

How can marine engines become more efficient?

The results from the Hercules long-term research project which began in 2004 have been especially important for ABB Turbocharging. The advantages of two-stage turbocharging on two and four-stroke engines have been successfully proven.

Since 1997 ABB Turbocharging has been involved in three European Union sponsored R&D projects. All of them brought together specialists from the worlds of industry and academia and resulted in an excellent mix of the theoretical and the experimental. Valuable information was gained regarding the computation and measurement of complex systems. Of special interest were measurements of the hydrodynamic resistance of ships and propeller characteristics in a test tank.



Power2 – the Hercules research project provided the basic knowledge for two-stage turbocharging

Simulations

Over the years, numerous additional new models were developed for the ABB Turbocharging simulation system:

- Simulation of compressor surge.
- Simulation of a complete marine propulsion system consisting of the ship, the engine, the propeller and the engine controller.
- Fouling of compressor and turbine.
- Computation of radial turbines under pulse turbocharging taking into account losses due to uneven admission.
- Innovative 1-D compressor model for the simulation of jet-assist and pre-swirl control.

In parallel it was also possible to realize and test Controlled Pulse Turbocharging (CPT) and air injection into the charge air receiver as a means of improving engine load acceptance.

Hercules is the future

Under the leadership of Professor Nikolaos Kyrtatos, the laboratory for Marine Engineering at the University of Athens, Greece, has established itself as the authority in the research of marine propulsion systems. A project with high ambitions was launched: Higher Efficiency, Reduced Emissions, Increased Reliability and Lifetime, Engines for Ships (Hercules). Hercules has been under way from 2004 to 2014. With an overall budget of EUR 80 million the project consists of three sections and is operated by a consortium of over 40 partners, including engine builders MAN and Wärtsilä as well as component and systems suppliers, universities and research institutions, shipowners and classification societies.

The role of ABB Turbocharging within Hercules involved the development and testing of new turbocharging concepts capable of making a substantial contribution to the overall aims of the project. These are higher engine efficiencies, lower emissions and increased reliability.



Test engine at one of the Hercules partners, Helsinki University of Technology, Finland, showing some local inventiveness – sand as burst protection.

As part of the Hercules project, a turbocharger with very high pressure ratios was run on a test engine: 6.6 from a single-stage system (see picture above). Thereafter, two-stage turbocharging systems for a low-speed two-stroke engine and small and large medium-speed four-stroke engines were constructed and their performance measured. In the first version of an engine with two-stage turbocharging, it was possible to measure simultaneous improvements in engine efficiency of more than two percent and a reduction in NOx emissions of more than 40 percent.

High-pressure turbocharging is a central aspect of ABB Turbocharging's research work. Projects like Hercules are thus an extremely valuable and fertile platform for the exchange of ideas among experts with very diverse areas of expertise. In addition, they allow results to be achieved rapidly and efficiently.

Working on solutions together

Collaborations with Imperial College and participation on EU projects are just two of numerous examples of how ABB Turbo Systems Ltd takes its R&D outside the company and is influenced by the external contacts it forges. Of great significance in this respect are also work within the FVV (Research Association for Combustion Engines e. V.), projects with ETH Zurich Switzerland and other academic institutions and, of course, the development work carried out with customers.

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