Machinery for high-speed LNG-ferries

In this project, Mols-Linien A/S and DTU Mechanical Engineering co-operate on studying the machinery for future gas-powered high-speed ferries. Computational tools developed within the Danish Center for Maritime Technology (DCMT) are used for the modelling work. The use of gas will reduce the pollutant emissions significantly, thereby lowering ferries' contribution to global warming and pollution in coastal regions.

One way to reduce pollutant emissions from ferries is to change to liquid natural gas (LNG) as fuel. Considering a propulsion system with the same efficiency, using LNG instead of diesel reduces the carbon dioxide emissions (CO_2) by about 25%, the nitrogen oxide (NO_x) emissions by about 35%, and eliminates the sulphur oxide emissions (SO_x). In addition, further emission reductions can be attained by advanced design of the machinery.

Scope and objectives

The aim of this project is to design highly efficient machinery suitable for LNG-fuelled ferries. By application of mathematical models developed within DCMT, different possible configurations are investigated by performing numerical simulations. The ferry under consideration is a 112 m Incat catamaran vessel. Normally these ferries are powered either by diesel engines or gas turbines, of which there is one in each hull. Each of the engines is connected to waterjets which propels the vessel. In this project, advanced designs of machinery based on gas turbines are considered. Using machinery with more components will increase the weight and volume requirement of the engine, which, to some extent, will increase the propulsion power demand of the vessel. Therefore, the improvement in vessel performance is expected to be less than the performance improvement of the machinery.

Machinery designs

A promising option, which is considered in this study, is to introduce recuperation in the gas turbine. This implies that the compressed air is heated prior to the combustion chamber using the exhaust gases, resulting in less fuel input.

Another option considered is to use a combined cycle. That is, use the exhaust gases from the gas turbine to generate vapour which is expanded in a turbine. Due to the additional power from the vapour turbine, the efficiency of the machinery is increased. The most frequently used working fluid in combined cycles is water/steam. However, for small-size plants, where minimum weight and volume of the equipment is paramount, a so-called Organic Rankine Cycle (ORC) is suitable. In such plants, an organic fluid is used instead of water/steam.

Results

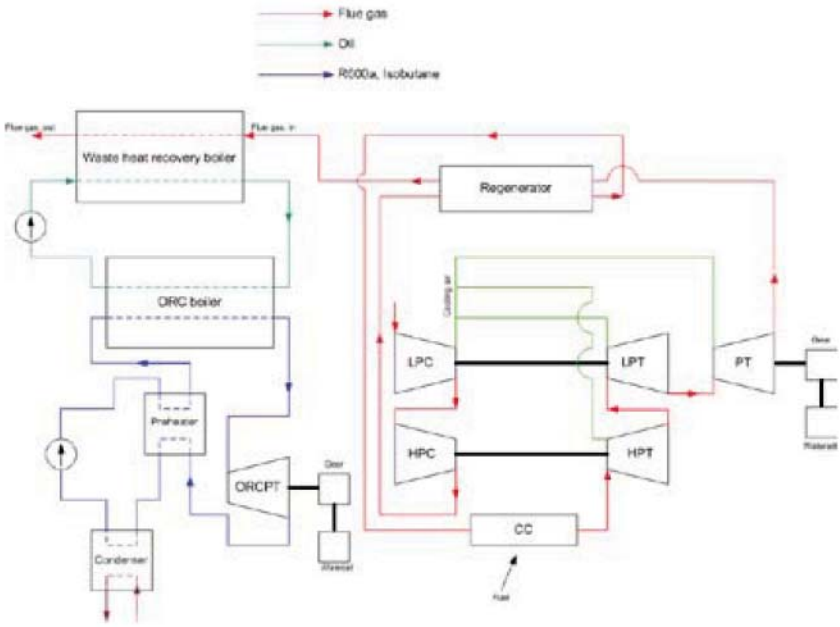
The first preliminary results suggest that if the recuperated gas turbine is combined with an ORC, an efficiency of about 48% would be achievable which is about 30-35% higher than in existing machinery. It is expected that these improvements can be increased by further optimizations of the processes. One of the tasks for future work is to evaluate the machineries with respect also to the vessel performance, taking into account their increased weight and volume.

Project facts

Category: **Machinery**

Emission reductions:
CO_2 25%
NO_x 35%
SO_x 100%

Partners:
DTU
Mols-Linien



Recuperated gas turbine combined with Organic Rankine Cycle (ORC).