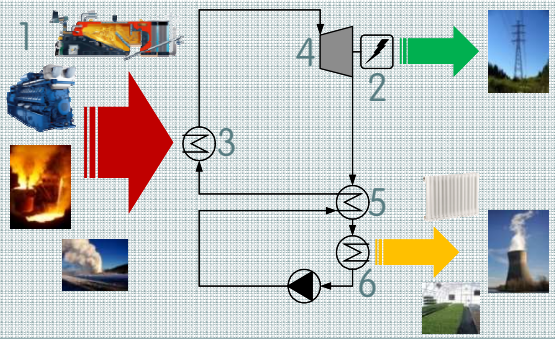
Turn waste heat into electricity

www.orcycle.eu

howest
De Hogeschool West-Vlaanderen
Lid van de Associatie Universiteit Gent

European Era SME-project on industrial waste heat

Project goals are to transfer ORC technology to Flanders (Belgium) by proving its technical and economic feasibility. Some included actions are: intensive state of the art research, complete market overview, study of cost-effectiveness for several applications, case studies, laboratory setup, comparison with other heat recovery technologies, publications, presentations, conference organization.



The Organic Rankine Cycle or ORC converts heat from various sources (1) into electricity or mechanical work (2). In a boiler (3), a preheated organic working fluid under high pressure evaporates. This vapor produces work while passing through an expander (4). Then, the expanded vapor exchanges its perceptible heat in the recuperator (5) before being liquidized in the condenser (6). The latent heat can be used for district heating or dissipated to the ambient. The liquid is then pumped to evaporation pressure and preheated in the recuperator before it arrives in the boiler, where the cycle restarts.

Cases studies:

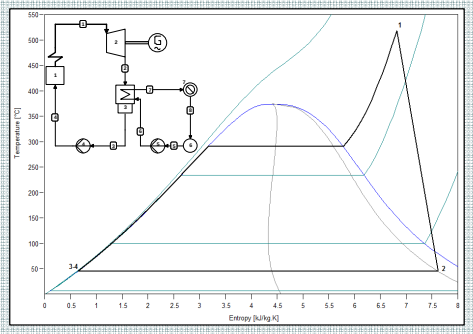
1. Steel wire production: flue gases at 700 - 800°C, cooling water at 90°C (low power)
2. Steel plant: flue gases 8 – 10 MWth at 350°C, cooling water at 85°C, 16 MWth for 1 furnace.
3. Foam glass manufacturer: CO afterburning of exhaust gases from foaming installation about 3600kWth at >750°C.
4. Car plant: heat recovery from regenerative air cleaning systems, exhaust air at 340°C (small spread sources).
5. Paper mill: "renew" CHP installation based on a gas turbine, various heat sources
6. Food plant: waste heat from cooling water
7. Chemical plant: steam at 2,5 bar, 140°C, 3-5 tons per hour, ORC ordered.
8. Municipal incinerator: total heat capacity 24,3 MW with heat recovery steam turbine. Some usable waste heat available.
9. Water treatment station: exhaust after boiler LUVO at 220°C, hot water at 85°C.
10. Brown coal powder fired drum furnace : 100 000 Nm³/h exhaust gas at 250-280°C

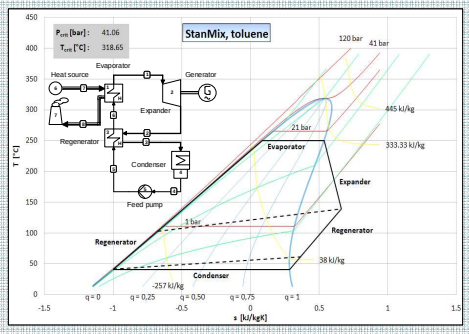
Research and simulations

Objectives

- Thermodynamic analysis and comparative study of the cycle efficiency for a simplified steam cycle versus ORC
- Organic fluids: Solkatherm, R245fa, toluene, (cyclo)-pentane, and 2 silicone oils: MM and MDM.
- Working fluid selection based on fluid characteristics and application area.
- Influence process parameters : p, T, ηi, regenerator, q
- Influence temperature profile heat source
- Steam cycle with bottoming ORC
- Economic analysis and comparison
- Selection criteria steam vs. ORC
- Elaborate industrial case studies on low grade waste heat sources

* Simulations are made in CycleTempo (TUDelft)





Steam cycle

- Wet fluid
- Superheated steam
- High superheating temperatures
- High evaporation pressures
- Flexible power/heat ratio (CHP)
- Direct heating and evaporation
- Water treatment and deaerator

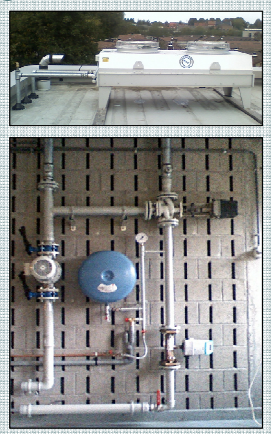
Organic Rankine Cycle

- Dry fluids
- Saturated vapour
- Superheated vapour after expander
- Low evaporation pressure
- Efficient part load behaviour
- Often additional thermal oil circuit
- Less complex installation, easy to operate

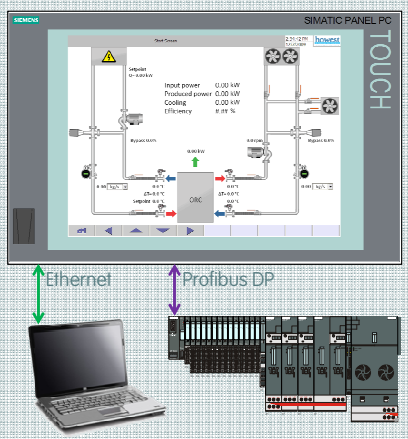
Test and demo rig at Howest

Heat source: Thermal oil boiler 250kW, Maxxtec

ORC, 10kWe, BEP-Europe E-Rational



Cooling loop



Measurement and acquisition system, Siemens

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