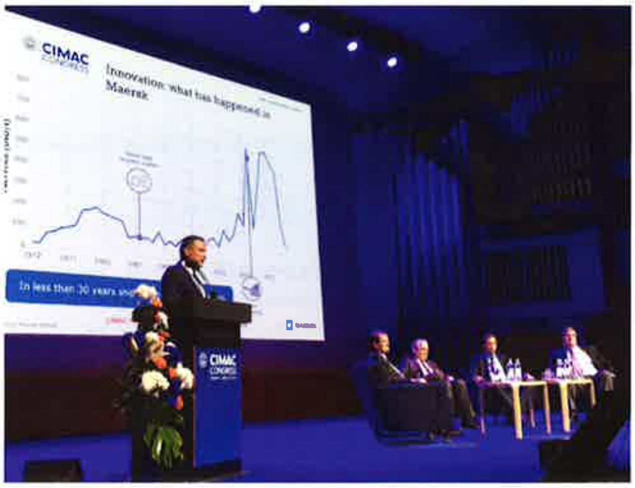
CIMAC CONGRESS LOOKS TO THE FUTURE

Tough times in shipping did not stop 2016 CIMAC World Congress participants from keeping their eyes on better times ahead



The 28th CIMAC World Congress in Helsinki, Finland in June saw 815 participants from 34 countries enjoy an event which included 220 papers from contributors based in 24 countries, categorised into twelve topics and delivered in 47 forum sessions, with 32 in the poster session format. The exhibition, which is an integral part of every CIMAC Congress, attracted exhibitors from 53 organisations from 13 countries and covered a total area of some 800m^2.

The World Congress is a triennial event organised by CIMAC, the international council on combustion engines. This year's event was entitled 'Meeting the Future of Combustion Engines'.

The opening ceremony featured a showcase of Finnish culture and emphasised the challenges faced by the current generation of engineers in the large engine industry. At the welcome reception at Helsinki City Hall, the event and its participants were welcomed by local dignitaries and the Federation of Finnish Technology Industries. Wärtsilä Corp chief executive Jaakko Eskola delivered the keynote speech. Meanwhile, the traditional ABB evening event offered the chance to go aboard one of the ice-breakers that keep commerce moving in the Baltic winter.

Within the Technical Programme system integration was a major topic, with its own session. This prepared the ground for another area of innovation that is set to gain in importance, as the improvement of exhaust emissions and fuel efficiency enters a new phase.

One of the highlights of the programme was the inaugural Users Day, with a keynote speech from Harry Robertsson, technical director at shipowner Stena Rederi. Mr Robertsson outlined the shipping line's three major focuses in future ship design, which are reduced environmental footprint, increased safety, and increased cost efficiency. Major factors that would help Stena achieve these aims are fuel flexibility and new fuels, vessel autonomy for increased safety, reduced air resistance and further developed hullforms and propulsion arrangements, with an emphasis on electric drives, including fuel cells and hybrid and battery assisted propulsion and manoeuvring.

In terms of fuels, Mr Robertsson made it clear that he believed that using heavy fuel oil (HFO) with sulphur scrubbers could be the most cost-efficient fuel option – even if a carbon tax or fee was introduced on top of the fuel price.

Stena has installed four scrubbers to date, with a further three units planned. At a cost of between US$5 million and US$10 million per installation, this is expensive and potentially complicated work. Liquefied natural gas (LNG) retrofitting has been discounted for the time being, except on the group's LNG carriers, because of the high cost of conversion (around US$30 million for a ropax vessel) and the loss of power. This was up to 20 per cent of installed power in some cases studied by Stena Teknik, a deficit that would make it difficult for ships to keep to their schedules.

"When energy prices are low, other cost aspects become more important"

"Our approach to fuels is driven by the 0.1 per cent sulphur limit in the North European ECA [emission control area], as our activities for Stena Line and Stena RoRo are very much in this area," said Mr Robertsson. "I agree that we will have a fuel 'mosaic' in the future – different ships on different routes in different parts of the world will be running on different fuels."

The Congress closed with a panel discussion entitled The Lowest Oil Price in a Decade – A Game Changer for Ship Operators and Engine Makers? This was chaired by CIMAC vice president for communications Axel Kettmann of ABB Turbocharging.

