

Coupled Optical and Thermal Modeling of Novel Solar Thermal Collectors

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Abstract

In the present study, the performance of the two novel solar thermal collectors are modeled using COMSOL Multiphysics. Firstly, Parabola and seagull geometries are utilized as primary and secondary reflector with high concentrator(50X) for high temperature application (650°C). Secondly the Compound Parabolic Concentrator (CPC) geometry used as a single reflector with lower concentration(1.45X) for medium temperature application (200°C). "Multiphysics" module in COMSOL enabled us to couple two different physics (optics and heat transfer) which it reduced computation cost and ease the post-processing procedure (compared to design in two different software). "Geometrical Optics" module is used for ray tracing and "Heat transfer in solid" for both heat transfer analysis in absorber(solid) and fluid (heat transfer fluid). Material properties are assigned to each part of the collector such as quartz glass, aluminum and water for both models. In geometrical optics, illuminated source is assigned with 10000 rays per release where the ray direction is chosen normal to the aperture. Reflector and absorber with respective optical properties like transmissivity (92%), reflectivity and absorptivity are inputted respect to real-world data. Also, to justify the chosen number of rays and meshes, mesh and ray independency investigated based on equivalency of energy which input energy of rays must be equal to output energy of heat transfer fluid in ideal case (100% reflectivity, transmittance and absorptance). At the end the thermal efficiency of each collector is reported respect to inlet temperature of heat transfer fluid.