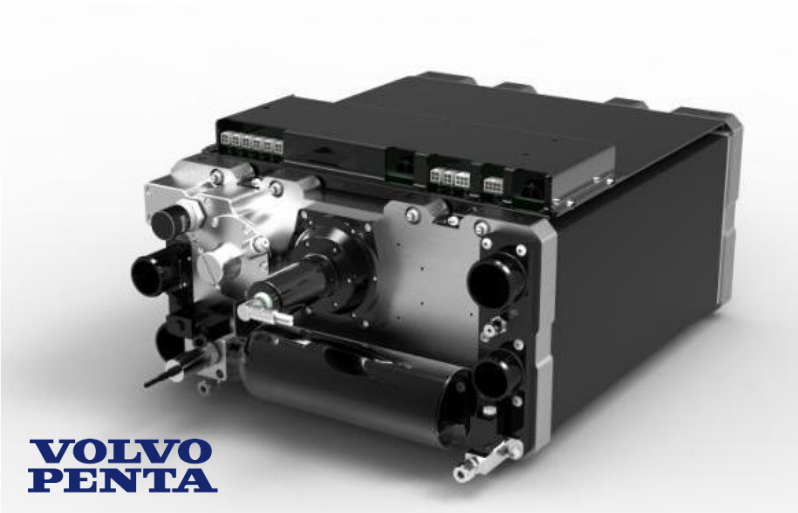
Waste heat recovery for fuel cells



Background

The first fuel cells were invented by Sir William Grove in 1838. A fuel cell is an electrochemical cell that converts the chemical energy of a fuel, mostly hydrogen, and an oxidizing agent, mostly oxygen, into electricity through a pair of redox reactions. Fuel cells are different in that they require a continuous source of fuel and oxygen to sustain the chemical reaction compared to a battery where the chemical energy comes from metals and their ions or oxides that are already present in the battery. There are many types of fuel cells, however, the most common for vehicles and vessels are PEM (Proton Exchange Membrane), which is a fast low temperature technology – and this is the base in this study. A good diesel engine will have a peak efficiency slightly above 40%, whereas a fuel cell is close to 60%. In a diesel engine roughly 40% of the rejected heat will come through the exhaust, however, in a fuel cell there is no exhausts, apart from water created in the process, why the cooling system must handle 100% of the rejected heat. The rejected heat from a fuel cell is also at a lower temperature, usually 70 degrees Celsius. This leads to much larger cooling systems, especially since the ambient temperature delta becomes less. Waste heat recovery systems is an energy recovery heat exchanger that transfers heat from process outputs at high temperature to another part of the process for some purpose, usually increased efficiency.

Tasks

1. Learn to work in a global product development team
2. Study the challenges in a how to recover heat from low temperature fluids – literature, simulation, IP etc.
3. Study how existing WHR systems work to find out what are available, including temperature boosters
4. Design a vehicle or a vessel powered by a FC including the best WHR candidate. The vehicle/vessel should be using a 300kW FC
5. Investigate other means of using the heat, as well as other possible extended functions
6. Provide design sketches / simplified CAD-models and simulation results of the final candidate

Global Capstone Projects with Chalmers, Penn State and Volvo Group

Students
The project is in cooperation with Pennsylvania State University (Penn State). The project team will consist of three to four students from Chalmers and Penn state, respectively.

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Target group

Maskinteknik TKMAS, Teknisk fysik TKTFY, Kemiteknik med fysisk TKKEF

Group-size
3 - 4 students from Chalmers (and 3 - 4 students from Penn State)
(Projektet kan ej fördubblas)

Reference

Classic waste heat recovery systems are usually handling high temperatures, i.e, >100 degrees Celsius. The most common ones are organic Rankine, turbo compound, cogeneration, thermos acoustic, Stirling etc. Some companies are, however, working with lower temperatures and use a heat pump to generate steam in a turbine, but they are all stationary.