Summarising the presentations and discussion, Mr Kettmann concluded that while the low price of oil was putting a brake on investment, especially in oil and gas, and on technical developments such as waste heat recovery and gas engines, this was countered by new challenges and opportunities. These included greater fuel flexibility, more flexible power via electric drives and hybrids, further improvements in engine fuel efficiency and an even greater focus on total cost of ownership.

During the debate Paolo Tonon, head of Maersk Maritime Technology, outlined the situation that shipowners face. "We are navigating in the perfect storm," he said. "We have the lowest historical index rate for containers, and oil prices close to their low point in the 1970s."

Christian Poensgen, senior vice president of engineering at MAN Diesel & Turbo, outlined the gains to be made from better management of propulsion systems. He pointed out that engine design was garnering efficiency improvements of around 0.3 per cent a year, but that the benefits to be derived from better systems, software and engine mapping could reach 6.5 per cent over the next decade. "Our focus will be to work much more on system integration and big data applications, with efficiency driven more through software solutions than by hardware," he said.

Joel D Feucht, director for gas engines at Caterpillar, pointed out the potential for savings through elements other than engine design, too. "When energy prices

are low, other cost aspects become more important. How do we reduce planned and unplanned down-time? How do we improve service and parts availability? How do we help to keep customers' efficiency really high? And integration, digitisation and information management are all key innovations."

Stefan Wiik, vice president for engines at Wärtsilä Marine Solutions, looked ahead to an even more distant future, saying: "Imagine a disruptive energy source in the future that would mean we did not need our engines any more. Could that actually happen? How do we cope with new technologies such as batteries and renewable electricity and use our engines in combination with that?"

At the closing ceremony CIMAC's new president, Klaus Heim of OMT, captured the mood of delegates, who recognised that the industry is entering a new era following the enactment of the Energy Efficiency Design Index (EEDI), IMO Tier III emissions regulations and the progressive expansion of ECAs. "It was an outstanding event for all of us involved and for the large engine business. We look forward to some challenging yet interesting and fruitful times ahead for our industry."

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The pick of CIMAC

The CIMAC World Congress 2016 featured 220 technical papers from contributors based in 24 countries and from a range of companies. Here, *Marine Propulsion* presents a taste of some of the topics discussed

New single-stage turbochargers for large high speed diesel engines, **Michael Gisiger, ABB Turbo Systems**

Large high speed diesel engines are typically developed as multipurpose platforms which are then used in very different application segments. The operation profiles of these individual application types vary in a very wide range.

In many of the applications the engine is used as a mission-critical element, which means that any unexpected down-time causes significant consequential damage. The turbocharger concept needs to cope with these demanding operation profiles and harsh ambient conditions with uncompromising reliability.

While the variety of the application requirements would drive specific technical solutions, the enginebuilder naturally faces cost constraints which typically lead to a more modular approach based on a common engine platform. The turbocharger needs to support this concept and thus equally needs a wide application range based on limited hardware variants.

The engine's performance characteristics are defined to a large extent by the capabilities of the turbocharging system. Ongoing engine development therefore continues to drive the advancement of turbochargers. Modern turbocharging systems for high speed diesel engines need to provide a high compressor pressure ratio over a very wide range of compressor volume flow and at the same time provide superior efficiency resulting in low engine fuel consumption. In order to satisfy further application requirements such as enabling fast load pick up and acceleration, as well as coping with changing ambient conditions, new turbochargers need to be developed.

ABB is developing a new range of turbochargers specifically for high speed diesel engines and setting the focus on providing:

- maximum reliability and durability
- high available boost pressure
- wide compressor flow range
- enhanced part load performance.

These turbocharger characteristics enable high availability and uptime of the equipment, avoiding unplanned down-time, high engine power density and reduced derating at severe ambient conditions, a large operation range for variable engine speed applications, and good load response. With this, ABB brings the proven reliability of its current products TPS and A100 to the high speed diesel market.

