Mining and aggregates industries
Process Technology & Innovation
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Process Technology & Innovation (PTI)

PTI’s particular focus is providing industry with Total Process Integration and Optimisation services. These include optimisation of the mining (drill and blast), comminution, flotation/leaching and dewatering processes for both greenfield and existing operations. The main objectives are to reduce operating costs, increase production rates and improve overall process, energy and water efficiency.

An Introduction to Metso Process Technology and Innovation

Our central office is in Brisbane, Australia and we have engineers based in different regions of the world so that we can better service our customers. Our offices and facilities are in Australia, Finland, Brazil, Peru, Chile, Russia, India, South Africa, Mexico and Turkey. Our services are tailored to provide solutions and suit the requirements of our customers. They usually involve four steps:

1. **Scoping study**
   This involves collecting historical data and information to identify problems, processing bottlenecks and opportunities for improvement. Detailed analysis of these data and information is then used to produce a project proposal.

2. **Benchmarking and optimisation**
   This involves rigorous collection of operational data through audits and comprehensive surveys of the key processes (drill and blast, crushing, grinding, flotation/leaching and dewatering). PTI staff use mathematical models, ore characterisation measurements, their database of historical information and their extensive experience to identify strategies for optimisation of the total process for different ore types and domains.

3. **Validation and implementation**
   A detailed plan is developed to implement optimisation strategies which have merit based on mine and plant constraints and a cost/benefit analysis. Key performance indicators are measured during the implementation stage conducted on site to quantify improvements and fine tune recommendations, as needed.

4. **Sustaining the benefits**
   This involves incorporation of recommended process changes into managerial and site operating procedures and training of operators and engineers so that the benefits are maintained over the longer term.

   We have been able to deliver considerable increases in the production of our customers operations with little or no capital expenditure on their part: significant increases in throughput (5 to 30%) and metal recovery, cost and energy reduction, as well as overall process efficiency increases (from the mine to the plant) have been achieved at a number of operations worldwide.
transport to the final customer. This will allow monitoring and optimisation of ore and track ore from mines through ports to their final destinations offshore. This will improve profitability. PTI are currently extending the application of the SmartTag™ system to mark and optimize for different ore types, thereby reducing costs and increasing operating parameters and control strategies in the mine and processing plant to be adjusted and optimised for different ore hardness, fragmentation and mineral characteristics in the mine such as ore mining processes enables spatially based ore content to be linked with time based measurement using SmartTag™ allows for performance in the processing plants. PTI products consist of rugged microphones, a signal transducer system and software to process any control system. The SmartEar™ system can operate standalone and/or interface to existing process control systems. SmartEar™ is an acoustic monitoring system designed mainly to prevent damage and minimise wear to mill liners caused by the impact of grinding balls. The system can also estimate the charge level in mills and it can be used to identify process limitations and to optimise the communition and flotation processes at Barrick’s copper/gold operation to remove bottlenecks and enable processing of ore at higher tonnage rates. Scope - Simultaneous surveys of the crushing, grinding and flotation circuits were performed in combination with ore liberation, hardness and floatability measures. Integrated models of both the grinding and flotation circuits were developed to enable optimisation of the Total Process. Results - PTI provided a range of recommendations for the Barrick Osborne to operate at higher tonnage rates and to improve metallurgical grade and recovery.

Minera Antamina, Peru
Challenge - To optimise the blasting, crushing and grinding processes at this copper/zinc mining operation located in the Andes in Peru. Scope - Review of the current drill, blast and comminution practices, characterisation of the ore, comprehensive mine audit and surveying of the crushing and grinding circuits, modelling and simulation. Results - PTI supplied a number of recommended changes and assisted in the implementation of these changes. A 20% increase in production was achieved and maintained when the mine was processing hard ore.

Barrick Osborne, Australia
Challenge - Optimise the comminution and flotation processes at Barrick’s copper/gold operation to remove bottlenecks and enable processing of ore at higher tonnage rates. Scope - Simultaneous surveys of the crushing, grinding and flotation circuits were performed in combination with ore liberation, hardness and floatability measures. Integrated models of both the grinding and flotation circuits were developed to enable optimisation of the Total Process. Results - PTI provided a range of recommendations for the Barrick Osborne to operate at higher tonnage rates and to improve metallurgical grade and recovery.

