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CFD ANALYSIS OF PRESSURE DROPS WITHIN RIFFLED PIPES OF VERTICAL GROUND HEAT EXCHANGER

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One of the most common way of extracting heat from the ground is the application of a vertical ground heat exchangers. They are classified as either closed loops or open loops depending on how they utilise the fluid flowing through the system. No matter which solution is considered, the operating costs of the heat exchanger (and in consequence of the whole installation) depends strongly on the pumping power which is proportional to existing pressure drops.

In this work 3D CFD analysis of a fluid flow problem within vertical ground heat exchanger is discussed. Both downward and upward pipes of the heat exchanger are made of polyethylene (PE100) and they are equipped with internal micro-fins. These fins form a sort of threads with the pitch varying between 1200 mm and 1600 mm. Both pipes (almost 250 meter long each) are connected at the lowest point either by standard U-turn or by specially designed bottom chamber. Depending on the external conditions, two different water-ethanol solutions can circulate within the pipes of the heat exchanger. The considered ethanol concentrations in these solutions are 24% or 35%, respectively.

Computer simulations have been carried out using Ansys Fluent package and specially designed User Defined Functions. Because of the heat exchanger length the whole computational domain was generally divided into three parts: inlet part (longer than 50 internal diameter of the pipe), both pipes connection and remaining pipes for which pressure drops depend linearly on the pipe length. The pressure drop along 1 meter of the pipe was determined modelling solution flow within repeatable segment. These three parts were analysed separately and obtained solutions have finally been coupled iteratively.

Processing numerical results of 3D CFD simulations the special correlations to determine pressure drops in the pipe equipped with internal micro-fins were developed. Additionally, influence of pipe deformation (i.e. ovality) caused by transport, storing of pipes in coils, applying of clamping devise, etc. is also considered. Finally, obtained results are related to some measurements [1].

REFERENCES

[1] J. Acuña and B. Palm, Experimental comparison of four borehole heat exchangers. 8th IIR Gustav Lorentzen Conference. Copenhagen, 2008.