Engine builders tackle new challenges

Slow-speed diesels remain the engine of choice for most tanker owners but alternatives are making inroads. Redundancy levels and emission control are the key issues of the day

The tanker market is an important and attractive transport segment for marine engine builders.
Research by MAN B&W has shown that, under the agreed timetable for the phase-out of older single-hull tankers, there will be a need to replace some 150-175 tankers per annum in the years ahead just to keep the tanker fleet at its current capacity. On top of that, there will be a need for an additional 25-50 tanker newbuildings per annum, covering ships 30,000 dwt and larger, to meet the increasing demand for the transport of crude oil, petroleum products and chemicals.
The engine builder's research also revealed that the average working life of a tanker spans the relatively long period of 25 years. Despite growing concerns about tanker age prompted by a handful of sinkings involving the structural failure of older single-hull tankers in recent years, engine builders need to assume that tanker owners will continue to design and build their ships with a 25-year service life in mind.
With tanker safety under greater scrutiny than ever before, the demands placed on the reliability, efficiency and need for low maintenance costs of the main engines for tankers are growing. For engine builders, only their top-of-the-range products can meet these demands.

Two-stroke vs four-stroke
Two-stroke, low-speed diesels are the engine of choice for tanker owners, certainly for the great majority of tankers over 30,000 dwt. The notable exceptions are the use of diesel electric propulsion on shuttle tankers, due to the variable loads placed on the ship and the need to provide a high level of redundancy, and a handful of chemical parcel tankers.
Even on tankers in the 10,000-30,000 dwt size range two-stroke engines predominate. For tankers below 10,000 dwt in size two-stroke engines face considerable competition for market share from the four-stroke diesel alternative.
After a century of development, diesel engines are a highly evolved piece of machinery. The advance of technology has been particularly rapid over the last three decades, yielding significant improvements in power ratings, reduced emissions, enhanced reliability, overall economy, increased compactness, reduced weight and the ability to burn low-grade fuel.

Lubricating the works
There are few, if any, areas, in tanker design and operation where establishing the right balance between quality and price is not a major challenge, and this extends to engine lubricating oils. Engine performance, especially under high loads, can be compromised by inferior quality lube oil, so opting for the lower priced, lower specification marine lubricant can have immediate as well as longer term adverse effects.
MAN B&W began investigating reductions in cylinder lube oil dosage in the late 1990s and developed its Alpha Lubricator System. Now available for all the company's two-stroke engines, the system uses electronics to ensure an exact amount of lube oil is injected into the cylinder, directly onto the piston ring pack, at the optimal moment. Trials have shown that the use of Alpha can result in a 20 per cent savings in lube oil consumption.

