BENEFICIATION

SGS MINERALS SERVICES' EXPERTISE WITH BENEFICIATION

Beneficiation is the process where ore is reduced in size and gange separated from the ore. Since all iron ore deposits have unique mineralogy, the beneficiation process is specific to each deposit. Separation of certain minerals can be efficiently achieved by taking advantage of the physical, electrical and magnetic properties.

SGS provides a comprehensive range of test work services for the minerals sector. Our extensive global network of laboratory and metallurgical testing facilities support most of the processes that are used in the exploration and treatment of most metals and commodities globally. All physical separation techniques can be tested at SGS, both on the laboratory and pilot plant scales. We have expertise in the following beneficiation techniques including:

- Scrubbing
- Crushing
- Gravity and magnetic separation
- Selective flocculation
- Flotation

SCRUBBING

Scrubbing is the process whereby clays, slimes and any potential oxidization present in or on the ore typically using water. Scrubbing conditions the ore surface for further beneficiation. Crushing and grinding are preformed after the scrubbing stage

SAG POWER INDEX (SPI®) TEST

This test includes the SAG Power Index (SPI®) and Crusher Index measurements. The SPI® is a measure of the hardness of the iron ore from the perspective of semi-autogenous milling. The CEET Crusher Index (Ci) is used to predict the SAG feed size distribution of the ore, and is measured during the SPI® feed preparation procedure. It requires 10 kg of minus 2-mesh material that is preferably prepared at the testing facility.

BOND BALL MILL GRINDABILITY TEST

The Bond Ball Mill Grindability Test is performed according the original Bond procedure. It requires 10 kg of minus 6-mesh material that is preferably prepared at the testing facility. The Bond Ball Mill Work Index has been widely used for ball mill sizing, and is also utilized in computer simulation.

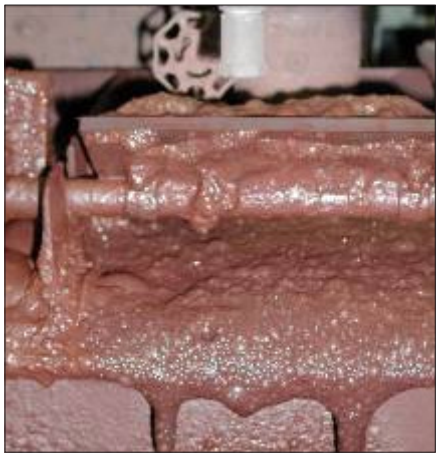
BOND ROD MILL GRINDABILITY TEST

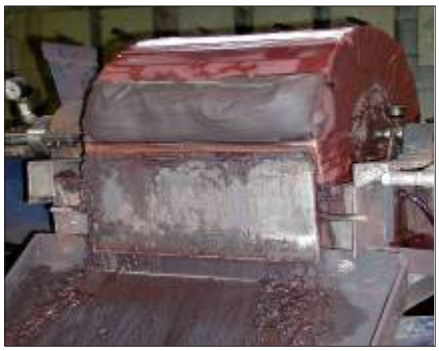
The Bond Rod Mill Grindability Test is also performed according to the original Bond procedure. It requires 15 kg of minus ½ mesh material that is preferably prepared at the testing facility. The Bond Rod Work Index has been widely used for rod mill sizing.

JKTECH DROP-WEIGH TEST

The JKTech Drop-Weight Test measures the apparent breakage function of the ore under a range of impact breakage conditions, which is subsequently reduced to two parameters: A and B. As part of the procedure, the abrasion characteristic of the sample (ta) is also measured. The apparent function can be used in the JKSimMet modeling and simulation package to predict how the ore breaks in the AG/SAG mill and crusher models.

Bench scale testing provides a reasonable compromise, providing valuable grinding data at a fraction of the cost of piloting. At the bench scale stage, SGS can perform a full suite of grinding tests, however piloting is the most reliable method of demonstrating a flowsheet. Our grinding experts travel around the world to assist you with comprehensive grinding expertise you can depend on.



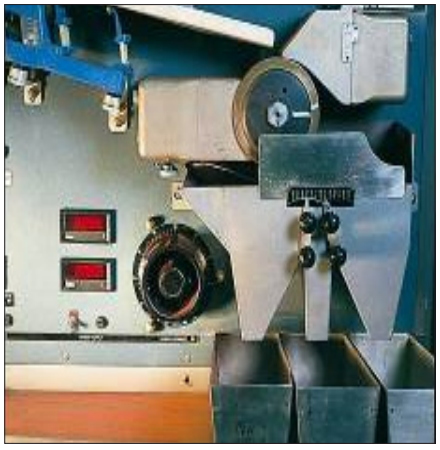


GRAVITY SEPARATION

Gravity separation is the best proven and accepted technique of concentrating many minerals and has been used as a primary form of mineral concentration for decades. Because of its high efficiency and low cost, gravity separation is always the first consideration in a flowsheet development program and always features in any flowsheet where there is sufficient differences between the specific gravity of the valuable and gangue minerals.

