Flow and thermal mechanisms in receiver tube of parabolic trough collectors with rings axially connected together and radially connected to the inner tube surface

ABSTRACT

Artificial obstructions on the underside of receiver tubes can increase the heat transfer coefficient between the receiver tubes (Heat Exchanger, HX) of Parabolic Trough Collectors (PTCs) and water as a working fluid. In this study, we numerically and experimentally tested the behavior of laminar mixed convective heat transfer in HX tube installed with baffles. These baffles are rings that are connected together axially and connected radially to the inner tube surface. Using ANSYS fluent Version 15.0, we performed computation fluid dynamics modeling to achieve heat transfer enhancement in HX tubes equipped with turbulator baffles under laminar flow conditions. Moreover, the effects of Pitch ratio (P/D) = 3, 6 and 10 and Reynolds number Re#480 were recorded. The novel application of the rings that are connected axially together and radially to the inner tube surface contributes to the long-term storage of thermal energy and promotes heat transfer via. conduction from the tube surface to the center line of the water flow within a short period. In the study, the baffles generated a vortex to increase the Nusselt number (Nu) inside the HX. To simulate heat flux, we calculated the constant wall heat flux of the receiver tube using an electric heater. Results indicated that using 20 rings as baffles instead of plain tubes improves heat transfer by up to 75%. As P/D decreased and re increased, the heat transfer rate, friction factor (f) and Thermal Enhancement Factor (TEF) increased.

Keyword: Thermal mechanism; Receiver tube; Ring baffles inserted; Parabolic trough collector; Flow mechanism; Generated