Symposium on Energy Geotechnics
Accelerating the energy transition
3-5 October 2023, Delft, the Netherlands

Peer-reviewed Conference Contribution

In-situ experimental study on heat exchange capacity of long-span energy tunnel exchangers

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Energy tunnel is a new type of geothermal exchanger in ground source heat pump systems due to their technical and cost improvements over traditional borehole geothermal exchangers. The main reason that the factors affecting the heat exchange capacity of energy tunnel are unclear makes its development be restricted. An in-situ full-scale study using the thermal response tests (TRT) and thermal performance tests (TPT) is performed to investigate the factors affecting the heat exchange capacity in Badaling Energy Tunnel of Beijing-Zhangjiakou High-speed Railway. This paper analyzes the influences of constant heating power, inlet water temperature, air temperature in tunnel, circulating water flow velocity, operation mode, and pipe connection on the heat exchange capacity of the energy tunnel. The test results reveal that (1) the heat exchange rate of the energy tunnel decreases with the increasing constant heating power, (2) the heat exchange rate of the energy tunnel is positively proportional to the inlet water temperature, (3) the heat exchange rate of the energy tunnel at a circulating water flow velocity of 1.1 m^3/h is larger than that at 0.5 m^3/h, it is smaller than that at 0.8 m^3/h, (4) the air temperature in tunnel has a great effect on the heat exchange rate of the energy tunnel, and the pipes connected in parallel or connected in series have a slight effect on the heat exchange rate of the energy tunnel, (5) the average heat exchange rate in an intermittent operation mode is approximately 18.5% larger than that in a continuous operation mode. The test results can be used for the thermal design of energy tunnels.

Contributor statement

Wen Guan: In-situ experiment and writing; Xiaohui Cheng: Doctoral supervisor

Acknowledgments

The authors gratefully acknowledge financial support from China Scholarship Council (201706465003) and Beijing capital highway development group co., LTD.

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DOI: https://doi.org/10.59490/seg23.2023.545