

ENERGETICAL, TECHNICAL AND ECONOMICAL CONSIDERATIONS BY CHOOSING BETWEEN A STEAM AND AN ORGANIC RANKINE CYCLE FOR SMALL SCALE POWER GENERATION

Ignace Vankeirsbilck*, Bruno Vanslambrouck*, Sergei Gusev*, Michel De Paep†

*Howest, University College of West Flanders
Electromechanics Department, Research Group on Energy Conversion
Graaf Karel de Goedelaan 5, 8500, Kortrijk, Belgium
E-mail: (Bruno.Vanslambrouck, Ignace.Vankeirsbilck, Sergei.gusev)@howest.be
Web page: <http://www.howest.be>; <http://www.orcycle.eu>

†Ghent University-UGent
Department of Flow, Heat and Combustion Mechanics
Sint-Pietersnieuwstraat 41, 9000 Gent, Belgium
E-mail: Michel.Depaepe@ugent.be
Web page: <http://www.ugent.be/ea/floheacom/en>

ABSTRACT

To generate electricity from biomass combustion heat, geothermal wells, recovered waste heat from internal combustion engines, gas turbines or industrial processes, both the steam cycle and the Organic Rankine Cycle (ORC) are widely in use. Both technologies are well established and can be found on comparable applications.

This paper presents a thermodynamic analysis and a comparative study of the cycle efficiency for a simplified steam cycle versus an ORC. The most commonly used organic fluids have been considered : R245fa, Toluene, (cyclo)-pentane, Solkatherm and 2 silicone-oils (MM and MDM). Working fluid selection and its application area is being discussed based on fluid characteristics.

The thermal efficiency is mainly determined by the temperature level of the heat source and the condenser conditions. The influence of several process parameters such as turbine inlet and condenser temperature, turbine isentropic efficiency, vapour quality and pressure, use of a regenerator (ORC), is derived from numerous computer simulations. The temperature profile of the heat source is the main restricting factor for the evaporation temperature and pressure.

Finally, some general and economic considerations related to the choice between a steam vs. ORC are discussed.

REFERENCES

- [1] P.J. Mago, L.M. Chamra, K. Srinivasan, C. Somayaji, 2008, "An examination of regenerative organic Rankine cycles using dry fluids", *Applied Thermal Engineering*, vol. 28, Jun. 2008, p. 998—1007.
- [2] T. Hung, 2001, "Waste heat recovery of organic Rankine cycle using dry fluids", *Energy Conversion and Management*, vol. 42, Mar. 2001, p. 539—553.

- [3] B. Liu, K. Chien, en C. Wang, 2004, “Effect of working fluids on organic Rankine cycle for waste heat recovery”, *Energy*, vol. 29, Jun. 2004, p. 1207—1217.
- [4] G. Angelino, P. Colonna di Paliano, 1998, “Multi-component Working Fluids For Organic Rankine Cycles (ORCs)”, *Energy*, vol. 23, Jun. 1998, p. 449—463.
- [5] P. Colonna, T.P. van der Stelt, 2004, FluidProp: a program for the estimation of thermo physical properties of fluids, Energy Technology Section, Delft University of Technology, The Netherlands (www.FluidProp.com).
- [6] Simulation software Cycle-Tempo Website: <http://www.Cycle-Tempo.nl>
- [7] Chacartegui R., Sánchez D., Muñoz J.M., Sánchez T., 2009, “Alternative ORC bottoming cycles for combined cycle power plants.”, *Applied Energy*, vol. 86, 2009, p. 2162 – 2170
- [8] Angelino G., Invernizzi C, Molteni G, 1999, “The potential role of organic bottoming Rankine cycles in steam power stations.”, *Proceedings of the Institution of Mechanical Engineers : A journal of power and energy*, vol. 213, 1999, No A2, p. 75 – 81