Hercules alliance set to break new ground

The prolongation of the Hercules research programme is pushing the bounds in marine engine technology, and the next set of results will ultimately help strengthen Europe's product offering

As the most ambitious and long-running collaborative endeavour of its kind, the continuation of the Hercules programme into a fourth, major phase of study denotes a further raising of the bar in terms of the technological challenges addressed.

Moreover, as the three preceding stages have generated the biggest practical yield ever from any EU-funded research in the field of marine engineering, the latest Hercules-2 project holds out the firm prospect of outcomes being quickly manifested in products and methodologies.

Maintaining core partner alliances forged and tempered through the Hercules-A, -B and -C stages from 2004 to 2014, Hercules-2 was launched in May 2015 with a three-year work plan. It aims to build upon and surpass the targets of the previous phases, going beyond state-of-the art.

At this year's CIMAC Congress, an overview of the entire and sustained endeavour was delivered by Nikolaos Kyrtatos, the coordinator of each stage of the programme.

Professor Kyrtatos, from the Laboratory of Marine Engineering at the National Technical University of Athens (NTUA), identified the overarching target of Hercules-2 as the development of a fuel-flexible marine engine, optimally adaptive to changing operating conditions and requirements.

The new phase of the programme exemplifies the EU's drive in sponsored research for pan-industry, multidisciplinary collaboration and scale. It involves 35 participating organisations from 10 EU countries and also non-EU Switzerland, a fountainhead of large marine engine technology. Besides the 32 partners from industry and academia, the user community is represented through an EXAG (external associates group) comprising fleet operators Hapag-Lloyd, AP Moller-Maersk, and Costamare.

Professor Nikolaos Kyrtatos, director of the Laboratory of Marine Engineering at the National Technical University of Athens (NTUA), and co-ordinator of the Hercules programme

Hercules is the outcome of the joint vision of Europe's two major players in the global marine engine market, MAN Diesel & Turbo and Wärtsilä Corporation. The idea of a large-scale cooperative R&D project had been discussed by companies on the sidelines of the 2001 CIMAC Congress in Hamburg. An EU-funded, pan-aerospace industry project under way at that time provided something of a template for the ensuing Hercules-A initiative.

In his address to the 2016 CIMAC gathering, Kyrtatos highlighted the significance of the Hercules programme in having brought MAN and Wärtsilä together for the first time to conduct a project with commonly defined research areas, while the companies independently maintained specific product development targets. Such a link between arch rival heavyweights would have been inconceivable previously. The fact that this alliance, starting in 2004, persists today is an indicator of the effectiveness of the project structure, project management and results.

Professor Kyrtatos is unequivocal as to the value of the work so far: "The three completed projects Hercules-A, -B and –C have cumulatively resulted in 38 patent applications and 91 scientific publications. Other metrics of results from the completed projects are a total of 49 prototypes, with some prototype systems tested onboard eight ships of major operators Hapag-Lloyd, Maersk and Wallenius. A total of 18 active products resulting from the projects are presently supported by the manufacturer partners."

Highlights of the programme have included the demonstration in 2014, under Hercules-C, of a 3% increase in engine efficiency and an 80% reduction in NOx emissions relative to 2010 commercial 'best available technology'. Furthermore, a world record was achieved whereby a prototype, experimental engine operated at 300bar maximum cylinder pressure.

Important advances in technologies and methodologies resulting from the Hercules programme in relation to large engines have embraced turbocharging, valve timing, cylinder pressures, cylinder auto-tuning, waste heat recovery (WHR), selective catalytic reduction (SCR), exhaust gas recirculation (EGR), scrubbers, tribology, and advanced materials. More than 10 full-scale engine experimental set-ups have been undertaken.

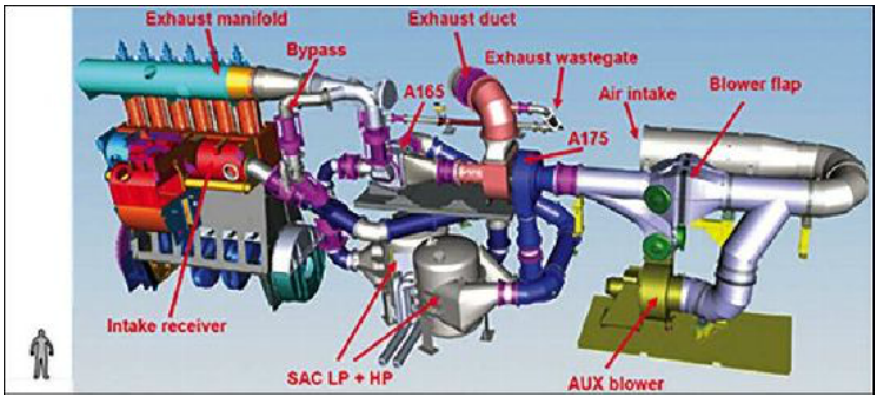
The priorities under Hercules-2, reflected in the project's four working groups, are the application of alternative fuels and the optimisation of fuel flexibility for seamless switching between fuel types; the development of new materials to support high-temperature component applications; the development of adaptive control methodologies to enhance through-life engine performance; and an ambitious bid to achieve near-zero emissions through

