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# Effects of using Expander and Internal Heat Exchanger on Carbon Dioxide Direct-Expansion Geothermal Heat Pump

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**Abstract** In this article, the effects of using expander and Internal Heat Exchanger (IHE) have been investigated numerically in a horizontal Direct-Expansion Geothermal Heat Pump (DX-GHP), based on energy and exergy analyses. Carbon dioxide (CO<sub>2</sub>) in transcritical cycle has been used as the refrigerant, and the effects of the refrigerant pressure drop on heat exchangers, including gas cooler, evaporator, and IHE have been considered. A comparative study has been conducted among four cycles: (a) the cycle with expansion valve (EVC), (b) the cycle with expander (EC), (c) the cycle with expansion valve and IHE (EVC + IHE), and (d) the cycle with expander and IHE (EC + IHE). In the numerical model, the energy and exergy analyses have been performed for four cycles in different operational conditions and two different scenarios of (1) specific heating load and (2) constant Evaporator Loop Length (ELL). The model evaluates the performance of four cycles based on the coefficient of performance (COP), heating capacity, exergy efficiency, exergy destruction rates, and ELL. As a result, the COP and the exergy efficiency of the ECs are more than that of the EVCs. Using an additional IHE in the EVC always leads to a slight increase in the COP and the exergy efficiency. However, the use of an additional IHE in the EC has no significant effect on the COP and the exergy efficiency,

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