulation and subsequent optimisation of existing mill(s) and the associated grinding circuit.

In designing and optimising a milling circuit using the BBMWI, the following equations are used (Bond, 1961):

\[
W = 10W_i \left( \frac{1}{P_{80}} - \frac{1}{F_{80}} \right)
\]

and

\[
P = \frac{T * W}{P}
\]

where

- \( W \) = Work Input (kWh/t)
- \( W_i \) = Work Index (kWh/t)
- \( P \) = Power Draw (kW)
- \( T \) = Throughput of New Feed (t/h)
- \( F_{80} \) = 80% passing size of feed (μm)
- \( P_{80} \) = 80% passing size of product (μm)

Based on this equation it is possible to calculate, for example, the specific energy requirement for a given grinding duty, BBMWI, feed size and required product size. It is then possible to determine the size of mill required based on throughput, and therefore motor power.

The standard Bond Ball Mill Work Index test procedure is firstly to stage crush the feed to minus 3.35mm, and size a representative sample. The test then involves a series of batch grinds in a standard Bond mill. A Bond mill is 0.305m by 0.305m, with rounded corners, a smooth lining, and runs at 70rpm. The charge consists of 285 balls, weighing a total of 20.125kg.
Initially, a 700 ml sub-sample of feed is prepared for use in the first batch grind. It is ground in the mill for 100 revolutions. After each batch grind, the contents of the mill are sieved on the selected ‘closing’ screen to remove the undersize. This is replaced by an equal weight of fresh feed to bring the weight back to that of the original charge. This sample is then returned to the mill and ground for a predetermined number of revolutions calculated to produce a 250% circulating load. This procedure is repeated at least 7 times until the weight of undersize produced per mill revolution reaches equilibrium.

The average of net mass per revolution from the last three cycles is taken as the ball mill grindability (Gbp) in g/revolution. A representative sample of product is sized to determine the P80. Finally, the BBMWI is calculated using the Bond equation (1961).

For every Bond Ball Mill Work Index test carried out at JKTech, a standard report is issued. The report details the Bond test procedure method, and presents the results including F80, P80, Grindability and Work Index. Further interpretation of the results is available if required.

### Frequently Asked Questions - Bond Ball Mill Work Index

#### What do the Results mean?

The Bond Ball Mill Work Index provides a measure of how much energy is required to grind a sample of ore in a ball mill. The following table indicates some typical figures, and a relative measure of what they mean.

<table>
<thead>
<tr>
<th>Property</th>
<th>Soft</th>
<th>Medium</th>
<th>Hard</th>
<th>Very Hard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond WI (kWh/t)</td>
<td>7 - 9</td>
<td>9 -14</td>
<td>14 -20</td>
<td>&gt; 20</td>
</tr>
</tbody>
</table>

#### How long does it take?

The usual turnaround time for a BBMWI test is two to three weeks from the time a sample is received until preliminary results are available. This may vary depending on the amount of work already being carried out in the lab, if there are any special requirements, if the material is hazardous, or if the results are required more urgently.

#### How is the required closing sieve size determined?

The rule of thumb is that for a given closing sieve size, the resulting product P80 will be approximately one root 2 series sieve size smaller. For example, if the required product P80 is approximately 106µm then a closing sieve size of 150µm would be used.

#### When is wet sieving required?

Wet sieving is generally required in one of two cases: when the material is likely to agglomerate, or when the closing sieve size is 75µm or less.

#### How does wet sieving affect the test?

Wet sieving will significantly increase the amount of time it takes to complete a test. The test must be carried out on dry material, so at the end of each wet sieving process the sample must be completely oven-dried before the next stage can start. There may also be issues of material degradation either in water or at the high drying temperatures. This should be considered before the test is carried out.

### JKTech Services

- Consulting (comminution, flotation, mineralogy, mining & metallurgy, social responsibility, risk management, and sustainability)
- Specialist Software (JKSimMet, JKSImFloat, JKMultiBal, JKSImBlast)
- Specialist Equipment (ore breakage characterisation, flotation characterisation)
- Metallurgical Laboratory Services
- SMI Knowledge Transfer

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