Industrial Technologies Program

Online SAG Mill Grinding Pulse Measurement and Optimization

New Integrated Grinding Ball (IGB) Technology Will Optimize SAG Mill Operations and Reduce Energy Usage

Current semi-autogenous grinding (SAG) and ball mills are inherently inefficient, using less than 1 percent of the energy input required for size reduction. Grinding mills also consume tons of steel balls and liners. Proper monitoring and optimization of the operating conditions can greatly increase the energy efficiency of grinding mills.

The grinding efficiency of semi-autogenous and ball milling depends on the tumbling motion of the total charge within the mill. Utilization of this tumbling motion for efficient breakage of particles depends on the conditions inside the mill. However, any kind of monitoring device to measure the conditions inside the mill shell during operation is virtually impossible due to the severe environment presented by the tumbling charge.

To address this challenge, researchers at the University of Utah are developing an instrumented grinding ball (IGB), which is capable of surviving a few hours within the grinding mill and able to sense and transmit the impacts it experiences. This technology is expected to increase the energy efficiency of grinding mills by 10 percent. The spectrum of impacts collected over 100 revolutions of the mills presents the signature of the grinding environment inside the mill. This signature could be effectively used to optimize the milling performance by investigating this signature's relation to mill product size, mill throughput, make-up ball size, mill speed, liner profile and ball addition rates. At the same time, it can also be used to design balls and liner systems that can survive longer in the mill.

The IGB technology will allow the mill operators to assess the conditions in the operating SAG and ball mills by producing an instantaneous 'grinding pulse'. They can then adjust the operating parameters to optimize mill production, increasing mill throughput and reducing energy usage per ton of throughput.

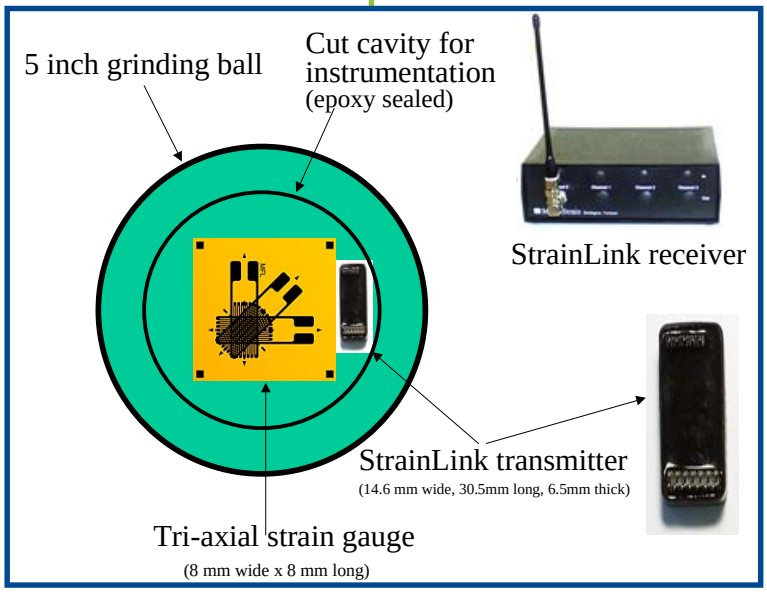
Besides mill optimization, the impact spectra obtained could be used in three additional ways. First, the signature data from industrial SAG mills can set the engineering standards for ball-drop tests, usually conducted at the manufacturing site to determine the competency of the balls. Additionally, unusual ball breakage at a mine site can be investigated by comparing the current signature with the expected signature recorded during "good operation." Finally, to determine if a large ball is suitable for increasing production or liable to damage liners and break on its own.

Benefits for Our Industry and Our Nation

- *Increases energy efficiency in grinding mills by as much as 10% by optimizing the grinding (breakage) conditions.*
- *Reduces steel consumption indirectly by reducing the amount of steel-on-steel impacts of grinding balls and liners.*
- *Reduces ball consumption by 20% due to its ability to optimize ball to rock ratio.*
- *Improves equipment life and reduces operation costs.*

Applications in Our Nation's Industry

This project will help the mining industry optimize milling performance. It is applicable to all mineral products that use SAG and ball mills.



