

ORC INTEGRATED INTO ENGINE FOR SIMPLIFIED DIRECT WASTE HEAT RECOVERY FROM COOLING AND FLUE GAS – SYSTEM CONSIDERATIONS

David J. Szucs, Jan Spale, Vaclav Novotny, Vaclav Vodicka, Jakub Mascuch*

** University Centre for Energy Efficient Buildings, Czech Technical University in Prague,
Třinecká 1024, 273 43 Buštěhrad
Czech Republic*

ABSTRACT

Current systems of waste heat recovery (WHR) in internal combustion engines (ICE) are typically considered only for exhaust gas of the engine. The heat can be utilized directly for recuperation into heating system or in bottoming ORC system. These applications are mostly mature technologies. ICE additionally requires cooling of the cylinders to prevent overheating. Low-potential heat recovered from engine cooling system is not typically utilized and is released to the environment. Some projects have studied a use of jacket-cooling heat in a bottoming cycle or for preheating of the working fluid, but only through an intermediate cooling fluid loop.

A novel integrated ICE-ORC system that uses both high-potential heat from the exhaust gas and low-potential heat from the jacket cooling system is presented. The novelty is in direct use of the organic working fluid of the ORC system in the jacket cooling. The ability and the limits of the cooling systems of conventional ICEs are explored and analysed in the work. The advantage of the novel ICE-ORC system is in reduction of capital costs and complexity of the system by eliminating the intermediate cooling fluid loop, as well as in an increase of total power output and fuel utilization efficiency.

This work presents the results for ORC integration into a small-scale 22 kWe ICE. Theoretical analyses for a range of system parameters of the novel system show expectation of 5-6 % increase in total power output. Design considerations are discussed, such as material compatibility, pressure limits, heat transfer considerations or overall operation regimes. Lastly an experimental design for future experiments is shown.