PRELIMINARY EXPERIMENTAL INVESTIGATION OF A BIOMASS-FIRED ORC-BASED CHP SYSTEM FOR AN INDOOR SWIMMING POOL

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ABSTRACT

Small-scale CHP systems are particularly suitable for applications in commercial and domestic buildings because not only reduces the losses of the energy conversion process but also avoids the losses associated with its transportation and distribution, improving the sustainability of the whole process.

This work presents the preliminary results of an experimental investigation of a biomass-fired CHP system based on an organic Rankine cycle (ORC) in a lab-scale test-rig that intends to emulate an indoor swimming pool. After a thorough investigation of possible CHP applications, indoor swimming pools fitted the requirements, reasonable high thermal needs at relatively low temperature.

For a real cycle, the performance of the ORCs vary with several factors, such as the heat source temperature, heat sink conditions, the load of the system and the expansion machine. The test-rig includes a biomass boiler (350 kWt) as heat source and uses the hot water at 95ºC to evaporate the working fluid of the ORC and to heat up the domestic hot waters. The use of hot water from the boiler at a quite low temperature allows the application of the ORC module to existing installations. The organic Rankine cycle runs with R245fa as the ORC working fluid, plate heat exchangers are adopted for evaporator and condenser and a radial flow type turbine to simultaneously heat the indoor swimming pool water and produce electricity.

Experiments were conducted to evaluate the performance of the developed system for different customer heat demands. The impact of the fluid charge on the ORC was evaluated on the CHP performance in the design and part-load conditions. The experimental data obtained in the tests were compared with the previously developed simulation model. The system developed in this study and the experimental results may serve as tools for proof of concept and further optimization of ORC-based CHP systems.