Newmont Boddington, Australia
Challenge - Assist the Newmont Boddington operation with circuit commissioning and optimisation of their drill and blast, crushing, HPGR, ball mill and flotation circuits. Scope - Newmont has engaged the services of PTI on a 2 year service contract. This involves PTI conducting a full Mine to Mill Process Integration and Optimisation, assisting with an expansion study and developing a throughput forecast and geometallurgical model. PTI was chosen to provide this assistance due to its previous successful optimisation of many large mining operations (including Cerro Verde) and its long running association with Newmont where it has provided invaluable consulting services to its other operations (e.g. Batu Hijau, KCGM, Ahafo, Yanacocha, Phoenix and Carlin). Results - To date, PTI has provided the support required to achieve grinding throughout target rates and has helped to identify process limitations and recommendations to eliminate them.

Examples of typical projects and results

“An interesting exercise of combining both the comminution/grounding and flotation processes together which should be a pre-requisite to both understanding and improving of any processing circuit.”

Michelle Korte
Metallurgist, Barrick

“The personnel of PTI are highly capable, organized and effective. They provide a service that clearly provides benefits to the industry – Antamina is testament to this statement”

Chris Dechert
VP Corporate Development, Minera Antamina
Blasting is the first stage of comminution in most mining operations and should not be seen solely as a means of getting the rock size to a point where it can be loaded into a truck. The ROM size distribution has a significant impact on the performance of the downstream crushing and grinding processes.

The in-situ ore properties, drill blast pattern and properties of the explosive govern the size distribution of rocks produced from a blast and the degree to which the energy of the blast is utilised. PTI has blast fragmentation models and systems which can be used to assess the optimum blast conditions required for a particular ore type. The aim is to produce a ROM size distribution which will maximise throughput and the efficiency of comminution within the subsequent crushing and grinding operations.

Comminution circuit design and optimisation
A change in comminution circuit design or operational philosophy can often result in a reduction in power usage or an increase in circuit throughput. PTI has vast experience in crushing, screening and grinding modelling and simulation techniques. This simulation expertise, coupled with extensive industrial and consulting experience, is used to assess comminution circuit configuration and the key design variables of the system. Different equipment options (including fine and ultrafine grinding as well as equipment from within and outside the Metso portfolio) can be compared and evaluated.

The operation of a comminution circuit is often strongly constrained by the feed size distribution and the ultimate losses in flotation recovery that result from a change in comminution product size. PTI conducts comminution optimisation with a fundamental understanding of these upstream constraints and downstream effects.

Flotation circuit design and optimisation
Non recovery in the flotation circuit should be seen as a lost opportunity. PTI has extensive flotation circuit analysis capabilities. This includes the ability to characterise the operation of the cells in a flotation circuit using cell hydrodynamic and froth sensors, conduct and manage flotation circuit surveys, mass balance survey results, analyse mineral liberation data and develop models for flotation circuit simulation. These results can be analysed to determine opportunities for improvement in flotation circuit performance.

For a given ore type and reagent regime, PTI can develop relationships between grind size and the grade-recovery achievable in a particular flotation circuit – enabling the operation of the flotation circuit to be linked and therefore optimised within the constraints of the blasting and grinding operations.
Dewatering and thickener optimisation
Many operations do not operate their water circuits optimally. This results in high water consumption and increased operating costs. While it is true that wet processing of the ore will always consume water, it is possible to significantly reduce water consumption by evaluating water reticulation circuits, available water sources and any dewatering equipment in use.

PTI have expertise in analysing plant water circuits to identify opportunities to improve water utilisation. PTI also have expertise in the application of state-of-the-art flocculation and thickening characterisation tools which can be used to either design a thickener for a new application or optimise an existing thickener.

Throughput forecasting and geometallurgical modelling
To maintain long-term profitability, it is important to be able to predict the throughput, grind size and flotation recovery of different blocks of ore in the mine plan. This requires the development of geometallurgical models which predict circuit performance based on measurable in-situ ore properties and are dependent on the mining methodology.

PTI have expertise in the development of these types of forecasts. We can implement or advise customers on the appropriate testing programs to establish an ore's blastability, grindability and floatability, often using existing geotechnical data such as RQD, point load indices, UCS, SMC and flotation tests. We also have the expertise to develop models using these ore characterisation measurements to predict performance. These models are developed from historical production data and from detailed information obtained from comprehensive surveys of blasting operation, and grinding/flotation circuits.

