BX01 - Reduction of Bauxite Moisture Using Concentrated Solar Energy

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Abstract

Moisture in minerals impacts on logistics (dead weight) and processing (steals energy via evaporation) costs with direct link to GHG (green house gases) and pollution. Sustainable mining is at the top of the agenda for many, and societies, governments and investors are increasing pressure for a sustainable mining chain. We are developing solutions to use CSE (concentrated solar energy) to dry-reduce moisture in minerals and concentrates. Classical available solutions use a receptor and thermal fluid to collect and transfer CSE to a horizontal kiln. These are complex and CAPEX and OPEX intensive. Our solutions use double tracking heliostats to focus and inject CSE into an ore pile forming at the courtyards. As ore is dumped onto the pile, CSE is injected in the amount required to dry or reduce the moisture as defined by the customers. Our solutions are able to handle large daily amounts of ore with minimal operational changes. Our solutions require lower CAPEX and OPEX than other presently available solutions. By using CSE, drying-reducing moisture becomes a fixed cost.

Keywords: moisture, humidity, drying, concentrate solar energy, minerals, sustainable mining.

1. General Remarks

Moisture in minerals impacts on logistics (dead weight) and processing (steals energy via evaporation) costs with direct link to GHG emissions and pollution [1, 3]. Society, Governments and investors are demanding more sustainable and cleaner mining and processing. Present solutions use fossil fuels or biomass to dry-reduce moisture in minerals and concentrates. These are CAPEX and OPEX intensive operations with impacts on GHG emissions and pollution.

Available dewatering technologies utilize vacuum filters, pressure (hyperbaric) filters, thickeners, centrifuges, dewatering screens to reduce moisture to a lower value [1] and dewatering chemicals / surfactants [2]. These are mechanical and chemical solutions. Thermal solutions use a fossil fuel or biomass to produce thermal energy that is them used in kilns to dry minerals and its concentrates. These solutions contribute to GHG and pollution [1]. New technologies that use renewable energies (such as concentrated solar energy, CSE) for drying and reducing moisture in minerals have to be developed for a more sustainable mining, in the near future.

This paper shows possible direct CSE injection solutions for drying and reducing moisture in minerals. In their publication, Li et. al. [1] said: "*It should be possible to benefit from advances made in other industries. Use of solar energy, ambient air, and windmills is possible at vast mine sites.*"

1.1 The Challenges

Most mining operations use a feeder to dump ore onto a courtyard forming a so-called stockpile. As the pile grows, the ore dropping point moves in 3 axes (X, Y and Z). The CSE point (like the fixed receptor in a CSP - Concentrated solar power plant) should move along, so CSE focused on the ore dropping point. For this, you need a double tracking heliostat. Since tons of ore are involved, large amounts of CSE are needed. Harvesting it in a mine or port operation is challenging. Heliostats shadowing must be considered and solved.

CSE is a proven technology used for decades in CSP (concentrated solar power plants) to generate electricity. The quality of heliostats is high and prices are dropping making the financial viable with in a 6-7 years ROI depending on the required parameters.

1.2 Some of the Unknowns

If you ever went to a beach on a hot summer day, you felt on your feet what solar energy does to a mineral. By focusing CSE into a growing pile this will produce layers of hot ore that will speed up the evaporation. But how would evaporation take place in a 40.000-50.000 ton heated ore pile? How much will local air humidity and wind effects influence ore pile evaporation? How long will evaporation in a large ore pile take to reach a certain residual moisture target? What is the efficiency of direct CSE focusing onto minerals? How will different ores behave under the same processing conditions? These are some of the unknowns that our PoC (proof of concept) with Vale will try to answer for iron ore.

1.3 The Proof-of-Concept Project at Vale

To develop a PoC that could clarify the above unknowns at a low cost, was a challenge. So, we decided to use 30 kg samples and controls. Because Vale's daily ore volumes are so large using a solar kiln is not an option. Therefore, the PoC project focused on two alternative solutions, as follows:

1) Dry-reduce ore in courtyard pile forming
2) Focus and inject CSE onto ore being transported by conveyors.

Experiment 1) In order to simulate the ore being drop onto the pile at courtyards, we built an equipment that has in its center a funnel surrounded by heliostats. The heliostats focus the CSE on the center where the ore is dropping, hitting, heating it up in all layers. See Figure 1 for details.

Figure 1. Experiment 1 set up showing the heliostats, funnel and sand dropping being hit by CSE from all sides. (Flir E4 model thermal camera – Normal mode)

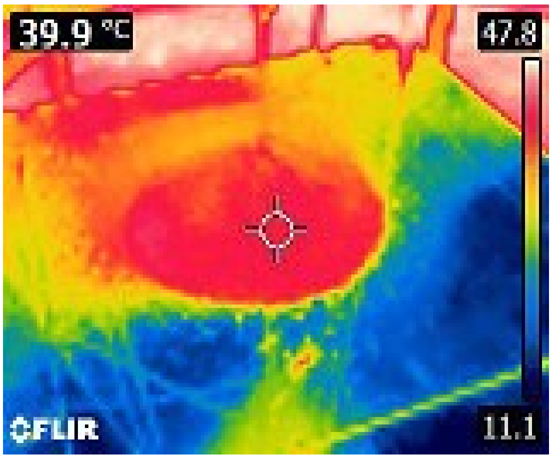

Figure 2. Experiment 1 Thermal image of the same set up taken at the same time. (Flir E4 model thermal mode).

Experiment 2) Ore is placed inside a tray. The tray is placed under the Fresnel lens. Above the lens, a reflective mirror beams down CSE. The same circular heliostats focus the CSE onto the reflective mirror. See figure 2 for details.

irradiation and availability are the key factors. The interaction between ore and CSE influences the process efficiency and impacts on the CAPEX.

What makes our solution unique is the ability to focus and inject CSE in each and all ore layers during pile forming, regardless of its size, using double tracking heliostats. As a way to harvest more CSE a Fresnel lens for conveyor belts just prior courtyard dumping is a promising solution since conveyor belts are typically very long and thus good for CSE harvesting. Both solution work on the principle that the CSE is focused and injected in "close" proximity to the ore layers as the pile is forming on the courtyards, not requiring thermal conductivity in "long" distances. Our solutions can be used in any pile format.

We would like to acknowledge Vale for supporting our PoC project.

5. References

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