Organic Rankine Cycle

The purpose of an ORC is to drive a turbine at relatively low heat (<500°C). Instead of water and steam, this is done using an organic working medium (eg. toluene) that vaporises at a lower temperature than water. The liquid-vapour cycle is the same as that in a steam turbine.

Triple function of working medium

The secondary pump also pumps the working medium to the turbogenerator, where it acts as a lubricant for the bearings and a coolant. Because only one liquid is being pumped around the system, its structure is relatively simple. The working medium can double as a coolant because it is electrically inert.

Effective power 60 - 165 kW
Maximum efficiency 19.5%

Turbogenerator and pump in a single housing

What makes the Triogen ORC so special is that the turbine, generator and pump are all connected to the same driveshift. Consequently, the turbine drives both the generator and the pump. The starting point for this feature was the optimum rotation speed of the turbine (25,000 rpm). A unique generator was then developed with the same high speed of rotation, as well as a pump which delivers the correct mass and flow of liquid at that speed. Because no gearing is needed between the turbine and the generator, they and the pump can all be contained inside the same sealed housing. There are no openings for the driveshift and no sealing rings, and hence no opportunity for the working medium to leak.

TU Delft Mini-ORC

Delft researchers are currently working on a residual heat system for lorries. This is technically possible, although no working ORC prototype of such a system has been produced until now. The provisional design indicates that it can deliver an additional 9.6 kW from a 150 kW engine. It is estimated that the exhaust gases can increase the efficiency of the engine by about 10%.

R&D CHALLENGE

1 Integration

The inclusion of a mini-ORC will increase the volume of the engine by 12-50%. Since that amount of room is not available, adding a separate ORC module is not an option. Only by cleverly integrating its components within the existing engine can it be incorporated into a lorry without increasing its volume.

R&D CHALLENGE

2 Turbine miniaturisation

The research is focusing upon the development of a turbine with axial shift. The small rotor, (diameter 8-20 cm) rotates at very high speeds (10,000-40,000 rpm) because the working medium flows at the same rate as in a unit of normal size (the thermodynamic process is scale-independent).

R&D CHALLENGE

3 Ideal working medium

The aim is to develop a thermally stable, non-flammable working medium with a low boiling point and a critical point equal to the temperature of the exhaust fumes.

Prototype test

The mini-turbine should be ready about two years from now. The project partners, TU Delft and Dana-Spicer Delft, will then measure its performance on an ORC testbed.