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Simulation of Thermal Processes in a Hot Mirror Parabolic Trough Solar Receiver

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Abstract :

Parabolic Trough Solar Technology is one of the most proven solar thermal power technology available today. Using linear parabolic mirrors, a Parabolic Trough Solar Collector focuses sunlight onto an absorber surface. A heat transfer fluid is passed through the absorber tube and heated, and then either used directly or passed through heat exchangers for conversion to other energy forms. Existing systems use a selective coating on the absorber surface to enhance solar energy absorption. However, thermal radiation losses are high and the selective coating material on the absorber decomposes at high temperatures. Efforts to improve the performance efficiency have largely been directed towards chemically stabilizing the selective coating at high temperatures. In our study, we replaced the absorber selective coating with an Infrared reflecting material (Hot Mirror) on the inner surface of the glass envelope enclosing the absorber. This eliminates the problem of thermal degradation of the absorber selective material and reduces radiation losses resulting in an increased working temperature. The Infrared selective material transmits in all wavelength bands in the incident solar radiation, but reflects Infrared radiation in the thermal emission from the absorber surface back onto it. The Hot Mirror traps the thermal emissions within the receiver tube through multiple reflections and absorptions on the glass envelope inner surface and absorber outer surface respectively. In our work, we simulate the heat transfer processes in the receiver tube, namely conduction, convection and radiation and determine the useful heat gain by the heat transfer fluid. The simulation also models the effects on the overall energy gain by changes in the HTF flow rate, type of fluid, solar flux, absorber and glass envelope diameters and length, and the Hot Mirror material properties. The simulation answers questions regarding an increase in the performance efficiency and characterizes temperature profiles and spectral-thermal processes on the circumference and along the longitudinal axis in the flow direction of the heat transfer fluid.

Award :

yes

Level :

PhD

Supervisor :

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Paper :

No

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