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Numerical simulation and experimental validation of a controlled flow solar water disinfection system

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ABSTRACT

A controlled flow solar thermal disinfection system was manufactured, tested and numerically investigated. The system is simply constructed of a 2.34 m² flat-plate solar collector at which the outlet flow temperature is controlled by a solenoid valve to a disinfection temperature. The outlet hot disinfected water is used to preheat the inlet untreated water through a heat exchanger. Different disinfection temperatures are considered with their corresponding heating periods of time. The system is numerically simulated to investigate their annual performance and life cycle savings. The simulation model is validated by measured data with close agreement. It is obtained that the considered simple system working at 60°C disinfection temperature can daily produce 171 l of clean water by m² of solar collector where it reduces into about 39 l/m² at 90°C. That corresponds to 81.5 and 1.1 l/m² per kWh of incident solar radiation respectively. The disinfected liter of water can cost about US$ 0.00001 along the system lifetime.

Keywords: Collector controlled flow; Solar heating; Numerical simulation; Water disinfection

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