Analysis of groundwater advection and ground-heat exchanger spacing on intermittent ground-source heat pump operation

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Abstract

Shallow geothermal systems allow both heating and cooling of structures by using the ground as a renewable energy source. These systems have received significant attention in recent decades and careful design consideration is nec-essary to ensure maximum efficiency. In this paper, the authors examine the impact of spacing between ground heat exchangers (GHE) and groundwater advection on a 5x5 array using a transient numerical model. The conditions chosen represent those experienced in Brisbane, Australia. The energy load used represents four months of cooling and three months of heating annually, a simplification based on local conditions. The spacing explored ranged from 4 – 10 m between GHEs and the groundwater flow examined included 0.1, 10, 30 and 50 m/year. The results show increasing spacing reduces thermal inter-ference and increases the sustainability over the lifetime of the system, repre-sented as 25 years in this study. In these conditions, a GHE spacing of 4 m can experience temperatures 8.5°C larger then when the spacing is 10 m. While increasing spacing increased sustainability, this did not prevent an imbalanced load reducing efficiency overtime. Furthermore, it was found groundwater flow had a positive impact on sustainability, over the lifetime of the system a temperature 3.1°C lower was experienced when a groundwater flow of 0.1 m/year was compared to 50m/year. Such an impact should be taken into con-sideration during the design phase due to the reduced GHE length required.