Spirals are the most practical equipment to use for gravity separation when high throughput is needed. SGS has a variety of spiral test rigs, including the mineral specific designs. Our accessory equipment allows sizing of feeds, multiple spiral stages, and recycling of products. Other gravity separation equipment, such as shaking tables, Falcon and Knelson centrifugal separators, Mozley MGS units and hydrosizers, are also available.

In certain circumstances, dense media separation followed by complex gravity circuits, in conjunction with multi gravity separation and/or other separation techniques, is required to provide effective low cost solutions to allow the optimal economic recovery of complex iron ores. With our array of equipment and experience, SGS can readily provide bankable cost effective processing flowsheets and advise on operational best practices during plant start up based on our extensive production experience.



MAGNETIC SEPARATION

A full range of magnetic separators is available, from low intensity drum separators to high gradient/high intensity separators, and for either wet or dry feeds. Separation is achieved by exploiting differences in the magnetic susceptibilities of the component minerals. There are four basic types of separator designed to exploit differences in the magnetic properties from the simplest low intensity unit for separating magnetite to high intensity/gradient units for removing minor impurities.

SGS has a wide selection of separators for bench and pilot scale testing, so we can meet a wide range of requirements. The equipment can either be used in stand-alone mode or integrated with other separation processes. In addition SGS has additional capabilities in magnetic and electrostatic separation.

Magnetic separation is used in many flowsheets. SGS metallurgical group has wide experience in the application of magnetic separation to the beneficiation of materials and its integration within the process flowsheet. SGS can:

- Provide expertise to assist with the commissioning of the magnetic separators within your process
- Conduct audits of your existing operations

- Provide trouble shooting/diagnostic assistance to overcome processing problems
- Assist with the development of existing magnetic separators to meet new process challenges.

SELECTIVE FLOCCULATION

Flocculation is used for the removal of clays and gangue with the use of liquid reagents. The technique of flocculation can be used to separate visible sediments and materials and to treat colloids. A colloid is a solution which looks uniform, but actually consists of one or more components blended together. Selective flocculation is accomplished through the employment of partially carboxylated polyacrylamides or other reagents as the selective flocculant.

FLOTATION

SGS has extensive experience designing and installing flotation systems. SGS flotation experts understand how to integrate, design, fabricate, commission, maintain and troubleshoot flotation circuits. We have been involved in the design and construction of many iron flotation circuits globally.

Our core philosophy is to understand the variability of the ore parameters that affect flotation performance and then design, optimize or forecast based on these parameters. We can determine flotation kinetics, appropriate reagents, and perform computer modeling to design and optimize your system. We combine new and conventional technologies to ensure you receive the best results in the most cost effective manner.

THE FLOTATION PROCESS

A standard flotation circuit starts by separating the scrubbed ore into a coarse (for example +20 mesh) and fine (-20 mesh) portions. To design optimum flotation circuits, we must understand your processing needs, and the technical and mineralogical characteristics of your ore. Successful flotation involves proper liberation, adding the proper reagents to induce selected minerals to become hydrophobic (water repelling) or hydrophilic (water attracting). Aeration (bubbles) is added through spargers at the bottom of the flotation cell. The bubbles attract and then float the hydrophilic minerals, leaving the hydrophobic component in the underflow as tailings. Your flotation circuit then will concentrate and separate numerous minerals including:

- The isomorphous minerals sylvite (KCl) from halite (NaCl).
- KCl from other sulfate minerals (kieserite, kainite, schoenite, carnallite, etc.).
- Apatite from carbonate minerals.

Once the flowsheet has been fine tuned and optimized, we provide you with circuit options that trade-off upfront capital expenditure and/or operating flexibility with grade-recovery performance. Our technical team will ensure that you receive a bankable custom flowsheet design that meets your recovery targets and incorporates flotation equipment of the proper sizing and configuration.

CONCLUSION

SGS offers you the unique advantage of combined skill sets and industry expertise that you won't find anywhere else. Our global network of labs and facilities offer beneficiation expertise to help you ensure higher product quality, improve recovery, reduce costs and improve revenue.

CONTACT INFORMATION

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