

COMMINUTION

Trusted Bench Scale and Pilot Scale Comminution Expertise Across Canada



Grinding is a significant capital and operating cost for a processing plant and often the largest operating costs can be directly attributed to crushing and milling. Ore hardness is measured through bench-scale comminution (grindability) testing, and these test results are used to design comminution circuits. Several grindability tests have been developed for different crushing and grinding applications, and each test has its own strengths and weaknesses. Proper selection of sample(s) for grindability testing is a vital factor that could affect your overall mine plan. It is important to be confident in your greenfield design without the crutch of arbitrary “safety margins”, It is important to be confident in your greenfield design without the crutch of arbitrary “safety margins”; the incorporation of such multipliers unnecessarily increase capital costs and may ultimately make your project uneconomical.

Across Canada, SGS has three metallurgical facilities which delivers the best solutions to grinding circuit design, optimization and production forecasting. In the early stages of a project, SAG Power Index (SPI®), Bond ball mill grindability and JK drop weight tests are used to characterize ore samples. For subsequent design simulations, SGS’ IGS and JKSimMet are used. For production forecasting, a more rigorous model of the orebody is created using the geometallurgical methodology pioneered by our geometallurgical group. Design uncertainty is quantified using statistical techniques.

To maintain high quality and reliability of results, international round robin campaigns are routinely conducted on tests controlled by SGS. We have established a strong and vast experience in comminution, relying supported by a team of skilled and committed team to dedicated to providing quality work and reliable results. In addition to grindability



testing, SGS also offers support in sample selection, grinding circuit design, throughput forecasting studies, as well as grinding circuit plant audits and optimisation.

BENCH-SCALE TESTING

Grindability circuits are typically determined by conducting a combination of grindability tests including:

- SAG Power Index (SPI)
- Bond Ball Mill Grindability Test
- Bond Rod Mill Grindability Test
- Bond Low-Energy Impact Test
- Bond Abrasion Test
- Modified Bond Ball Mill Test (ModBond)
- JK Drop-weight Test (DWT)
- JK Abrasion Test
- SMC Test
- MacPherson Autogenous Grindability Test
- High Pressure Grinding Roll (HPGR)
- Static Pressure Test (SPT)

SIMULATIONS

Simulations are performed to evaluate plant parameters, which are of specific interest to you. The deliverables of the simulations are typically the grinding mill(s) equipment sizing. When JKSimMet is used for designing the circuit, the material balance projection including flow rate, water rate, % solids, particle size distribution can be used to size the additional equipment such as pumps, water supply, screens, crusher, cyclones, etc. The predicted plant performance (power draw, kWh/t and operating work index) is also presented as a product of for each simulation. For Greenfield design of an AG/SAG-ball mill circuit with JKSimMet, the additional power requirement in the ball mill(s) is determined with the Bond ball mill work index and the phantom cyclone technique.

SGS

We offer two in-depth simulation options that can help suit your comminution circuit needs.

Integrated Geometallurgical Simulator (IGS)

To mitigate risk and optimize your plant, we offer you the Integrated Geometallurgical Simulator (IGS) tool. IGS simulates comminution and flotation circuits either separately or as combined processes. Using previously determined results from bankable SGS comminution and metallurgical test work, IGS enables you to easily see how changes made to any part of your grinding or flotation circuit will affect your overall performance. IGS can be used for a variety of purposes including plant design and scenario testing, energy optimization and production forecasting.

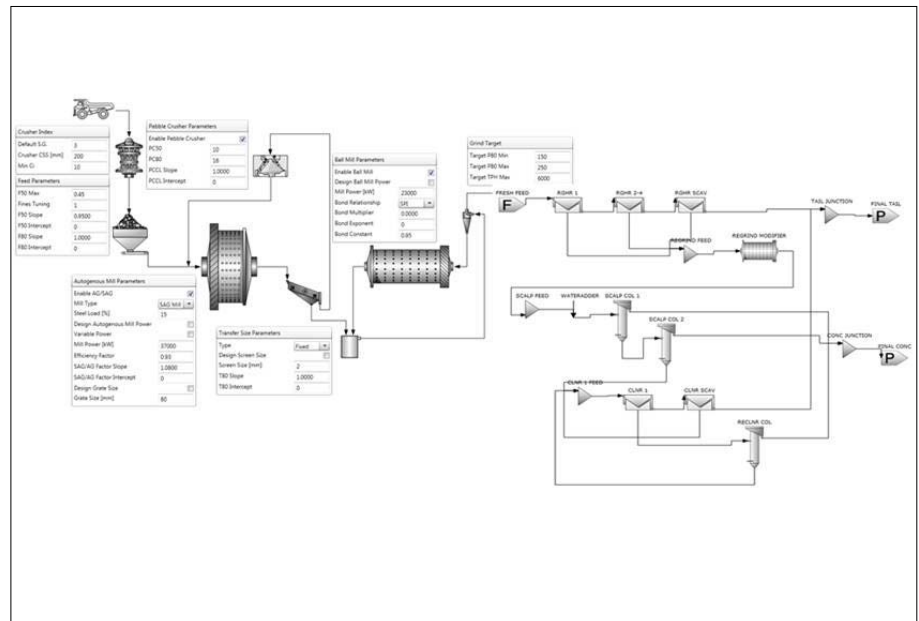
Once you have completed the necessary SGS testwork to obtain the required input parameters, you can simulate your existing comminution and/or flotation circuits using IGS.

