Novel Solar hybrid system for Producing heat and electricity

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Introduction

Solar Hybrid system consist of Solar cell and heat sink. For modeling the system, we used optical simulation software to model the distribution of the concentrated solar irradiance for various receiver configuration candidates. The result shows that the horizontal configuration of the receiver is least affected by the reflectivity loss of the mirror. A Finite Element Analysis (FEA) is used to calculate the convection heat loss for each **flow through** receiver configuration. The horizontal configuration of the receiver is also shown to have least amount of convective heat loss. The radiative heat loss of the receiver is analyzed for different solar cell choices. The result points to the direction of using a low emissivity coating on the solar cell to produce better thermal performance.

1)Optical Modeling

The current simulation is built as a simple model in Lighttools raytracing software :

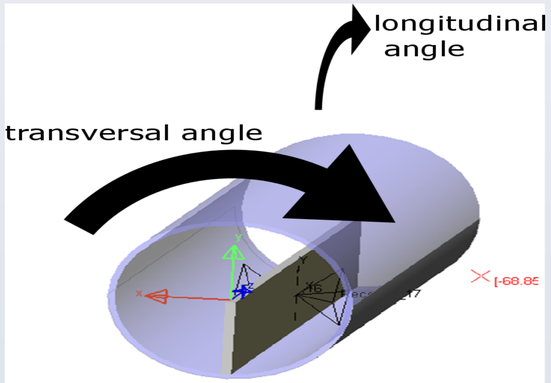

Fig. 1 The 3D Model

After simulation of multiple angles, the best absorber positions for highest optical efficiency is:

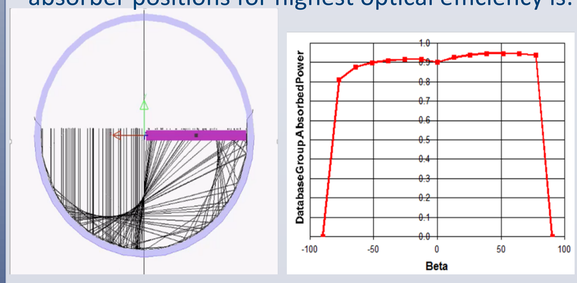

Fig. 2 Best Overall optical efficiency according to different candidate positions of the receiver.

2) Thermal Modeling

I. Free Convection Heat Loss of the absorber

Instead of Air, We choose to fill the device with argon gas because it reduces the free convection by 1/3 compared to air in figure 3.

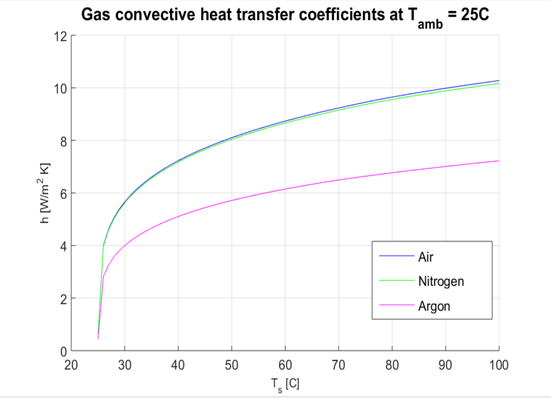

Fig. 3 Effect of using argon gas to reduce the free convection heat loss

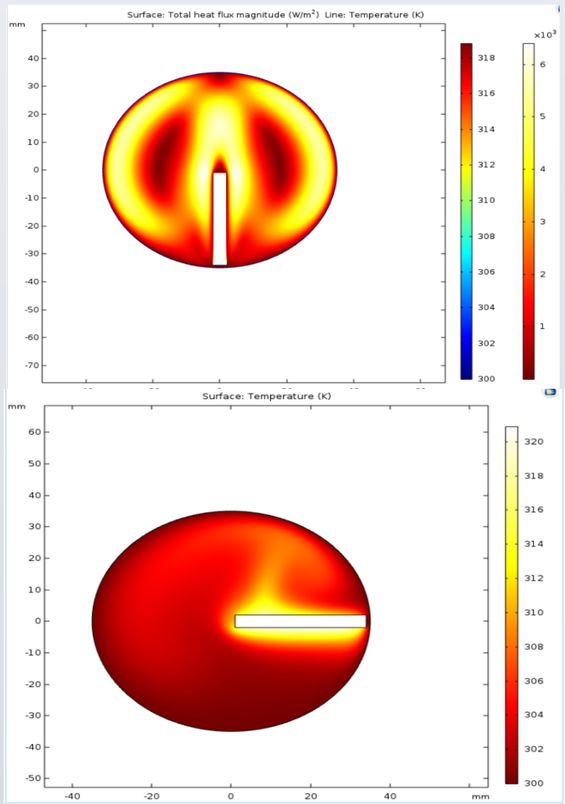

Fig. 4 simulation of Free convection heat loss for horizontal and vertical receiver

II. Forced Convection in the Minichannel

The heat transfer from the rear surface of solar cell To the mini channel is simulated below?

