APPLICATION NOTE

Ore sorting – helping make clean energy greener

Introduction

Clean energy is a step in the right direction for the environment, but behind the scenes there is a secret that is far from clean. Clean energy is reliant on mining and as the demand for electric vehicles, batteries, charging stations and wind turbines grows, so does the demand for copper, nickel, iron ore, platinum, lithium, cobalt, and many other raw materials. Herein lies the problem of making clean energy greener, since historically mining has not been considered environmentally friendly.

Crushing and grinding rock uses 5% of the world's power and every tonne of ore processed uses on average 600 liters of water. These are just two examples of the energy and resource intensive nature of mining that impacts the environment. This is not news to the mining industry; they have been aware of this for a long time. However, many of the world's largest miners have now committed to net zero emissions by 2050 and the question is how are they going to achieve that? To improve environmental credentials, the mining industry needs to reduce water consumption, recover more water, use less power and chemical reagents, limit dust, build smaller mines, move away from tailings dams and become much more efficient in recovering copper to ensure this valuable resource does not end up in the waste pile or tailings dam.

For many years mining has been a tonnes game and metrics have encouraged miners to maximize the number of tonnes extracted and processed. To achieve the zero emissions targets, the mindset needs to change from maximizing tonnes processed to processing the right tonnes, and that's where ore sorting can help. As technologies have evolved, ore sorting is now a legitimate option to reliably sort waste from ore, minimizing the amount of below cut-off grade material reaching the mill and saving power by not grinding rock that has sub-economic value.

Sorting waste on the feed conveyor

The most discussed opportunity for ore sorting is on the feed conveyor. The aim here is to use an elemental on-belt analyzer to measure the grade and provide a trigger to a diverter to sort below cut-off grade material to the waste pile and above cut-off grade material to the mill. The amount that can be sorted into waste will vary from site-to-site based on the heterogeneity of the ore, and the material handling process of getting the ore to the belt. The less mixing that is done in the process, the more the variability that is present in the ore body is maintained and therefore the greater the opportunity to sort.

The benefits of an ore sorting program depend on where the constraint is. If it is in the plant and it is possible to sort out 25% of below-grade material with a sorting program, this allows 25% of available capacity in the mill to process additional above grade material. This leads to a higher mill feed grade and a corresponding increase in recovery.

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If the constraint is in the mine, then the benefits of rejecting 25% of below grade material are cost savings and a positive environmental impact due to reduced throughput, whilst still maintaining similar product revenue.

Water

In many mines, water is a significant part of the processing cost. Whether pumping water via a desalination plant from the sea or taking it out of a local aquafer or dam, reducing water usage has a positive impact in terms of both cost and reducing environmental impact. From a cost perspective, the savings come from less water usage, as well as wear and tear on pipes, pumps, desalination plants and water recovery equipment. But the environmental impact is even more significant, as every liter of water not taken from a dam, or aquifer is returned to the local community, for drinking water and to water crops and maintain the local countryside.

Additionally, every liter of water not used in the process reduces the volume of the tailings dam. This could help to reduce the need to expand the dam and reduce the chance of a dam collapse, which could have a devastating impact on the local community and the reputation of a company.

Power

Crushing and grinding rock on mine sites reportedly accounts for 5% of the world's total power usage. The environmental impact of this is significant, considering this power has traditionally come from coal-fired power stations. In a recent feasibility study, we estimated that for an Australian copper mine, a high spec online analyzer like the Thermo Scientific™ CB Omni™ Fusion Online Elemental Analyzer could sort out 26% of waste material. Reducing the amount of grinding will have a significant impact on power usage. This in itself has a very positive impact on the environment, but also a significant cost impact, not only in terms of the direct cost reduction of power, but also through less wear and tear on very expensive equipment like grinding mills.

Smaller mines

If designing a new mine or considering an expansion to an existing mill, ore sorting has a very positive impact on the size of the project, both in terms of environmental impact and cost. Having a smaller plant footprint reduces the environmental impact through less clearing of natural habitat, using less materials and reducing the recovery work at the end of the mine life. With the cost of a new mill being in the region of a billion USD, the cost savings are significant.

