

**Marius Sugentaitis, Lyncis, Lithuania,** examines how the adoption of new sensor measurement technologies, such as laser-induced breakdown spectroscopy (LIBS), can lead to more efficient mineral processing.

# ROD LIBS AND

# INNOVATE

**A**t the end of February 2021, a NASA rover landed on the surface of Mars, starting the next stage in the exploration of the 'Red Planet'. The mission will gather information on the planet's geology and possibly determine whether life ever existed on Mars. The rover is equipped with the latest sensing technologies to gather information on rock properties in Mars.

An understanding of rock and raw ore properties is crucial to the fertilizer mining and processing industry as well. This article will examine fertilizer manufacturing to see if the industry is keeping pace with the latest sensor technologies and whether this technology can bring benefits to the industry.

Traditionally, raw materials used in the fertilizer industry are analysed in laboratories. Typical tasks involved in the assaying include collecting samples from stockpiles or conveyor belts and delivering them to the laboratory's facilities. Various degrees of sample preparation are usually involved before the analysis can be carried out, such as sample drying, crushing, milling and pressing or chemical treatment. Next, the prepared sample is placed in a laboratory device for analysis. The entire process is often a time-consuming job that takes at least several hours to complete. Such a process is used for product certification and general quality control purposes. But is there room for improvement?

Carlos Perucca, a potash and phosphate process design professional from CPPC Ltd. in Canada, has said that potash producers have been going through a long period of low prices and increasing costs and regulations. He believes that there is ample room to look for process optimisation alternatives that might result in reduced operating costs, increased efficiencies and lower regulatory requirements. A potential area of improvement, according to him, would

be highly automated operations with tight online measurement systems.

Raw ore often has a significant variation in chemical and mineralogical composition. Variations in mineralogy and the presence of impurities not only influence processing efficiency but also increase production costs and decrease the final product quality. Online measurement technologies are used for process optimisation, and help mining and

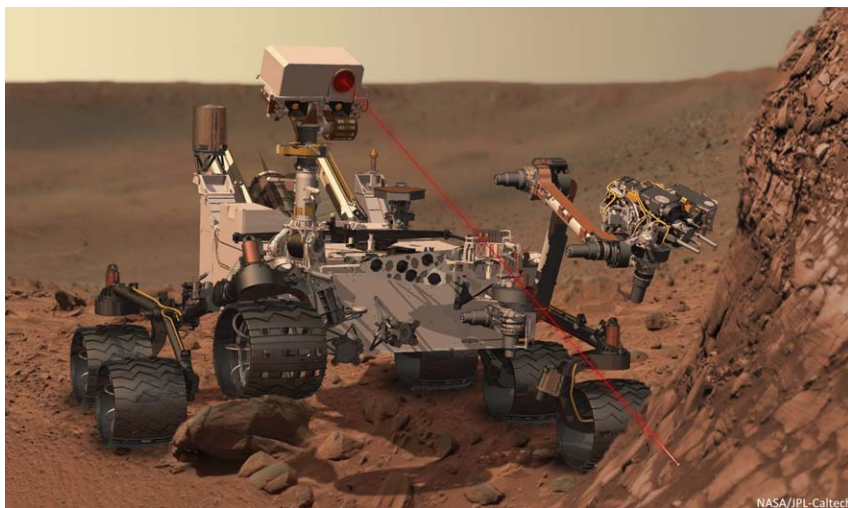
mineral processing companies control the production process without delaying waiting for laboratory results. In this way the production process can adapt to raw material changes in real-time and act accordingly. Such real-time process control improves mineral recovery and can extend the mine's lifetime. Operation costs can be reduced by minimising consumption of reagent, water and energy.

At the mine site, such systems are most commonly used for grade sorting and stockpile formation. The raw material flow is automatically diverted to different stages of the beneficiation process or stockpiles based on the incoming ore grade.

Another application is impurities rejection, when waste rock is removed from the feed at the earliest mining stage prior to further processing. As a result, mill throughput can be increased with the same processing infrastructure.

In the processing plant, online measurement systems are used for feed-forward control by monitoring incoming production quality or tailings. The dosage of reagents, water and additive can be adjusted based on real-time data to ensure the highest mineral recovery. Tailings are monitored, making sure the production is set to minimise the loss of valuable minerals.

One of the most common online measurement systems used in the potash industry is the K40 online analyser. Potassium ore contains small quantities of the radioactive isotope K40. The concentration of potassium oxide ( $K_2O$ ) and/or potassium chloride (KCl) in an ore is measured by detecting variations in K40 radiation. Such measuring technology has been used for several decades in the potash industry and continues to be the dominant presence in the online analysis process. The vast majority of these analysers are installed at the front-end, working in tandem with conveyor scales to measure the quantity of KCl feeding the mill at any given time. Such information is used for accounting purposes and can be incorporated into the flotation process to control reagent dosages.



**Figure 1.** This artist's concept depicts the Curiosity Rover as it uses its Chemistry and Camera (ChemCam) instrument to investigate the composition of a rock surface.



**Figure 2.** Laser measurement system focused on a moving conveyor with potash product.



**Figure 3.** Manual sampling for laboratory analysis.

For more complex process control tasks at further stages of the beneficiation process – especially at higher concentrations of KCl – more advanced online measurement technologies are required.

