HERCULES-2 — Result In Brief

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Eco-engines for sustainable shipping

A major EU-funded collaborative undertaking has investigated numerous technology directions to make shipping cleaner and more energy efficient.

Partly funded by the EU, Hercules-2 adopted a holistic approach to help the shipping industry move in the green direction. The project represents the follow-up phase of the Hercules R&D programme for large engine technologies, which was originally conceived in 2004 by two major European engine manufacturing groups. The Hercules-2 technologies will eventually be employed aboard large ships.

More power and fuel options

Fuel flexibility has become prominent over the last decade with the advent of dual-fuel engines and the need to switch to low-sulfur fuels in emission control areas (ECAs) or ports where local regulations are in force. “A major benefit of fuel flexibility is that it allows ship engines to seamlessly switch between conventional or more environmentally friendly fuels of variable composition and quality,” notes Professor Nikolaos Kyrtatos, a marine engineer at the National Technical University of Athens.

Using advanced testing facilities comprising state-of-the-art optical measurement tools and computational software, researchers investigated the injection and ignition characteristics of different fuels for both low- and medium-speed diesel engines. Focus was placed on combining inherently more sustainable fuels such as natural gas, liquid petroleum gas, methanol, biogas and dimethyl ether with more regular ones – heavy or distillate fuel oils.

“With higher temperatures being necessary for increasing efficiency and lowering emissions, future engines will need to be manufactured from more durable materials,” notes Prof. Kyrtatos. The quest for new materials focused on components such as castings, cylinder heads and turbocharger turbine casings that withstand heavy mechanical or thermal load.

Researchers investigated the use of intermetallic and cast-iron materials for creating more durable components. These robust materials will not only increase the wear resistance of components, but also the engine’s operating window for a wider range of vessel speeds.

Novel adaptive control techniques

Major focus was geared towards combining electronics, mechanics and software to develop an engine that can optimally adapt to its operating environment. The main motive behind the new developments relied on this: any parameter that determines

engine performance shall not deteriorate more than 5 % throughout the whole lifetime compared to a new engine.

Project achievements included a flexible lubrication system and an advanced real-time tribosystem performance monitoring system. These are expected to overcome the issue of lube oil choice and application when switching between heavy fuel oils and low-sulfur fuels. Furthermore, researchers developed a new unconventional controller that improves engine operation close to the knock margin.

A breath of fresh air

Developing abatement technologies for achieving near-zero emission engines was at the heart of Hercules-2. The advanced integrated after-treatment technologies introduced provide a useful means towards meeting not only the ECA limits but also the IMO Tier III.

Researchers combined exhaust gas recirculation and water-fuel emulsion to simultaneously abate nitrogen oxide and particulate matter. The integration of methane and ethane abatement technologies into lean-burn four-stroke engines is currently under investigation. What's more, researchers developed improved methods of selective catalytic reduction (SCR) agent injections and also investigated robust catalysts for pre-turbo SCR operations.

Hercules-2 achievements should further accelerate the shipping industry's transition to increased fuel efficiency and a significantly reduced environmental footprint. They will also strengthen the position of the participating partners in the market place.

Keywords

HERCULES-2, engine, fuel flexibility, shipping industry, emission control area (ECA), selective catalytic reduction (SCR), near-zero emission, tribosystem

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