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Thermal performance and biological evaluation of solar water disinfection systems using parabolic trough collectors

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ABSTRACT

Thermal and optical performance of solar water disinfecting systems using parabolic trough collector, PTC, have been investigated experimentally and numerically. Four PTCs systems were designed, manufactured and field tested under the same weather conditions of Cairo 30°N. The four systems were installed to be compared thermally and biologically. Each system consists of a 2-m^2 PTC and line-focus pipe to carry the water sample to be disinfected. In the first system (thermal system), a black painted stainless steel pipe covered by Pyrex glass envelope, to minimize the convective and radiative heat loss, is supported through the line-focus of the PTC. While in the second system (optical system) the contaminated water is used as absorber through a Pyrex glass tube, the two above processes are considered respectively in the third system. In the fourth system, a black tube including and surrounded by the contaminated water are considered as the absorber. The contaminated water is passed through the annular space between the Pyrex glass tube and the collector absorber. The experimental results indicate that the third system has better performance than the other studied systems from the biological point of view with twice area. It has the minimum biological contamination, Spore-former bacteria count, total bacterial counts and total coliforms. While the thermal system is thermally efficient, the optical system is not recommended to use alone. A numerical modeling of the systems was developed and validated by experimental data. The annual performance of the systems is presented. Under the same environmental and technical conditions the third system can be considered as the most efficient one that can produce about Million liter of clean water a year.

Keywords: Thermal disinfection; Optical disinfection; Parabolic trough; Bacteriological examination; Numerical simulation

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