Comminution service offering
Minerals Processing Division
Mintek
The Commination Group consists of a highly skilled and experienced team that focuses on development of total commination solutions for various types of ore according to the client’s needs. The services available include bench and pilot scale test work, comminution circuit simulation and optimisation, plant survey and sample preparation. Testwork are conducted at Mintek facility located in Johannesburg, South Africa. A team of engineers is also available for on-site plant survey of industrial units operating within and outside of South Africa. A client centred approach is adopted when initiating and handling projects. Based on the client’s requirements a testwork programme is developed that is tailored to the unique nature of each project. Upon completion of test work Mintek provides the client with a detailed service report that can be used as input into a bankable feasibility study.

Overview of Main Services Provided by the Mintek Commination Group

**Bench Scale Commination Test Work**
- Bond Work Index Testing
  - Bond Ball Work Index
  - Bond Rod Work Index
  - Bond Crushability Work Index
  - Bond Abrasion Work Index
- JK Tech Testing
  - JK Drop weight Test
  - SAG Milling Commination Test (SMC)
- Advanced Media Competency Test (AMCT)
- Mintek SAG design test
- Uni-axial Compressive Strength Test (UCS)
- Point load test
- Grindmill and stirred mill Tests
- Scrubbing testwork
- HPGR using the Polysius Labwal unit
- Other Bench scale Test Work
  - Rheology
  - Steel balls and ceramic media wear test
  - Impact tests
  - Piston die testwork

**Commination Pilot Plant**
- AG/SAG Pilot Milling
  - Mill dimensions: Ø1.7m x 0.6m length
  - Typical throughput 0.5 - 3.5 t/h depending on ore characteristics and circuit
  - Accurate instrumentation for feed rate, charge mass, and mill power
  - Incorporation of pebble crusher possible
- Ball, Rod, Pebble Pilot Milling
  - Mills of different dimensions ranging from Ø0.94m x 1.5m length to Ø 0.4m
  - Typical throughput 0.3 - 3.0 t/h depending on ore characteristics and circuit
  - Accurate instrumentation for feed rate and mill power
- Classification using:
  - Hydrocyclones of different dimensions
  - Derrick screen using polyurethane panels
  - Pilot Screens and Spiral classifiers
- HPGR
  - Pilot scale Köppern HPGR with a diameter of 1 m and a width of 0.25m. The unit is fully instrumented.
- Fine and ultrafine milling using:
  - Metso SMD
  - Deswick mill (25 litre)

**Circuit Simulation, Plant Survey and Optimisation**
- Circuit Modelling
  - Set up population balance circuit models based on bench scale, pilot scale, or actual plant operating data (through plant survey).
  - Services includes:
    - gathering of data
    - reconciled mass balancing
    - modelling of full circuit with different unit operations
- Plant survey and optimisation
  - Simulating different circuit configurations and providing recommendations on steps to take to improve on plant performance related to throughput, energy consumption, and process efficiency.

**Sample Preparation**
- Sample drying and sorting up to 500t capacity
- Pilot-scale crushing and screening from -150mm to -6mm
- Laboratory crushing units up to 2t/h capacity
- Run of mine sizing to below 38µm
- Particle sizing down to 1µm
- Sample blending using various techniques
- Viscosity measurement
- Particle density and bulk density of samples
- Preparation of standard analytical samples
Mintek offers a wide range of **standard bench scale comminution test work services** which includes determination of various Bond Work Indices, Uniaxial Compressive Strength, JKTech Drop weight and SAG Mill Commination (SMC) tests, point load testing and Advanced Media Competency Test (AMCT). Mintek also provides **specialised bench scale test work services** related to ball mills (Mintek grindmill test), SAG mills (Mintek SAG design test), stirred media milling, scrubbing, HPGR milling, and crushing.

**Bond Work Indices:**
Service offering includes Bond Ball (BBWI), Bond Rod Work Index (BRWI), Bond Abrasion Index (AI) and Bond Crushability (Impact) Work Index (CWI) testing. BBWI and BRWI tests are conducted at Mintek's facility.

