



DETERMINING THE BOND EFFICIENCY OF INDUSTRIAL GRINDING CIRCUITS

EXECUTIVE SUMMARY

The Work Index (W_i) was defined by Bond as the comminution circuit equipment's needed specific energy input (W , in kWh/t) to reduce ore from a very large size (80% passing, or an F80 of infinity) to a circuit product size of 80% passing (a P80 of) 100 μm . Bond's Work Index Equation then relates all size reduction processes back to this value based on the observation that specific energy is related to the inverse of the square root of the circuit feed and product sizing, as follows.

$$W_i = \frac{W}{\left(\frac{10}{\sqrt{P80}} - \frac{10}{\sqrt{F80}}\right)}$$

In order to specify the design energy (W) input delivery requirements for new plants, laboratory tests were developed and scaled to a large database of plant (crushing, rod, and ball milling) equipment specific energy usages. The outcome of these tests provides Standard Circuit Bond Work Index ($W_{i\text{STD}}$) values of the ore for crushing ($W_{i\text{C}}$), rod milling ($W_{i\text{RM}}$) and ball milling ($W_{i\text{BM}}$). The W values calculated through this process can be totaled for the subsequent stages of crushing, rod milling, and ball milling. The Standard (design) Bond Work Index ($W_{i\text{STD}}$) for the combined stages of this standard circuit may then be back calculated.

A plant circuit's Actual Operating Bond Work Index ($W_{i\text{oACT}}$) is calculated from the respective plant data.

$$W_{i\text{oACT}} = \frac{W}{\left(\frac{10}{\sqrt{P80}} - \frac{10}{\sqrt{F80}}\right)}$$

Comparison of the ratio between the test (or design) value of the Work Index with actual plant operating work index thus provides a measure of that circuit's energy usage efficiency relative to that specified for crushing, rod milling, and ball milling using the Bond test scale-up method.

$$\text{Wi Efficiency Ratio} = \frac{W_{i\text{STD}}}{W_{i\text{oACT}}}$$

The actual plant circuit can deploy any type of size reduction equipment. Thus, this tool can be used by operators and designers to benchmark the energy efficiency of any size reduction circuit, over the applicable size reduction range, that exists in the industry. Examples of calculation of $W_{i\text{oACT}}$ and Wi Efficiency Ratio for different industrial circuits are provided.

Bond Work Index laboratory testing equipment and procedures have been generally described by the developer, Allis-Chalmers Manufacturing Company. However, lack of precise details has resulted in significant variability in test results from the many laboratories (both commercial testing facilities and those at operating mine sites) throughout the world which conduct these tests. This document is intended to provide guidelines to standardize Bond test equipment and procedures and thus to minimize the testing experimental error. This will then minimize plant Bond Efficiency measurement error and maximize the usefulness of this efficiency value for performance benchmarking and process improvement.