One such technology is laser-induced breakdown spectroscopy (LIBS). The technology has low detection limits and can provide composition measurements of all required elements simultaneously. By way of example, NASA's rover is equipped with a LIBS measurement system for gathering essential data on the composition of rocks on Mars. The same measurement principle is used in the fertilizer processing industry. The LIBS measurement unit is installed above a conveyor belt and provides online chemical composition measurements of raw material flow. Some plants use such systems for online measurements of slurry and brine. The technology can provide accurate measurements of calcium (Ca), potassium, phosphorus, nitrogen, magnesium (Mg), aluminium, iron or any other element or compound of interest.

The principle of a LIBS online measurement system is as follows: a laser beam is focused on the surface of the material to be analysed at a frequency ranging from 1 to 100 times per second. The laser beam raises the local temperature of the material above 50 000°C and thus generates plasma. The plasma quickly cools down, emitting a light that is detected through a lens system. Next, special software processes the obtained light spectral data and determines the concentration of all the elements in the material. Parameters such as moisture can be measured as well, based on relevant elements such as hydrogen. It is

important to note that the system does not emit any ionising radiation and can be safely used at any site.

### Case study: US

Lyncis, a Lithuanian-based company, supplied a US phosphate producer with LIBS online laser measurement technology to drive raw ore sorting applications. One of the producer's plants was experiencing high dolomite content in their feed. Installing real-time process control based on magnesium oxide content in the raw ore allowed them to remove the waste ore before the processing stage. The final product quality was improved and, more importantly, consumption of reagents and water was reduced; the technology promises cost-effective and more sustainable mining.

With improving sensors and advanced machine learning algorithms, such technologies can be pushed to much higher levels every day. The data streams allow the processing plants to make better control decisions more quickly and with greater confidence.

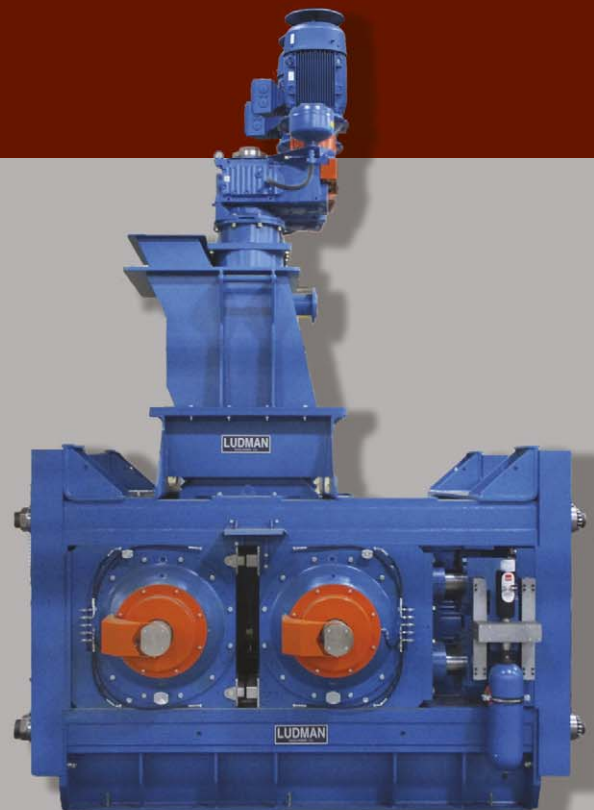
According to Perucca, mineral processing is still a conservative industry but there is a new generation of managers taking over. With the new crop of engineers and technicians in place, changes will come faster and faster. Potash crystallisation and flotation circuits (to name just a few of the most critical processes) are at the core of a potash processing plant, and running a highly efficient circuit has a significant impact on any company's bottomline.

Just recently LIBS online elemental measurement technology was implemented in the potash crystallisation process.



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**Figure 4.** Lyncis online element analyser in operation at Belaruskali facility.

### Case study: Belarus

With the help of a laser online elemental analyser Belaruskali is able to measure the mass fraction of all the main elements – KCl, sodium chloride (NaCl), Ca and Mg – in the final product in real-time. Constant monitoring prevents the overuse of the valuable components (e.g. potassium) in the process and at the same time removes impurities such as Na, Ca and Mg. As a result, the final KCl concentrate is obtained with values as close as possible to the specifications.

According to Vadim Naukovich, deputy chief engineer at one of Belaruskali's plants, the operator can control the

chemical composition of the concentrate cake based on laser online analyser data and manually adjust the process to maintain product quality. However, one difficulty is that the technological process is characterised by certain fluctuations, and to maintain an economical mode of washing off the concentrate cake the operator must frequently change the water flow rate.

The automatic process control system has become a key solution for the company. Today, the operator sets the key parameters for the system – the required NaCl content – and the system continuously compares it with the NaCl value measured by the LIBS online analyser and automatically

adjusts the water supply for washing off the concentrate cake.

### Conclusion

Improving measurement technologies and online measurement capabilities allows fertilizer and other mineral processing companies to understand the nature of fluctuations in the chemical composition of raw materials in real-time. Improved product quality, better utilisation of scarce resources and decreased energy consumption can be achieved by implementing automated process control solutions based on online sensor technologies. **WF**

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