Support during commissioning
There is often a considerable delay between mechanical commissioning of a plant and the time when it achieves design metallurgical performance. This delay represents a considerable loss in potential revenue.

PTI can provide the process expertise and support required to rapidly achieve process targets during comminution and flotation circuit commissioning. This support is provided on site followed by remote support where the consulting engineers can provide advice from afar by accessing the mine’s DCS systems.

Advanced training
PTI experts routinely conduct advanced training for engineers and operators on site. These can be a series of courses and workshops focused and tailored to customer needs or part of the technology transfer process within an optimisation project or support contract.
PTI products

**SmartTag™**

SmartTag™ (winner 2010 iAwards) is an innovative system for marking and tracking ores from the mine through to the processes of a plant (e.g. stockpiles, conveyors, crushers and screens). SmartTags™ are inserted in blast holes (open pit) or draw points (underground) and they survive blasting, primary and secondary crushing operations. Marking and tracking ores through the mining processes enables spatially based ore characteristics in the mine such as ore hardness, fragmentation and mineral content to be linked with time based performance in the processing plants. Measurement using SmartTag™ allows operating parameters and control strategies in the mine and processing plant to be adjusted and optimised for different ore types, thereby reducing costs and increasing profitability. PTI are currently extending application of the SmartTag™ system to mark and track ore from mines through ports to their final destinations offshore. This will allow monitoring and optimisation of ore transport to the final customer.

**SmartEar™**

SmartEar™ is an acoustic monitoring system designed mainly to prevent damage and minimise wear to mill liners caused by the impact of grinding balls. The system can also estimate the charge level in mills and it can operate standalone and/or interface to any control system. The SmartEar™ system consists of rugged microphones, a signal transducer system and software to process the data.

**SmartSAG™**

SmartSAG™ is a dynamic model for AG and SAG mills. It uses the ore feed rate, feed size distribution and water flow rates to estimate power consumption, charge level and profile (angles of the toe and shoulder, charge radius), slurry pool formation and mill product size distribution. It can be used as a real time soft sensor providing valuable information to the operators of a plant. SmartSAG™ can also be interfaced with existing process control systems.

SmartEar™ audio frequency spectrum.
PTI laboratories, equipment and resources

PTI laboratories and pilot plants

PTI have laboratories and pilot plants associated with its Brisbane (Australia), Sorocaba (Brazil) and Tampere (Finland) offices which have the resources to perform crushing, grinding and flotation testwork on supplied ore samples using state of the art equipment. The South American laboratory is licensed to perform the internationally recognised JKMRC and SMC breakage tests.

Results of any testwork program can be supplied directly to the client or alternatively interpreted and used by PTI engineers in greenfield and optimisation projects. Ore characterisation tests and measurements are important components of PTI’s total process integration and optimisation services.

PTI transportable flotation rig

Flotation circuits often consist of very large cells and variable stream flows. Often one cannot easily change the operation of the cells in industrial scale and it’s almost impossible to measure the outcome of any change. Metso PTI developed a 3m³ test cell to enable flotation testing at a realistic scale. The rig allows key operational parameters such as air rate, froth depth, feed flowrate, impeller speed, impeller size, froth launder configuration to be changed. It is fully instrumented and controlled by a PLC to enable stable operation and has been designed so that representative samples of all key samples can be collected in a safe manner.

Metso PTI can provide assistance with the development of the test cell experimental program and specialists to perform the testwork.

PTI has developed a 3m³ transportable flotation test rig available for hire in Australia.

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<th>Metallurgical testwork capabilities</th>
<th>Brisbane Australia</th>
<th>Sorocaba Brazil</th>
<th>Tampere Finland</th>
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<td>Bond ball and rod mill index</td>
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<td>JKMRC breakage test</td>
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<td>Metso crushability index</td>
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Software tools

PTI staff using FracSis to visualise drill hole spatial data.

Throughout most process optimisation projects, computer software is used to analyse data and perform mathematical modelling and simulation. PTI uses industry best practice software to perform these tasks: Split desktop to analyse rock fragmentation images, JKSimBlast to design the drill hole patterns, FracSis to visualise the 3D spacial data in the mine, JKSimMet and JKSimFloat to model and simulate the grinding and flotation processes, Limm to model and simulate non-conventional processes and Bilmat to mass balance. We also develop our own software and applications.
Expect results

Expect results is our promise to our customers and the essence of our strategy. It is the attitude we share globally. Our business is to deliver results to our customers, to help them reach their goals.