**Advanced Media Competency Test (AMCT):**
This test developed by Orway Minerals Consulting (OMC) provides information on competency of ore as a grinding media and provides information for design of Autogenous mills. The batch mill used for the test has a diameter of 1.83 m

**Laboratory Scrubbing testwork:**
Batch laboratory scrubbing testwork are conducted using a scrubber having a diameter of 1 m. The variable speed unit is fully instrumented to record the power drawn. Data generated can be directly scale-up to design an industrial scale scrubber

**Point load test:**
The Point load testing has been used for many years to determine rock strength in geotechnical practice. Data generated can be used in variability studies to classify ores in different domains.
**JK drop weight test:**
Mintek is accredited to conduct test work for full, partial Drop weight and SMC tests. Results of test work are submitted to JK Tech and a report is issued based on the data generated.

**Grindmill Tests:**
Grindmill test work provides data for the determination of selection and breakage functions required for conducting ball mill population balance simulations. Mintek is equipped to conduct grindmill test work on both ball and rod milling setups. The equipments used are fitted with instrumentation for accurate measurement of power and speed. Batch mills of different dimensions from 0.6m of diameter to 0.265m using seasoned ball charge are used. Data generated at different energy input for a specific ore (selection and breakage functions) can be used to predict a ball mill performance in different circuit configurations (open or closed circuit) or the power requirement to achieve a target grind.

**Stirred mill test:**
Tests conducted are similar to the grindmill tests and are used for fine and ultrafine grinding. Ceramic media of different size and density are used. The power draw and speed are accurately recorded to determine the specific energy input per test.

**Impact Tests:**
Breakage of coarser single rock at different energy input is investigated using the impact tester available at Mintek. Coarser rocks ranging from 212 to 75 mm are tested and data generated are used to integrate the size effect into the breakage of rocks in order to improve the accuracy of breakage predictions.
**Mintek SAG design test:**
Mintek SAG design test is a dry locked cycle test conducted in a 600 mm diameter mill using a top ore size of -75 +53 mm. The closing screen is chosen to simulate a typical SAG/AG in closed circuit operation. The grate discharge plate is flexible with possibilities of reducing the open area and including pebble port. The ball charge used varies (typical 10%) and the mill charge (typical 30%). The variable speed mill is fully instrumented to record the torque and the speed. At steady state, all data are recorded and linked to a population balance model to predict SAG mill performance.

**HPGR amenability testwork:**
HPGR amenability testwork are conducted on the Polysius Labwal unit having a diameter of 250 mm and a width of 100 mm. The unit equipped with studded rolls is fully instrumented to record the operating gap, the operating pressures and the power drawn by both motors. The effect of different operating conditions on HPGR performance can be investigated and their influence on m-dot and downstream performance. The HPGR flake competency can also be assessed by conducting the Mintek flake competency test.

**Piston die testwork:**
Mintek conduct piston die testwork mainly to investigate HPGR downstream benefits when there is limited amount of sample to conduct full HPGR testwork.
Mintek has a wide range of equipment available for conducting of pilot scale comminution test work. The majority of equipments are modular and mobile. This allows for a flexible setup since flowsheets can be setup on site according to clients requirements. An inter-disciplinary approach is used, when required, to incorporate comminution, flotation, and physical separation processes during the running of the pilot campaign. Below is a summary of some of the comminution equipment available at pilot scale.

**AG/SAG Milling Pilot:**

- Mill dimensions: Diameter: 1.7m x 0.6m length
- Typical throughput 0.5 - 3.5 t/h depending on ore characteristics and circuit configurations
- Feed system allowing accurate reconstitution of feed size distribution to the mill
- Accurate measurement of feed rate, recirculating load to the mill, charge holdup and mill power
- Easy integration of pebble crusher into the circuit
- Mintek StarCs Control system is used to control mill operation
**Ball, Rod, Pebble Pilot Milling Pilot:**

- Mills of different sizes available up to a diameter of 0.94 m
- Typical throughput 0.3 - 1.5 t/h depending on ore characteristics, circuit configuration and target grind
- Accurate instrumentation for feed rate and mill power
- Overflow or grate discharge options
- Seasoned ball charge available
- Various classifiers available, including hydrocyclones, screens, and spiral classifiers

**Pilot Stirred Media Mills:**

- One 25 litre Deswick / knelson mill
- One Metso Stirred Media Detractor (SMD)

Both unit are fully instrumented to record accurate torque and speed which are used for power calculation

Ceramic media of different size and density are used to achieve fine and ultrafine milling.
**Pilot Scale High Pressure Grinding Roll (HPGR):**

- Köppern HPGR unit having a diameter of 1 m and a width of 0.250 m
- The variable speed unit is equipped with hexadur rolls
- The top size of the ore feed is 40 mm. Up to 55t/h throughput capacity
- Accurate instrumentation and data logging for power, hydraulic pressure and operating gap.
- Data generated can be directly scale up to determine the performance of an industrial scale HPGR.

