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TESTING OF A NEW SUPERCRITICAL ORC TECHNOLOGY FOR EFFICIENT POWER GENERATION FROM GEOTHERMAL LOW TEMPERATURE RESOURCES

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ABSTRACT

Recent international focus on the value of increasing renewable energy supply highlights the need for revaluating all alternatives, particularly those that are large and well-distributed. One such option is geothermal energy from hydrothermal low temperature resources. The most efficient and cost-effective way to exploit this type of reservoir is based on the use of binary cycles. Purpose of ENEL Research in this field is to develop and design an optimized and highly flexible binary cycle to be applied to the exploitation of water dominant geothermal resources acquired by ENEL worldwide and to study options for its integration with solar energy. Different Rankine cycles for geothermal resources at temperature levels between 120°C and 180°C have been extensively studied and optimized to maximize overall conversion efficiency and to minimize plant costs, in collaboration with Politecnico di Milano. This analysis allowed the assessment both of subcritical optimized cycles and supercritical innovative advanced cycles using different working fluids (e.g. hydrocarbons and refrigerants). Moreover the carried out studies showed that in a supercritical cycle the possibility to operate outside the fluid saturation curve during the heat adduction phase guarantees a greater power production (no pinch-point problems) and operational flexibility with respect to subcritical cycles (e.g. reduced performance decline due to external condition variability such as brine temperature and mass flow rate and environment air temperature). Based on the carried out theoretical analysis, the decision to demonstrate an advanced, high efficient binary cycle at the pilot scale was taken. A preliminary design of the main components for a 500 kWe prototypal-sized supercritical binary power plant was carried out in collaboration with Turboden and Politecnico di Milano. The plant was designed and realized by Turboden and was installed in the Enel experimental platform (Livorno, Italy) at December 2011. In the first part of 2012 the pilot plant was put in operation and characterized for different geo-fluid conditions (e.g. temperature and flow rate) and ambient conditions. The experimental tests carried out on the supercritical pilot plant validate the achieved theoretical results, taking special care to plant performance flexibility and main component design criteria. This paper will give an overview of the theoretical and experimental activities carried out in order to characterize the ORC supercritical technology.