# NON-STATIONARY PERFORMANCE OF A GROUND HEAT EXCHANGER BASED ON T-FSI MODELLING

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In this paper there have been presented the results of a ground heat exchanger (GHE) non-stationary numerical analysis, which in general aim to predict the most accurate work parameters, such as: the heat flux, (Q_wall), the outlet medium temperature, the mass flow rate, the pressure drop, the velocity, the temperature distribution in the soil, and the most accurate constructing materials, etc., of a studied system. The main result is, inter alia, the characteristic describing the heat flux, Q_wall, received via side wall, over time, presented in the figure 1. That is a source of such information that the ground heat exchanger need to be switched off after two hours of continued work, so the soil could regenerate.

The whole studied domain consists of a 100 meters long Field's type ground heat exchanger, which is a so called "pipe in pipe" heat exchanger, and its surrounding – volume of the ground of a 50 meter radius. Internal and external GHE diameter is equal to 40 [mm] and 60 [mm], respectively. Mentioned GHE has been hooked in a low heat source, which was sand and gravel. The main reason of undertaking the work to solve this problem was to create a CFD model, which would be generating appropriate data for a "0D" heat pump application. Ipso facto, there has been presented the mathematical model of a thermal fluid-solid interaction (T-FSI) and also the results of the medium flow through the mentioned GHE. There have been studied different working medias and GHE constructing materials, but in the long run, glycol has been chosen as a working fluid and copper for the external pipe, and teflon for the internal one. As it has been discovered, the whole phenomenon of heat transfer in such a system is strongly determined by the soil parameters and that is why the constructing material of the GHE doesn't make much difference.

There has been used special computational tool to generate appropriate model and results. As it is an axisymmetric GHE geometry, computational time could have been shortened, in consequence of using a special option. There has been set the pressure-based type, so it was the outlet pressure having been changed. The Courant Number was set at the level of 50, while the viscous-laminar model has been applied. The examined system has been working in unsteady terms. The value of the Reynold Number varies in range [5-2000].

In the figure 1 there has been given one of the most interesting and valuable characteristic, which is on time dependent heat flux (Q_wall) received via GHE external wall. As it might be easily notice, the value of Q_wall decreases over time. These results are in accordance with the matter of fact. Total GHE length is 100 meters, consequently value of the highest unitary heat flux (q_unitary [W/lm]) is as follows, q_unitary=182,71[W/lm], what is a rewarding result.

In the figure 2, there has been shown the outline of the researched system. Two other figures 3 and 4 show the temperature distribution in the ground for transient and steady conditions, respectively.

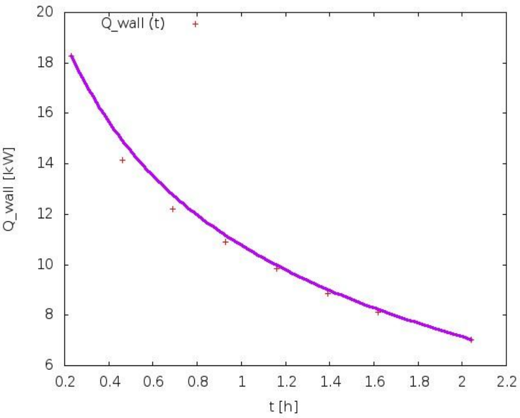

*Figure 1 On time dependent heat flux received from the ground.*

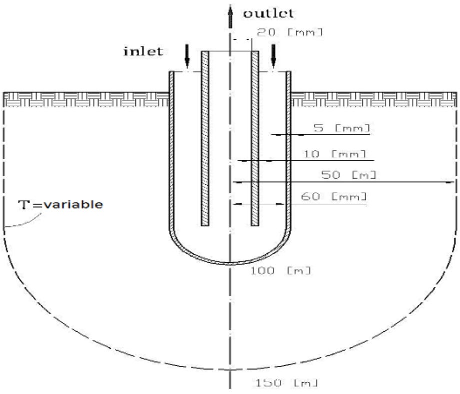

*Figure 2 The outline of studied system.*

Conclusions are as follows, figure 1 shows that after two hours of continued work of the GHE, the ground cools that much that further use of the low heat source doesn't bring any greater benefits, so the GHE should be switched off, so the ground could regenerate. This gives a user a valuable information about the proper work conditions, such as time of continuous work. Moreover, there has been designated glycol mass flow rate, $\dot{m} = 0.26 \ [\frac{kg}{s}]$ and its velocity, $v = 7 \ [\frac{cm}{s}]$ for the most effective heat transfer. Although there has been applied winter conditions and the ground surface temperature is negative, and equal -2 [ºC], there has been noticed high unitary heat flux received from the ground via side external pipe wall. As it is shown in the figure 2, there has been applied temperature profile to the envelope of the whole system. Special UDF (Users Defined Function), containing two linear temperature profiles, strongly determined by depth, has been implemented into computational software, so that to have an opportunity to set more accurate boundary conditions.

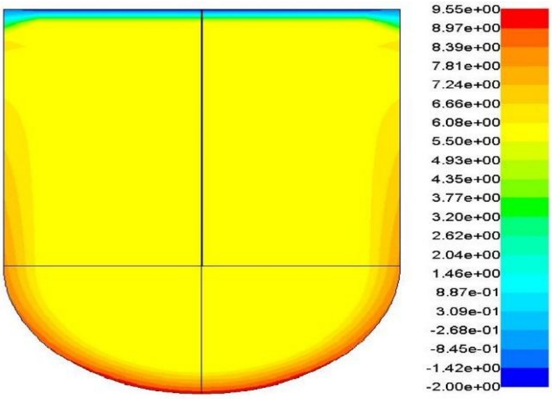

*Figure 3 Temperature distribution in the soil.*

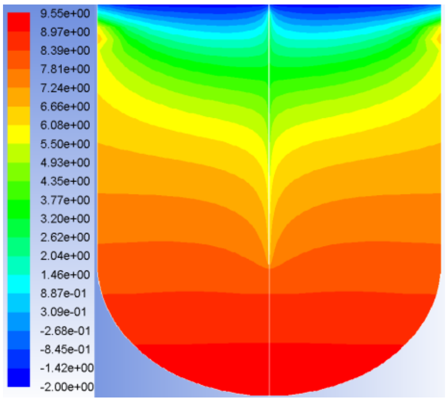

*Figure 4 Temperature shallpit, steady conditions.*

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