Assessment and Design of a Waste Heat Recovery and Energy Conversion System

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McMaster University ENGINEERING

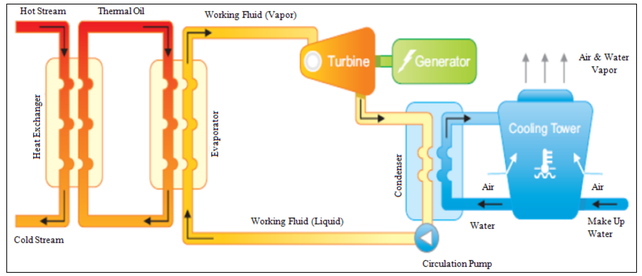
Project Goal: *To design an economically sound automated waste heat recovery and energy conversion system with minimal process interference*

Objectives

- *AMD: Reduce utility costs and lower environmental impact*
- *Hatch: Step forward for HEROS program*

Approach

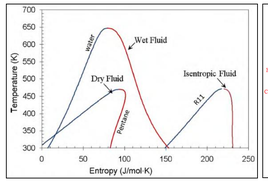
- *Recover waste heat and convert to power using Organic Rankine Cycle (ORC) principles*
- *Simulations modeled for base case, vendor's system, process variability and optimization*

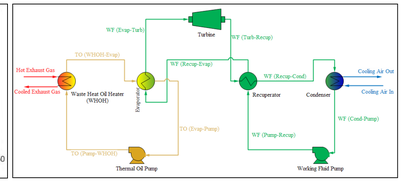


- *ORC*
  - *Heat is transferred from the waste heat source to the ORC via a thermal oil loop (added safety feature)*
  - *Working fluid is vaporized in the evaporator and expands in the turbine thereby generating power*
  - *The working fluid is then condensed by air or water*

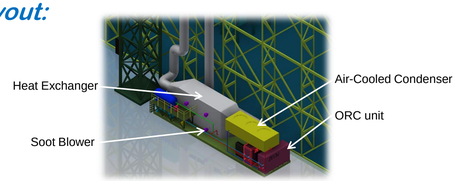
ORC System for AMD

- *Working fluids selected based on saturation curves*

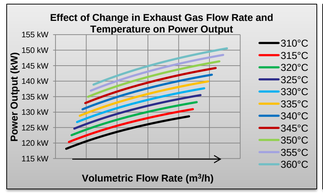


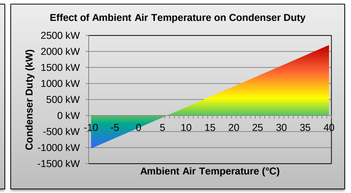


- *Power output: 176 kW; Efficiency: 16%*
- *Vendor's power output: 130 kW (equivalent power for 99 homes in Ontario)*
- *Overall layout:*



- *Process Variability (effects of change in waste heat source parameters):*

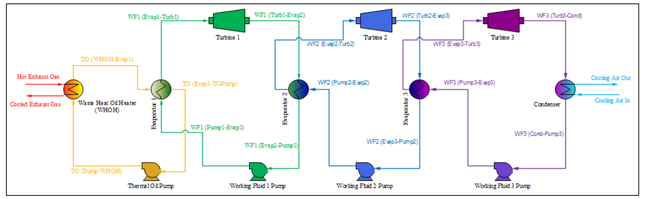




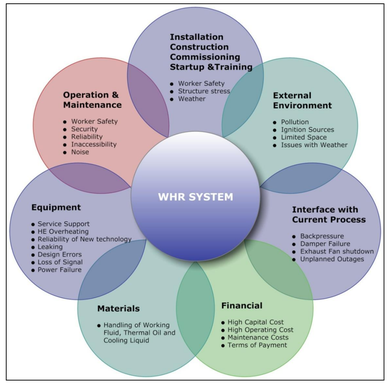
- *Levelized Cost of Elec.: $0.073/kWh (14% savings)*
- *GHG emission reduction:182 t CO2 eq./yr*

Optimization

- *Typical ORC efficiencies: 10-18%*
- *Multi-stage ORC:*



- *2-Stage ORC: 24% efficiency*
- *3-Stage ORC: 30% efficiency*

Risk Assessment

- *Divided into 7 categories*
- *Major risks moderated:*
  - *Process interference*
  - *Worker safety*
  - *Pollution*
  - *ORC reliability*
  - *Space availability*