INFLUENCE OF THE PINCH POINT TEMPERATURE DIFFERENCE ON THE PERFORMANCE OF THE "PREHEAT-PARALLEL" CONFIGURATION FOR A LOW-TEMPERATURE GEOTHERMALLY-FED CHP

Sarah Van Erdeweghe*, Johan Van Bael, Ben Laenen, William D'haeseleer

* [1.]*KU Leuven (University of Leuven), Applied Mechanics and Energy Conversion Section, Celestijnenlaan 300 – box 2421, B-3001 Leuven, Belgium*
[2.]*EnergyVille, Thor Park, Poort Genk 8310, B-3600 Genk, Belgium*

ABSTRACT

In this work, we investigate the performance of the so-called "Preheat-parallel" CHP configuration, for the connection to a thermal network (TN). A low-temperature geothermal source (130°C), and the connection to a 75°C/50°C and a 75°C/35°C thermal network are considered.
For a pure parallel CHP configuration, the brine delivers heat to the ORC and the thermal network in parallel. However, after having delivered heat to the ORC, the brine in the ORC branch still contains some energy which is not used. The "Preheat-parallel" configuration utilizes this heat to *preheat* the TN water before it enters the parallel branch, where the TN water is heated to the required supply temperature.
The "Preheat-parallel" configuration is especially favorable when connected to a thermal network with a low return temperature, a large temperature difference between supply and return temperatures – thereby exploiting the *preheating effect* – and for high heat demands.
In this paper, we focus on the effect of the pinch point temperature difference (ΔT_{pinch}) on the plant performance. ΔT_{pinch} is directly related with the size and cost of the heat exchangers and strongly influences the *preheating*-effect, which is the most characteristic feature of the "Preheat-parallel" configuration.
First, we present the results of a detailed sensitivity analysis of ΔT_{pinch}. A higher ΔT_{pinch} results in a lower *preheating*-effect, a lower net power output and, correspondingly, lower plant efficiency. Furthermore, we compare the performance of the "Preheat-parallel" configuration with the convenient parallel and series CHP configurations. For all three configurations, the performance decreases with an increase of ΔT_{pinch}.
For the considered thermal network requirements, the net power generation is the highest for the "Preheat-parallel" configuration. With respect to the parallel configuration, the gain in net power generation stays approximately constant (75°C/35°C TN) or decreases (75°C/50°C TN) with the imposed pinch point temperature difference. With respect to the series configuration, the gain in net power generation increases for a higher value of ΔT_{pinch}. This means that the impact of ΔT_{pinch} is the biggest for the series configuration, followed by the "Preheat-parallel" configuration, and that the impact on the performance of the parallel configuration is the smallest.