The next generation of MAN's large bore diesel engines **Sebastian Kunkel, MAN Diesel & Turbo**

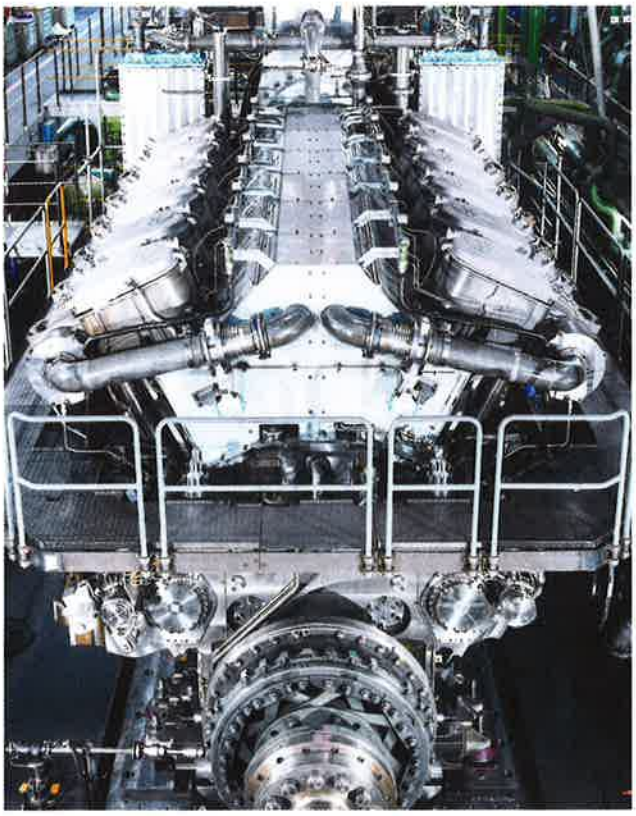
The next generation of MAN Diesel & Turbo's large bore diesel engines has been developed to succeed the existing 48/60 engine family. The main development objective is to set a benchmark in achieving best in class fuel consumption and power density for marine and stationary applications. This new medium speed four-stroke engine is highly flexible with regard to adaptation to the customer's needs, with a very advantageous power output.

After intensive research and documentation of the customer's requirements, detailed variant management was performed in order to develop a new product that is dedicated to the latest market requirements with the minimum variety of parts. Feedback from MAN Diesel & Turbo's considerable field experience of medium speed engines was integrated into the new engine development to reach the highest possible product maturity. The new design is using proven MAN technologies such as the common rail injection system and MAN Diesel & Turbo's own two-stage turbocharging system, which enables good product maturity right from the start of the field introduction.

During the engineering phase, intensive state-of-the-art simulations were carried out, especially FEM (finite element method) and CFD (computational fluid dynamics) calculations using multi criteria optimisations for optimum results.

Within the validation and testing phase, a single cylinder test engine was crucial to define the best combustion set-up before the full scale engine started at testbed. Early validation of the thermodynamic layout was a key milestone in the product development process, as it shortened the very costly full scale engine testing. This single cylinder engine also provided an opportunity to investigate a larger variety of engine components – for example, piston bowl geometry and nozzle layout – which opened up even more potential to optimise the trade-off between low emissions and best in class fuel consumption.

The new large bore engine family, with the new MAN 12V4812V48/60CR as its template, has been developed to succeed the well-known and successful MAN V48/60CR and V48/60TS. The new medium speed four-stroke engine includes established and well proven components such as the common rail system and the turbocharging module. MAN is able to apply a new innovative design to the V48/60 engine based on wide field experience with the MAN V48/60CR and V48/60TS. By evaluating key success factors from the customer's perspective and using MAN Diesel & Turbo's extensive variant management expertise, the new engine family was successfully adjusted to match market requirements.



The new large bore family has been developed to succeed the successful MAN V48/60CR and V48/60TS

Virtual design and simulation in two-stroke marine engine development

Alexander Brueckl, Winterthur Gas & Diesel

Today, various applications in the area of computer aided engineering offer extensive possibilities for a structured approach to design and development. More than ever there is a strong demand for seamless project execution across various disciplines, both on and off shore. In addition, competition forces companies active in product development to continuously rationalise their time to market. In order to be most efficient with the design and development of new products it is not enough to have the right engineering software applications in place. It is, rather, a question of how these tools are integrated in the corresponding environment and how structured the approach is for uniform application by all parties involved.

Looking at the two-stroke marine engine from the design and development point of view, it is a complex product which involves several systems and subsystems consisting of various assemblies and components. Depending on the type of system, the characteristics are different in terms of technical requirements, specification, function, validation, execution and operation. On top of that, there is the licence model which asks for a specific set-up in order to comply with the need to dispatch information from the engine designer to the enginebuilder. Within this heterogeneous environment, and considering all the conditions imposed by the product, the appropriate engineering tools landscape needs to be flexible and integrated at the same time.