You can manipulate your operating conditions, perform basic circuit layout changes and see how these changes affect the circuits and final product quality. Such modeling will allow you to make decisions that will ensure that your operations run at peak efficiency. IGS enables a geostatistically sound mill circuit design with optimized equipment selection and an accurate prediction of power consumption.

Upon downloading the IGS software, you can draw and configure your circuit based on two data types:

1. Operational data: This is day-to-day information that you gather from your plant. For comminution circuits, these include:

- Circuit configuration
- Installed power
- Grate and screen sizes
- Average circulating load
- Average mill load



2. Ore characterization: These are the input parameters determined from your samples using SGS bench-scale testwork. Ore characterization data for your comminution circuit includes results from:

- Bond ball mill grindability test
- ModBond grindability test
- SAG Power Index (SPI)
- Static Pressure Tests (SPT)

JKSimMet Simulations

JKSimMet computer simulations are used to investigate the ore response to various parameters including:

- Mill dimension
- Mill throughput
- Ball sizes and charges
- Flowsheet configurations
- SAG classification
- SAG grate (and pebble port) configuration
- Ore hardness
- SAG feed particle size distribution
- Mill speed (e.g. ore hardness vs. mill speed)

PILOT PLANT TESTING

Due to the size, complexity, or desire for absolute minimum start-up time or maximum efficiencies, there is no other substitute for pilot plant testing. Our comminution pilot-plant capabilities are headlined by the 1.68 m (6') diameter, fully instrumented Nordberg autogenous mill, followed by a wide variety of pilot rod and ball mills. For evaluation purposes, our circuit configurations include:

- AG
- SAG
- ABC or SABC
- Pebble milling

The circuit employs an integrated Bailey Distributive Control System (DCS) for monitoring plant conditions. Feed rate, mill speed, power, mill load, particle size distribution and other data are updated, trended, and recorded automatically for later retrieval. This fully instrumented pilot plant allows the circuit to be brought to steady-state rapidly and avoids wasted sample and pilot plant time. We have completed more than 150 pilot plant programs using this equipment. Shell extensions of 1' and 2' can be added to the 6'x2' SAG mill, in order to lower aspect ratio mills of 6'x3' or 6'x5'.

A typical test program involves investigating the ore response to fully or semi autogenous grinding, as well as the effect of pebble crushing. Other variables

such as the effect of pre-crushing the SAG mill feed, grate size, open area, classification size, ball diameter or ball charge, total mill load, mill speed, etc. can be investigated at pilot plant scale. All tests are evaluated based on:

- Feed rate
- Power consumption
- Product size analysis

Unless single-stage autogenous grinding is considered, we recommend that the secondary ball or pebble mill circuit be operated in all tests to provide overall power data and to optimize the operation of the secondary mill to obtain the desired fineness of grind. Continuous beneficiation piloting can also be coupled with the comminution pilot plant if required, to confirm and optimize the beneficiation process and produce representative concentrate or tailings for down stream testwork.

ON-SITE INVESTIGATIONS

Grinding Circuit Audits

SGS routinely provides audit and optimization programs for existing grinding circuits to ensure maximum efficiency in your plant. Working directly with your plant staff to understand the practical aspects of your operation, we perform on-site testing and evaluation, including a review of your mine plan and historical data analysis.

SGS has over 300 grinding circuit benchmark surveys in our database to date. These on-site campaigns typically consist of several surveys of a grinding circuit while milling the different ore types or the deposit. The deliverables from such work are:

- Fully calibrated computer models for off-line investigation of optimization options or production forecasting purposes
- Specific recommendations on how to improve the operation of the grinding circuit based on observations and data collected during the benchmark campaign
- Comparison of the efficiency of primary and secondary mill operation to similar plants in our database



With our approach, you will truly optimize the comminution design for your orebody and maximize your return. You will know exactly what the uncertainty is in your design and you will be able to add just the right amount of safety margin – and no more.

SUMMARY

Ensuring that your ore hardness is properly determined, and effective communications are designed are vital for your project success. SGS has a proven track record from providing trusted comminution results to the mining industry. Our team isWe are ready to discuss your comminution needs with your team about your comminution needs. Contact us today to learn more about how we can assist you today.



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WHEN YOU NEED TO BE SURE

SGS