

Optimization of pipe circuits in energy tunnels

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Abstract: Geothermal energy is a kind of green and renewable energy. Conventionally, ground source heat pumps can be used to harvest geothermal energy from the subsurface. To reduce the initial investment, a good solution is to use tunnel linings as heat exchangers to extract/dump heat. This special infrastructure is called an energy tunnel. In addition to the thermal performance, the impact of pipe network configuration on thermal efficiency is still challenging in the design of energy tunnels. To solve this problem, this study makes the first attempt to carry out research on the optimization of pipe circuits in energy tunnels by a series of numerical analyses. A fully coupled thermo-hydraulic 3D finite element model is established to investigate the response of tunnel-soil interaction under cyclical thermal loading (initial soil temperature varies from 8 °C to 18 °C), as well as the thermal transient interactions among air, absorber pipe, tunnel linings and ground, to quantify the amount of useful heat that can be extracted from the tunnel and the ground. On the other hand, the influence of various heat-carrying pipes layout is also investigated. It is found that higher heat transfer efficiency can be obtained when the entrance and exit of pipelines are located below the tunnel in the study. The spatial location of pipelines will also affect the exchanged heat output.

Key words: Energy tunnel; Thermal efficiency; Finite element model; Heat transfer