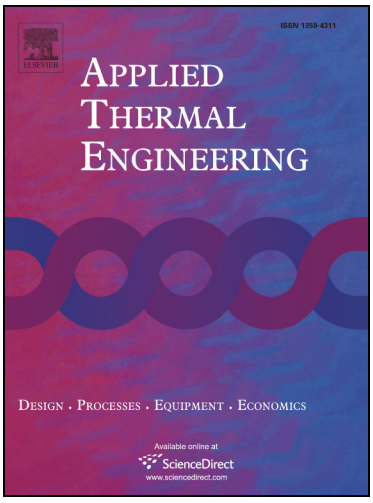

CFD assessment of multiple energy piles for ground source heat pump in heating mode

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CFD assessment of multiple energy piles for ground source heat pump in heating mode

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ABSTRACT

A three-dimensional (3D) computational fluid dynamics (CFD) model of ground source heat pump (GSHP) with multiple energy piles (EPs) is developed to investigate the system heating performances under continuous and intermittent operating conditions, the system thermal energy outputs and coefficients of performance (COPs) are evaluated. The 3D model is meshed based on the hybrid grids with tetrahedron, hexahedron unstructured and structured types, and the k-ε equations to describe the turbulence phenomena within U-tube are resolved by using computational fluid dynamics (CFD) software. A good agreement with less than 12% difference between the CFD model and experimental results is achieved. 10 h active and 14 h idle mode is adopted as the intermittent operating condition in this study. Based on the 3D model simulation data, it is found that the average monthly COPs of the intermittent operation are 3.63, 3.58, 3.45, 3.21, 3.25 and 3.34 from November to April respectively, which are corresponding to 9.3%, 9.5%, 7.1%, 5.9%, 4.8% and 3.1% increases relative to those of the continuous operation. Furthermore, the soil temperature under the intermittent operating condition is higher than that of the continuous operation. To sum up, the intermittent operation not only contributes to the soil temperature recovery but also improves the system performance, which is very favourable for the long-term operation.

Keywords: Energy piles, Ground heat exchangers, CFD model, Continuous operation, Intermittent operation.

1 Introduction

Energy pile (EP) can be utilized for building structural support and ground heat exchanger (GHE) for ground source heat pump (GSHP), which is one of the most promising renewable energy technologies due to its low cost and high efficiency [1,2]. Normally, a GSHP consists of three fundamental components: a GHE, a heat pump unit and an air duct network. Different GHE configurations involving single-, double-, triple U-tube, W-shaped tube, coaxial tube or helical-shaped tube and EPs are presented in Fig.1. Ground heat transfer surrounding the GHE is a key issue for the system design and performance evaluation. In order to clarify the influences of different parameters on the ground heat transfer, many experimental investigations are carried out with high costs. As a result,

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