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**Derrick screen test facility**

- Linear motion
- Non-blinding polyurethane panels down to 53 µm
- Adjustable frequency, stroke, and deck angle
- Design data generated can be scaled-up to commercial StackSizer unit
Circuit Modelling and Simulation:

The comminution group has built up an extensive capacity for modelling and simulation of various types of comminution equipment and circuits. The following types of comminution equipment can be simulated in open or closed circuit:

- Tumbling mills (ball, rod, pebble)
- AG/SAG mills
- High pressure grinding rolls (HPGR)
- Stirred media mills
- Crushers
- Classification equipment (cyclones, screens, etc.)

The following methodology is used when doing simulation work:

- Decide on type of equipment or circuits to be investigated
- Data gathering (through bench scale test work, pilot plant or plant survey)
- Set up population balance models for each equipment
- Simulate various equipment and circuit scenarios
- Generate recommendations for optimum equipment or circuit setup related to throughput, energy consumption and efficiency.

Role of Circuit Simulation:

When designing comminution circuits there are many choices that can influence the performance of the final circuit. Circuit simulation provides a tool for testing each possible circuit configuration before the design is finalised thereby ensuring that the optimal solution is implemented.
Plant Survey:

Engineers are available to conduct on-site plant surveys of industrial plants. The data obtained from sampling campaigns are used as input into circuit simulations to generate recommendations for plant improvement.

- Gather data from an actual operating plant
- Steady state process sampling campaigns
- Conduct mass balance reconciliation on data
- Set up circuit models based on data obtained
- Simulate various circuit scenarios
- Generate recommendations for improvements (throughput, energy consumption, efficiency)
Run of Mine Sizing

- Samples are received in either bulk bags or by road truck.
- The reception area has a capacity of up to 1000 ton.
- The +212 mm rocks are separated firstly.
- The remainder of the sample is further classified into different sizes by trommel screening.
- For feed to crushing plant the +212 mm material is broken down following sizing.

Crushing and Screening Plant

- Pilot scale crushing and screening plant.
- Jaw crusher followed by cone crushing.
- Various screen sizes available.
- Capacity 50 ton/h.
- Maximum feed size 212mm.

Sample Reception

Initial Separation of +212 mm material

Trommel Screening Used during Run of Mine Sizing

Pilot Scale Crushing Plant and Screening Plant Installation
Mintek is equipped with good sample preparation facilities. Some of the sample preparation services offered are listed below:

- Sample drying and sorting up to 500t capacity
- Sample blending and splitting using various techniques
- Pilot-scale continuous crushing and screening from -150mm to -6mm
- Additional small jaw and cone crushing units up to 2t capacity
- Grinding and pulverising of sample
- Run of mine sizing to below 38µm
- Particle sizing down to 1µm
- Viscosity measurement
- Particle density and bulk density of samples
- Preparation of standard analytical samples
SOME CURRENT CLIENTS

1. AMEC
2. ANGLOGOLD ASHANTI
3. ANGLOPLAT
4. AREVA
5. BATEMAN
6. DRA
7. ESSAR
8. GOLDFIELDS
9. HARMONY
10. LONMIN
11. MANAGEM
12. MDM
13. METALLICON
14. MIMOSA

15. NGEZI
16. NKOMATI
17. PMC
18. RÖSSING URANIUM
19. RUASHI MINNG
20. SENET
21. SMP
22. SWAKOP URANIUM
23. TATA
24. THARISSA
25. TWP
26. VALE
27. ZIMASCO

COLLABORATIONS

Equipment Suppliers
- Derrick corporation
- Deswick/Knelson
- Köppern
- Metso
- Polysius
- Weir minerals

Educational Institutions
- University of Cape Town
- University of KwaZulu-Natal
- University of Stellenbosch
- University of the Witwatersrand

Other Institutions
- JKTech
- Rocklab

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