

Development of Lab Scale Solar Reactor for Thermochemical Processes

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Extended Abstract

In recent years, research and development of renewable energy technologies, to replace fossil fuels, have been vigorously conducted to reduce global warming. Concentrating solar power (CSP) technology is also received considerable attention, to convert sunlight into electricity and fuels as well. Thus, to produce solar fuels, various types of thermochemical reactors have been proposed and developed for CSP systems to achieve efficient solar fuels production [1-3]. To build an optimal receiver-reactor for CSP plant, it is essential to perform experimental testing for various conditions, based on the range of operating conditions in actual CSP systems. This includes replicating the high DNI levels and stable atmospheric conditions typically found in Sunbelt regions. In this study, we have developed a lab scale solar simulator. The high-flux solar simulator consists of a 7kW xenon short-arc lamp, a truncated ellipsoid reflector, air-cooling system and 10 kW power supply. This high-intensity lamp mimics the spectral quality and intensity of natural sunlight, enabling us to conduct detailed laboratory-scale verification of CSP components, receivers, reactors and reacting materials. Using the developed solar simulator, we can systematically evaluate the performance and efficiency of various components, identify potential improvements, and optimize reactor designs before deploying them in actual CSP plants. To assess the air-cooling system of solar simulator and obtain the fluid flow around the simulator and xenon arc lamp, a numerical model has been developed as well.

Furthermore, a laboratory scale solar reactor has been developed to produce solar fuels. The cavity type receiver-reactor and the frustum shape aperture were built using alumina. The glass wool was used to insulate the receiver. Thermocouples were installed at various locations inside the reactor to monitor the experiments. Experiments were conducted for various operating conditions. The effects of operating conditions on heat transfer and fluid flow inside the reactor have been analysed. Using this reactor, various thermochemical materials and components can be tested under controlled environment.

References

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