Organic Rankine Cycle with Direct Liquid Injection into a Twin-Screw Expander

Abstract:
The Organic Rankine Cycle (ORC) is a thermal engine, which is applied to convert low temperature heat to electrical power using organic working fluids. It is an established technique for waste heat recovery, as well as for the utilization of biomass, geothermal energy and solar energy. This study presents a novel operational strategy of an ORC, which allows for reliable control of process parameter while simultaneously ensuring a high cycle efficiency. This strategy is analyzed experimentally and compared with a system simulation. With this method, preheated liquid working fluid is injected to partially expanded vapor inside a volumetric screw expander. The injected mass flow bypasses the evaporator and can be controlled by a valve. Thus, the direct liquid injection into the expander reduces the exhaust temperature, reducing the risk of thermal damages in case of a hermetic or semi-hermetic expander. The experimental and simulation results show, that the exhaust vapor temperature can be reduced by approx. 40 K for the investigated operation conditions. This enables the...
expander to run at higher live steam conditions by simultaneously ensuring sufficient cooling of 
the generator and thus allows for higher power production. Alternatively, lower exhaust 
temperatures lead to the advantage of less required desuperheating in the condenser and thus 
to higher overall heat transfer coefficients in the condenser, allowing for smaller heat transfer 
areas.

Stichworte: Control strategy; Direct liquid injection; Screw expander; Experimental study; Modelling; 
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