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Swiss Federal Office of Energy SFOE

CO_2 GEOTHERMAL HEAT PROBE

PHASE 2

Annual Report 2008

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SFOE Project/Contract-number	102'247 / 152'857
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Project Duration (Start-End)	August 2007 – August 2009
Date of Report	8 December 2008

SUMMARY

In this project the fluid dynamics and thermodynamics inside a CO_2 geothermal heat probe have been investigated. The functionality of such a probe, which works like a thermosyphon, was analyzed by means of a simulation model in MATLAB. The model couples the behaviour inside the heat probe with the heat conduction in the earth. A parameter study revealed that the self-circulation character of such a probe leads to flattening of the vertical earth temperature profile near the probe and, hence, leads to more uniform heat removal along the probe. This "energy shifting effect" from bottom to top even works when the heat pump is off, by a combination of evaporation of CO_2 in the lower part and condensation in the upper part of the probe. The heat transfer resistance of the evaporating CO_2 film flowing down the probe wall is very small compared to the conduction resistance of the earth. Therefore, no difference has been found between the performances of a conventional heat pipe and a configuration where the liquid phase injection is distributed on different height stages along the probe. By dimensioning a CO_2 heat pipe it has to be considered that the pipe diameter has to be wide enough in order to not limit the heat flow due to flooding (holdup of liquid film by gas flow). Wider pipes are also favourable regarding heat transfer, while on the other hand costs of construction will increase.