MODELING AND ANALYSIS OF a DIRECT EXPANSION GEOTHERMAL HEAT PUMP (DX): PART I-MODELING OF GROUND HEAT EXCHANGER.

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Abstract

Geothermal heat pump technology is actually one of the most interesting processes to provide heat and cold to building (Halozan, 2011). There are two design used in the industry: geothermal heat pump using a secondary ground loop and Direct Expansion (DX) ground source heat pump. Both operate on the simple vapor compressor refrigeration cycle. The main difference is that on the DX geothermal heat pump, figure 1, the ground heat exchanger is part of the refrigeration cycle. So, the energetic and operational performances of the system are directly related to the working fluid behavior, the refrigerant, in relation with the ground heat transfer. This study is in two part, in the first part, the model of ground heat exchanger is presented and in part 2 it's the model of the second exchanger (with water in that case). In this study, a model of the ground exchanger is going to be presented in 1 dimension. The model represents the phase change of the refrigerant, here Chlorodifluoromethane R22, with governing continuity, momentum and energy equations and with heat exchange between pipe and grout. This equation is solved by the use the PDE interface to program the governing equation. To take account the effect of the tube between them two flow is created, one for the ascending flow and one for the descending flow. The pipe and the grout are model with the heat transfer mode of COMSOL. The calculation of the heat exchanger coefficient uses the CHEN correlation (Chen, 1966) for two-phase flow mode and Gnielinski correlation (Gnielinski, 1975) for one-phase flow. A comparison between experimental measurements of a geothermal exchanger with R22 is presented. The Figure 2, show the evolution of quality in the exchanger and the temperature of the fluid. The Figure 3 compares the temperature in the pipe and measurement in an experience. The Figure 4, show the pressure drop in the pipe for the model and the experience. A model of a geothermal exchanger has been developed. This model resolves the governing continuity, momentum and energy equations in one dimension for the refrigerant. The comparison between the model and the experimental allow us to validate the model. This model is the first step to develop a global model of a Direct Expansion Geothermal heat pump.

Reference

1. Halozan, Hermann. 2011. « Ground-Source Heat Pumps - Overcoming Market and Technical Barriers ». no IEA HEAT PUMP PROGRAMME.

2. Chen, J. C. 1966. « Correlation for Boiling Heat Transfer to Saturated Fluids in Convective Flow ». Industrial & Engineering Chemistry Process Design and Development, vol. 5, no 3, p. 322-329.

Gnielinski, V. 1975. « New equations for heat and mass transfer in the turbulent flow in pipes and channels ». Forschung im Ingenieurwesen, vol. 41, no 1, p. 8.

Figures used in the abstract

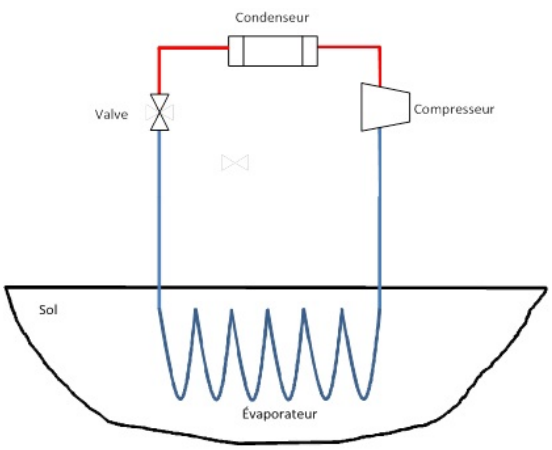

Figure 1: Geothermal heat pump.

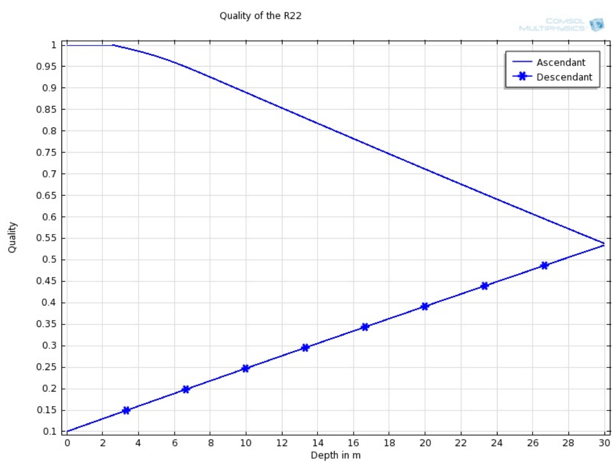

Figure 2: Quality in the pipe.

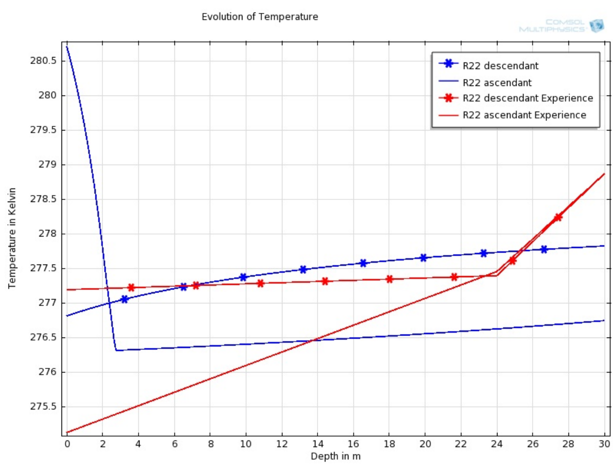

Figure 3: Temperature in the pipe.

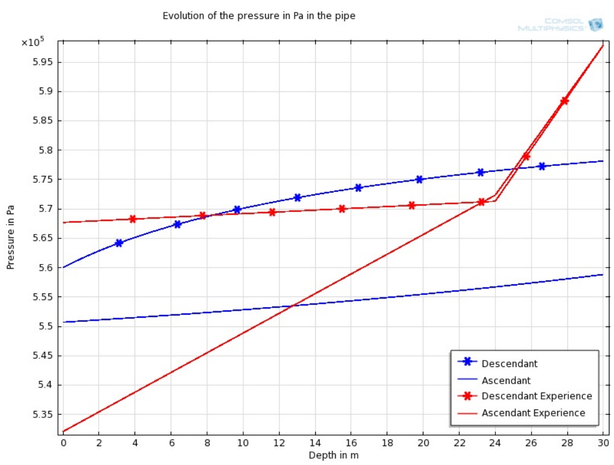

Figure 4: Pressure in the pipe.