Instrumented Grinding Ball and Its Components

Project Description

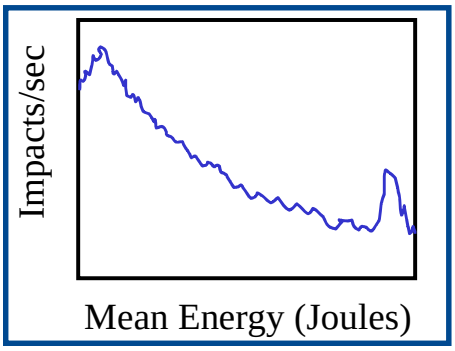
Objective: To assess the conditions inside the operating SAG and ball mills by producing an instantaneous "grinding pulse". The operating parameters are then adjusted to optimize mill production; increasing mill throughput and reducing energy usage per ton of throughput.

The goals of this project begin with the development of an instrumented grinding ball (IGB) that will allow mill operators to measure the impact spectrum of balls and rocks in grinding mill. Second, to relate the grinding pulse to the operating conditions of the mill. Third, to use the grinding pulse as a diagnostic tool for SAG mill operation.

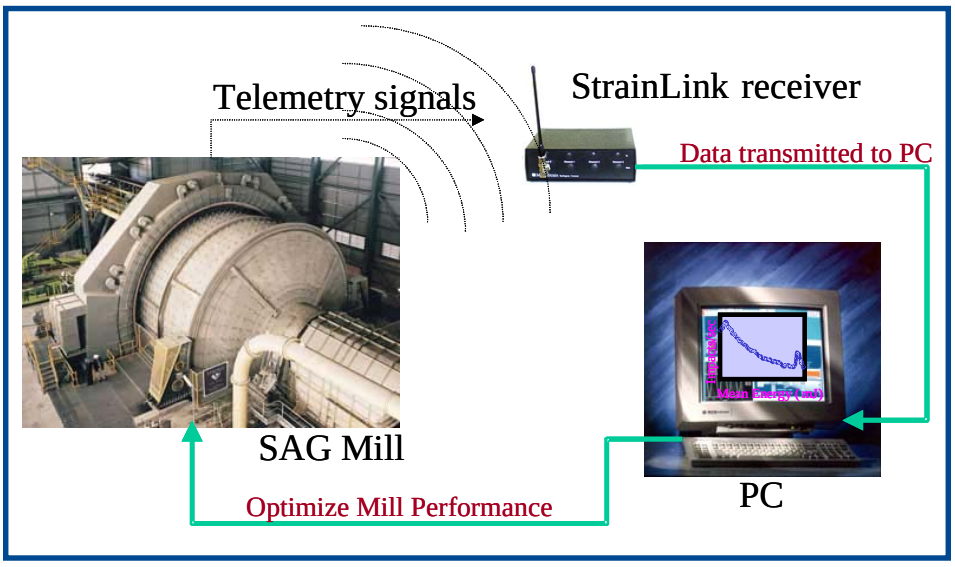
The impact spectrum will be measured for SAG and ball mills under various operating conditions including the optimum operation. Utilizing the impact spectrum, operators and researchers can identify operational strategies to optimize mill performance in conditions where the ore's characteristics change. These strategies will be used to detail actions to optimize mill operations and minimize energy usage per ton of throughput.

Milestones

- Test the IGB in a simulated impact tester and in laboratory and pilot-scale mills to measure impact spectrum under various operating conditions.
- Develop and refine IGB at two different plant-scale SAG mills.
- Develop relationship between observed grinding pulse and mill operating conditions through diagnostic capabilities that will optimize plant scale SAG mill operation.



A typical Impact spectra-the signature, generated in PC



Schematic of SAG mill, instrumented grinding ball and telemetry signal receiver

Project Partners

University of Utah
Salt Lake City, UT

Process Engineering Resources, Inc.
Salt Lake City, UT

Kennecott Utah Copper Corporation
Magna, UT

Phelps Dodge Mining Company
Phoenix, AZ

National Steel Pellet Co.
Keewatin, MN

American Grinding Systems, LLC
Kansas City, MO

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

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