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Integration of concentrated solar thermal energy into gibbsite calcination Process

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Gibbsite calcination is the final stage of the Bayer process, where gibbsite is calcined into smelter grade alumina. Gibbsite calcination process is an energy intensive process and it accounts for approximately 1/3 of the thermal energy consumes in the Bayer process. The thermal energy requirement for the calcination process is provided by combustion of natural gas, which emits vast quantities of CO_2. In 2014, the alumina refineries in Australia emitted more than 5 million tonnes of CO_2 or 15% of the total CO_2 emission in the manufacturing industry.

The effects of global climate change are becoming more prevalent, industries are exploring sustainable source of energy into their process in order to reduce the dependency on fossil fuels, CO_2 emissions and also lessen the effects of volatile fossil fuel prices. Gibbsite calcination is a highly endothermic reaction where concentrated solar thermal (CST) energy has the potential to provide high-grade heat to drive the high temperature reaction. Previous experimental study has proven gibbsite dehydration reaction can be carried out by exposing gibbsite or boehmite to concentrated solar radiation. Apart from the potential to reduce CO_2 emissions the study also reported better quality alumina, as contamination from combustion products are eliminated. However, directly irradiating the particles limits the amount of solar energy that could be used in the overall process and moreover due to the large scale of particles that needs to be handled through the system can be challenging. Therefore, in order to increase solar share in to the calcination process, as an alternative to directly irradiating gibbsite or boehmite particles, replacing the air preheat furnace with hybrid air preheat furnace which will allow solar thermal energy to be stored for when solar energy is not available.

In this study, a preliminary process model of the current flash calciner was developed, based on first principles. This process model will be further adopted to introduce CST energy and solar thermal energy to pre heat the air that is supplied to the main furnace, where calcination is carried out to produce alumina.