EVALUATION OF THE TECHNICAL FEASABILITY, ENERGY PERFORMANCE AND ECONOMICAL PROFITABILITY OF AN ORC-BASED MICRO-CHP SYSTEM INVOLVING A HERMETIC SCROLL EXPANDER

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ABSTRACT

Organic Ranking Cycle (ORC) is one of the technologies often considered well suited to micro Combined Heat and Power (CHP). Indeed, ORC can be associated with a boiler to produce heat and electricity. The advantages of this technology are a high reliability and simple maintenance because of reduced number of moving parts and a large fuel flexibility because of the external combustion.

Scroll machines are often considered for expander in ORC because of its reliability, simplicity, capacity to handle high ratio of pressure… Moreover, scroll compressor does not require much adaption to work in expander mode.

This paper aims to evaluate the performance and profitability of an ORC-based micro-CHP system. Especially, this paper focuses on the use of a hermetic scroll compressor used as expander in the ORC.

A prototype of hermetic scroll expander (compressor adapted to work in expander mode) was tested into a gas cycle test rig with R245fa as working fluid. A semi empirical model using a limited number of physical meaning parameters was built. This model was validated with the experimental results.

This model is inserted into an ORC model and coupled with a boiler model. With this global model, three systems configuration are evaluated in term of electrical and thermal efficiencies and the best one is chosen.

Once the best configuration is determined, the operation of the system is simulated on a full year with the global mode. This seasonal simulation can highlight the seasonal performance of the ORC based micro CHP system.

Using economical criterion as net present value and levelized electricity cost, the profitability of the system is evaluated. Parametric studies are made on the profitability varying several parameters like discount rate, price of fuel, subsidies…

Finally, adaptations of the hermetic scroll compressor are proposed to improve the efficiency of the system.