

STEP- Developing of a Mobile Outdoor System for the Solar Thermal Electrochemical Process for Green Cement Production

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Solar Thermal Electrochemical Process (STEP) for green cement production is a unique process that allows for the electrochemical conversion of calcium carbonate into calcium oxide in a molten carbonate system that releases no carbon dioxide into the atmosphere.¹ STEP cement production is one of a family of new processes of efficient solar synthesis.²⁻⁶ Utilizing a combination of solar thermal energy for heating processes and other renewable electric energy sources for electronic charge, STEP is able to electrochemically synthesize a variety of societal staples ranging from fuels and metal production (including iron and magnesium), carbon dioxide splitting, and wastewater treatment.¹⁻¹⁰ Each process offers a unique chemistry, but all processes use the full solar spectrum to lower and drive the energy of endothermic electrochemical reactions. High temperature molten salt electrolytes offer significant benefits to STEP of high reactant concentration and facile derivation of a wide range of useful gas, liquid and solid products. The effective chemistry of STEP in an increasing range of electrolytes and in the presence of impurities has been demonstrated.^{9,10}

A recent focus of our ongoing STEP research has been in development of a mobile outdoor system that can be used to demonstrate these unique processes. Outdoor operation supports the in-lab effectiveness and high current density (high rate) feasibility of STEP Cement production. Under concentrated direct sunlight, the molten carbonate electrolyte is maintained while performing the low energy electrolysis reaction. The molten electrolyte itself acts as a strong thermal buffer to prevent drastic cooling during intermittent sunlight. The production of cement is one of the largest sources of anthropogenic carbon dioxide in the world. The majority of this carbon dioxide release comes

from the decomposition of calcium carbonate into calcium oxide. STEP Cement, not only prevents this carbon dioxide release, but it utilizes this greenhouse gas to create a second useful and valuable product, graphite. By tackling this significant challenge of CO₂-free production, it is possible to remove one of the largest carbon dioxide producing processes in the world and have a significant impact on the amount of green house gases being released each year.

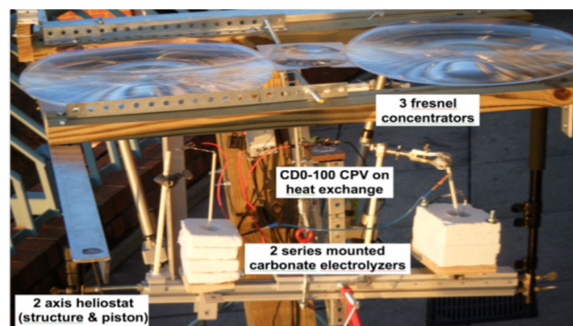


Figure 1: STEP cement outdoor system with carbonate electrolyzers, CPV and Fresnel concentrators mounted on a Suntura dual axis heliostat.

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