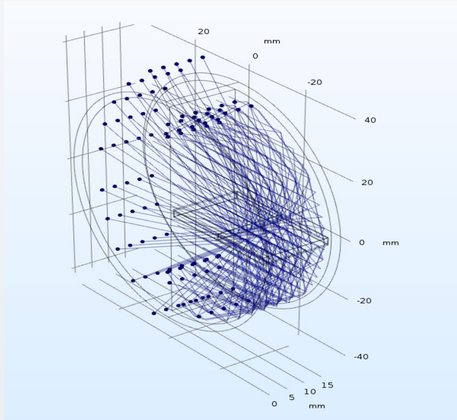

Fig. 5 Raytracing of solar light on Solar cells

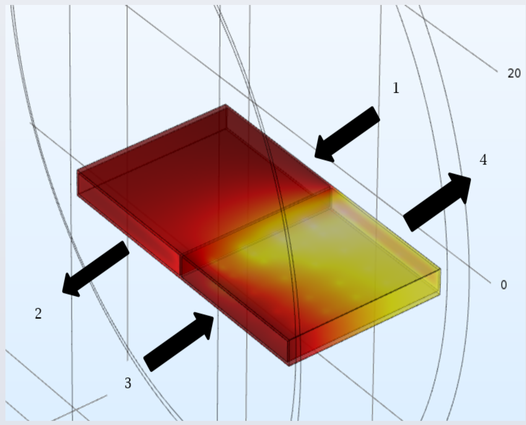

Fig. 6 Solar light effect on solar cell temperature

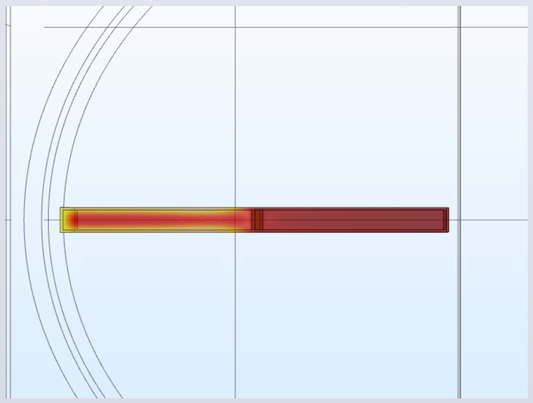

Fig. 7 Temperature difference between Solar cell and minichannel wall

3) Rendered shape of hybrid solar collector

Typical residential heat to electricity energy consumption has a ratio of 2.4:1 in California. Without using low emissivity solar cells (such as the Interdigited Back Contact solar cells, or IBC cells), the amount of heat harvested at low temperature is sufficient for such a ratio. Therefore the first stage for our prototyping is to directly apply the IBC cells onto Minichannel heat transfer element, as shown Fig.8 and 9.

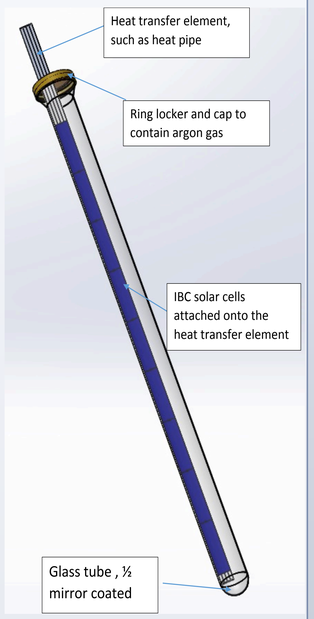

Fig.8 One unit of Minichannel with IBC solar

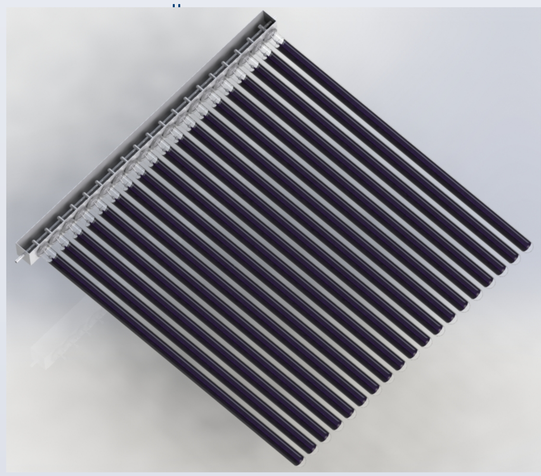

Fig.9 Array of the hybrid solar collector with manifold

The material selection, manifold design and experimental testing of the collector are researching in UC Solar research center.

Reference

1- Opric-Based Approach to Thermal Management of Photovoltaics: Selective-Spectral and Radiative Cooling. Xingshu Sun, Student Member, IEEE, Timothy J. Silverman, Zhiguang Zhou, Mohammad Ryyan Khan, Peter Bermel, and Muhammad Ashraful Alam, Fellow, IEEE.

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