Transient modelling and simulation of a double-stage Organic Rankine Cycle

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1 Introduction

Geothermal energy is a renewable resource for power and heat production. For low enthalpy reservoirs, the geothermal energy is usually converted to electricity by an Organic Rankine Cycle (ORC). The efficiency and profitability of these power plants can be increased by an additional heat supply. In this study, a dynamic model of a double-stage ORC power plant is developed to investigate and evaluate geothermal combined heat and power (CHP) plant concepts.

2 Methodology

For modelling and simulation of the double-stage ORC the software Dymola (Dassault Systèmes, 1992-2004) in combination with the library ThermoCycle (Quoilin et al., 2014) is used. The fluid properties are calculated with the software CoolProp (Bell et al., 2014).

3 Results

For the validation of the double-stage ORC a period of 24 hours in steps of one minute is simulated and the results are compared to operational data of a real geothermal power plant in the German Molasse Basin. The relative root mean squared error (RRMSE) between simulation and operational data is 3.6 % on average. An important parameter for the evaluation of different CHP-concepts is the generated electrical power. The validation results for the electrical power output of the generator are shown in Figure 1. The RRMSE is 3.9 %. The dynamic behavior is evaluated by the coefficient of correlation. For the electrical power output this coefficient is 0.99, which means that the both curves are almost identical in shape and the simulation model can predict the dynamic behavior of the real power plant.

4 Conclusion

In this study, a transient simulation model of a double-stage ORC is developed and validated by operational data of a real power plant. The electrical output of the generator can be predicted by 3.9 %.

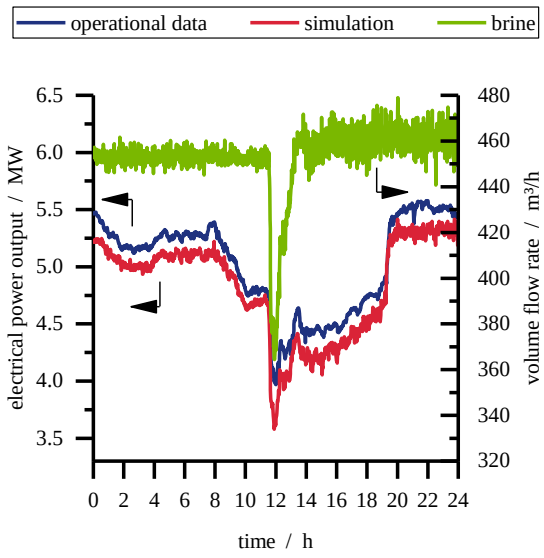

Figure 1. Validation results for the electrical power output of the double-stage Organic Rankine Cycle.

In future work, based on the dynamic simulation model different geothermal combined heat and power plant concepts are investigated and evaluated by annual return simulations.

References

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