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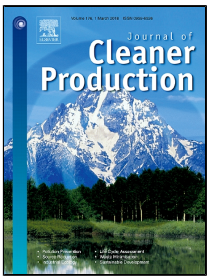

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Thermal design of Earth-to-Air Heat Exchanger. Part I A new transient semi-analytical model for determining soil temperature

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Abstract

This article is the first in a series about the thermal design of Earth-to-Air Heat Exchanger, EAHE, using a new developed semi-analytical method. The temperature distribution in the soil surrounding the EAHE is studied in the goal to determine the soil radius as a function of the operation duration. This radius is the first distance from the pipe axis where there is no effect of heat from EAHE. For that, a new transient semi- analytical model is developed in particular to facilitate the thermal design of EAHEs. The main application of the developed model is to predict the deterioration in EAHE's thermal performance as a function of the duration operation. This deterioration can be caused by soil thermal saturation where the nearby subsoil temperature becomes almost equal to the inlet air temperature resulting in minimum heat transfer between air and soil. The analytical solution of the proposed model has been integrated by means of the Bessel function method, for a constant heat flux per unit of length at the pipe surface in the radial dimension and constant inlet air temperature. The model has been verified with several results obtained from the literature. In addition, an investigation of continuous operation of an EAHE is made on thermal performance of the EAHE in the soil of the region of Biskra (Southern Algeria) (34°47'N - 005°43'E) by applying extreme ambient air temperature (57°C). Results show that the deterioration in thermal performance of EAHE is observed for longer duration in hot and dry climate. In the case of 6 hours of continuous operation, the soil radius can reach 0.55m from the pipe surface. The model proposed in this paper can be considered as the first of its kind which gives a

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