the adoption of combined, integrated aftertreatment of exhaust gases.

Several full-scale prototypes and shipboard demonstrators are planned over the three-year term of the studies. This will include combined SCR with diesel particulate filter (DPF) systems for both four-stroke and two-stroke engines. Some of the integrated solutions emanating from Hercules-2 are expected to quickly mature into commercially available products.

Hercules-A, -B and -C absorbed a total budgetary allocation of €76m (US$85m) over 11 years, more than half of which was covered by EU funding. Hercules-2 will take overall programme expenditure beyond the €100m (US$112m) mark, as it has a budget of €25m (US$28m), with a proportionally increased EU contribution of €16.8m (US$18.8m).

Kyrtatos referred to the evolution in the thematic content of the programme: "The Hercules-A project considered a wide spectrum of technologies in the three themes of efficiency, emissions and reliability. After assessment at the end of the project, some of these technologies were considered to be dead-ends, while others were selected as worth developing further in Hercules-B. Different technologies that could be used in combination to achieve the set objectives in efficiency, emissions and reliability were grouped and integrated in the subsequent project, Hercules-C. The present Hercules-2 project considers the issues of long-term flexibility in operation and the optimum performance over the lifetime of the products."



Pragmatic research under Hercules: full-scale experimental setup of a turbocharging system with exhaust gas recirculation (EGR)

Starting initially with a wide spectrum of R&D areas, there has been a successive filtering, combining and further development of fruitful technologies. In the current Hercules-2 phase, the major research themes of combustion, aftertreatment, materials and control are linked to the various work packages.

As a consequence of the 2015 acquisition of Wärtsilä's two-stroke business by joint venture Winterthur Gas & Diesel(WinGD), Hercules-2 has a third core partner in the shape of Swiss-based WinGD. The latter has this year become a wholly-owned Chinese company, following the acquisition by the China State Shipbuilding Corporation (CSSC) of Wärtsilä's 30% stake in the joint venture. *NA*

Home-grown offering augmented

Valuable insights into the development of indigenous marine engine technology in China and South Korea, which retain a high dependency on licensed production of foreign designs, were afforded at the CIMAC Congress in Helsinki this year

China's determination to strengthen its home-grown offering in the medium-speed stakes was exemplified by a presentation detailing a 390mm-bore series targeted by Hudong Heavy Machinery (HHM) at propulsion and auxiliary applications in the 5,000-17,000kW range.

For many years, E390VA serial engines and various models of the MAN-owned Pielstick marque have constituted a major part of HHM's portfolio. The recent completion of a 12-cylinder vee-form prototype, the 12MV390, is an outcome of a programme to update the E390VA with a design that can meet rising economic, performance and environmental requirements.

While suitability to the demands of China's expanding river and coastal shipping sectors is a key goal, the nascent type will offer increased business opportunities over the wider market, especially in marine genset aggregates.

HHM, part of China State Shipbuilding Corporation (CSSC), engaged the German engine and powertrain technology specialist FEV to assist with the creation of the new medium-speed generation. FEV's Markus Hermanns told CIMAC delegates that the V12 prototype is viewed as the forerunner of a complete family embracing in-line models from six to nine cylinders plus vee-types of up to 20-cylinder configuration.

The nascent 390 series employs a common rail fuel injection system capable of running with HFO at a maximum rail pressure of up to 2,000bar. The engine will deliver 850kW per cylinder at a crankshaft speed of 600rpm, with a peak cylinder pressure of 250bar. The charge air arrangements for the V12 demonstrator with single-stage turbocharging and low-temperature charge air cooling consists of two turbochargers operating in parallel.

For the future, HHM intends to provide a version achieving IMO Tier III compatibility through the adoption of an in-house selective catalytic reduction (SCR) system. Furthermore, a dual-fuel (DF) variant is planned for 2018 introduction. *NA*