Figure 1. The CB Omni Fusion Online Elemental Analyzer

If considering an expansion to increase capacity and meet the growing demand for copper, the size of the expansion could be reduced, or the need removed completely via ore sorting. Sorting below cut-off grade material before it reaches the mill, allows that material to be replaced by ore that is above cut-off grade and thereby increase mill feed grade and recovery. A recent case study for a 40,000T per day plant showed that the high spec CB Omni Fusion Online Elemental Analyzer could sort out 26% low grade ore. If replaced by above grade ore this would result in an additional 20,000T of copper sent to the mill per year, and an estimated $100m of additional product revenue without expanding the mill size.

Community relationship

The relationship with the local community is critical to a mining operation´s ongoing success. Often this is where many of the mine workers and their families live along with critical service suppliers and contractors, so the relationship that a mine has with the local community has a direct link to the satisfaction and retention of their employees. Particularly in arid locations, water is critical to this relationship, but in other communities' issues like dust, noise, power availability and safety are all of critical importance. Using less water, making less dust, reducing the size of the tailings dam are all areas that can be positively impacted by ore sorting and really help to improve the relationship with the local community.

Recovering ore from the reject line

The opportunities for ore sorting extend beyond the feed conveyor. In many mines, trucks are sent straight to the waste pile on a predetermined basis, according to the block model and mine plan, based on exploration drill core assays or sometimes by a geologist. So how much copper is being sent to waste due to the incorrect assumption that all material in a block is below cut-off

grade? From conversations with mine site employees, the truth is that no one really knows, and the quantity is likely to be significant.

The environmental impact of a mine is considerable, and each mine has a responsibility to maximize its recovery through efficient processes, to ensure that a maximum return is generated from the operation. Throwing copper into a waste pile, unanalyzed, does not only have a detrimental impact on recovery and profitability but it also lessens the return from the asset. Based on that, there is growing interest in using an elemental analyzer such as the CB Omni Fusion Online Elemental Analyzer on a waste or reject conveyor to measure the grade of the material, and sort above grade material back into the process.

Setting up an ore sorting program

The biggest barrier to setting up an ore sorting system is the cost of the infrastructure to sort large volumes of material and then transport it back to the reject pile. When considering a diverter, conveyors, shovels and trucks, the cost can be significant. However, the return on investment could be less than a year. To understand the ROI, it is critical to know the ore variability and how much below cut-off grade material could be rejected. This will determine the design of an ore sorting system, including the costs and benefits in terms of improved feed grade and recovery, cost savings and positive impact on the environment.

The only practical way to understand the true grade variability is to install a high spec Prompt-Gamma Neutron Activation Analyzer (PGNAA) like the CB Omni Fusion Online Elemental Analyzer on the feed belt and directly measure the grade variability for typically 3-6 months. This will enable the grade variability to be assessed across different locations in the mine and the expected amount of rejected material, as well as the expected improvement in grade/recovery and cost savings to be modeled. It also enables the mine to understand the ROI and build a business case for investment.

When sorting ore, it is important to purchase a high spec analyzer, designed for maximum uniformity of analysis, with a minimum 78ug of Cf-252, or a neutron generator, with at least 1000 cubic inches of detector volume. The consequences of purchasing a low spec analyzer will be a higher analyzer error which essentially means more above grade material will be sent to waste and low-grade material to the mill. A recent feasibility study demonstrated how the additional cost of a high spec analyzer can be recovered in less than a week through improved grade/recovery and cost savings.

Copper is a critical metal in the world's push towards clean energy, but as an industry there is the responsibility to reduce the environmental impact that comes from mining copper to help make clean energy greener. Bulk ore sorting will play a critical role in helping miners reach their target of net zero emissions by 2050. The first step is to purchase an analyzer, understand the ore variability and the environmental and economic benefits ore sorting can deliver.

References

1. *Creating the zero-carbon mine* | McKinsey, (29 June 2021)

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