One of the first steps in the execution phase is the development of the system's layout. Part of this step is the definition of all engine systems. The finalised engine control diagram (ECD) will illustrate all these systems in a schematic and simplified overview. The determination of flow requirements follows the development of the ECD.

This activity calls for intense cross-functional co-ordination since almost all disciplines are involved.

The results build the basis for the development of the piping diagrams. Together with the ECD the finalised piping diagrams will enable the complete functional description of the engine. In the conceptual design phase the system layout will get a third dimension by developing a 3D conceptual layout.

A total analysis of the engine helps to approach the further layout definition of components in a structured manner. During concept validation, layout concepts will be analysed by simulation and calculation in order to confirm the actual design approach. In the following detailed design phase, the engine layout will be completed and the drawing creation will start.

The technical drawing is still the most frequently used instrument to deliver information about engine production to customers, but in some cases component production is based directly on the 3D data model without the need to have drawings to hand.

There is a general trend towards shifting the focus from 2D drawing to the 3D model for production. However, this requires a certain level of automation at the production site, which is not always in place. For engineering as well as production there is a need to integrate as much data as possible into suitable data models to guarantee an efficient development and production process.

Dual-fuel engine optimised for marine applications

Andreas Banck, Caterpillar Motoren

Caterpillar develops medium speed dual-fuel engines for marine applications in the power range from 2,400kW to 15,440kW. Because of new emissions legislation, such as IMO Tier III set out in Marpol Annex VI, customers are looking for alternative solutions for propulsion and power generation which are able to operate like Caterpillar's well-known diesel engines.

The M 46 DF and M 34 DF Caterpillar dual-fuel engines – also offered under the MaK trademark – are able to burn liquefied natural gas (LNG) and liquid fuels such as diesel, heavy fuel oil (HFO) or crude oil. IMO Tier III emissions limits are met within gas operation. For liquid fuels, an exhaust gas after-treatment solution, selective catalytic reduction (SCR), is offered.

Transient response is a key requirement for a lot of marine applications. Supply vessels operate the majority of the time on low standby power and require fast ramp-up to a high level of thrust. Even with diesel engines, this demands additional features such as air injection into the charge air manifold.

Gas engines are known to be slow in load response. This is mainly caused by air-fuel ratio control depending on turbocharger inertia. Gas ignition is limited by the upper and lower air-fuel ratio limit, which leads to reduced rates in fuel ramp-up.

A faster speed governor would over-fuel the combustion chamber. A diesel engine would react with black smoke, but a gas engine would break down as a result of a mixture which is too rich.

The M 46 DF and M 34 DF engines are equipped with a superior engine control. All controls are handled in a MIMO (multiple input, multiple output) control architecture. One speed governor controls three fuel systems – main diesel fuel, ignition diesel fuel and gas admission). Thanks to this concept the load acceptance of dual fuel is such that it can be said to run like a diesel.

A second aspect is the low load operation in gas mode. Without additional technologies, common gas engines run with a very lean mixture and emit increased amounts of hydrocarbons. New technologies have been developed to enable unlimited engine operation with gas combustion.

The engine concept is based on the existing medium speed, long-stroke diesel platforms M 43 C, M 32 E and M 25 E. Operational safety and high power availability are secured with diesel back-up. Low exhaust gas emissions of NOx, SOx, particles and CO_2 are provided with gas combustion.

The engines are designed for genset applications and also to drive propellers. The required propulsion power for slow ship velocity is considerably lower, if the propeller speed is reduced according to the fixed pitch propeller curve. Engine operation is limited by the surge limit of the turbocharger compressor and high exhaust gas temperatures. A wide speed range of dual engine operation for propeller drives is provided by means of a cylinder bypass valve option.

Diesel combustion is much more robust than pure gas when it comes to power ramp-up so diesel apportionment is used for a few seconds to provide fast power ramp-up when the MaK dual-fuel engines are operating in gas mode.

Power ramp up in gas mode and in diesel mode shows that only minor frequency deviations occur when the behaviour of one mode is compared with the other.

Without further measures, low load operation and start in gas mode remain limited, because of the air-fuel ratio being too lean. To deal with this, Caterpillar has developed a new skip firing control method.

Gas combustion is carried out in a reduced number of cylinders with the appropriate air-fuel ratio. The engine start in gas mode occurs without any soot and low load operation in gas mode is optimised, with improved efficiency. *MP*

The M 46 DF and M 34 DF Caterpillar dual-fuel engines are able to burn liquefied natural gas and liquid fuels