Intelligent engines
Electronic control is also being applied to fuel injection and exhaust valve actuation systems to provide a new generation of so-called 'intelligent' low-speed diesel engines which hold the promise of reduced running costs and enhanced reliability. Wärtsilä and MAN B&W have both applied the technology in the development of new engines for use onboard VLCCs, Aframax tankers, chemical carriers, bulkers and reefer ships.
The Wärtsilä camp is promoting the Sulzer RT-flex diesel, the world's first low-speed marine engine to have common-rail fuel injection. The first such unit is already installed in the 47,000 dwt bulk carrier Gypsum Centennial delivered early in 2002, while a 105,400 dwt Aframax tanker building at Sumitomo Heavy Industries for the Italian owner Scinicariello Ship Management and handover in mid-2003 is amongst the first six orders for RT-flex engines. .
The Sulzer RT-flex engine does not require a camshaft, fuel injection pumps, valve actuation pumps or reversing servomotors. The design also makes maintenance easier, removes a source of engine vibration and generates no visible exhaust smoke, irrespective of the operating speed. According to Wärtsilä engineers, the design of the RT-flex system is such that it allows for reduced levels of other exhaust emissions at a later date as the technology is further developed.
The combination of common-rail injection and valve actuation with full electronic control provides a high degree of engine-operating flexibility, not only to lower exhaust emissions, but also to reduce fuel consumption at part load and enable better manoeuvrability. The ability to slow-run is also significantly enhanced, as evidenced by the ability of the RT-flex engine in Gypsum Centennial to run steadily at speeds down to 12 rpm.
The RT-flex common-rail fuel system operates on the same grades of heavy fuel, up to 700 cSt viscosity, as is usual for standard Sulzer RTA-series engines.
MAN B&W contribution
Development work at MAN B&W on intelligent engines passed a landmark in 1998 when the Odfjell chemical tanker Bow Cecil was fitted with a Hitachi-MAN B&W 6L60MC engine fitted with both conventional camshaft and electronic fuel injection and exhaust valve actuation systems. Tests at sea in 2000 proved the ability of the system to switch between modes and to function efficiently as an intelligent engine only.
Odfjell has now specified an intelligent version of MAN B&W's 7S50ME-C engine to propel a 37,500 dwt chemical parcel tanker currently under construction at the Kleven Floro yard in Norway. This will be the first MC model from the maker to be built solely with a fully integrated electronic control system. MAN B&W will deliver the engine in spring 2003.
Although fitted with conventional camshaft diesel engines from MAN B&W, Concordia Maritime's new twin-engine, V-Max-class VLCCs, Stena Vision and Stena Victory, have been prepared for later conversion of these engines to intelligent running.

Full redundancy
Although the overall safety record of the tanker industry has improved considerably over the past 20 years, and accidental oil spills from tankers are now at historic low levels, the repercussions from a single accident can still be significant. Should the tanker industry continue to experience events like the sinkings of the Erika and the Prestige, many believe that the provision of full backup power systems for tankers will be mandated.
Twin propulsion systems are now the chosen option for tankers being built for US domestic service, for example, due to the rigorous oil spill enforcement and liability regimes in force in that country. Heightened anxiety on the part of major oil company charterers over the need to ensure that tankers in their service keep out of trouble,

especially when sailing regularly in environmentally sensitive waters, has also prompted recent orders for tankers with two engine rooms.

Redundant propulsion systems have also been specified on ships such as shuttle tankers where the costs associated with shutting down offshore oil production due to a lack of suitable vessels with specialist cargo loading facilities can severely disrupt the economics of a project.

Coastwise advantages

The majority of twin propulsion systems specified for tankers in recent years have been for larger ships, of Aframax size and above, engaged on special, dedicated services. However, having more than one engine can also be advantageous onboard coastal tankers which, due to the nature of the distributive trades, spend a comparatively large amount of time in port. Power requirements onboard ship during the time in port can vary widely, especially with a number of cargo pumps operating simultaneously.

The latest ships to be ordered with full propulsion system redundancy are a pair of 3,500 dwt product/chemical tankers being built at the Rousse yard in Bulgaria for Crescent Tankships of Southampton and operation in Northern European waters. The ships will be fitted with twin engines, twin screws and twin rudders, the engines being MAN B&W medium-speed units which will run on clean-burning marine diesel oil. The innovative vessels are due for delivery in the fourth quarter of 2003, while Crescent also holds a series of options for further ships.

In addition to the redundancy factor, much less space is taken up by a twin-engine arrangement compared to a conventional engine room, thus enabling more internal hull capacity to be devoted to cargo tanks and revenue-earning cargoes.

Degrees of redundancy

In addition to the full redundancy propulsion system packages described above, there are a number of different approaches providing varying levels of emergency power and ‘get you home’ capability in the event of an accident.

For example, each of the current series of six Tarantella-class 47,500 dwt chemical/product tankers under construction in Croatia at the Trogir yard for Laurin Maritime is being fitted with two medium-speed diesel engines, which are connected through a reduction gear to a single Kamewa controllable pitch propeller.

Although not a fully redundant propulsion system, the twin engine arrangement is a feature which will find no doubt favour amongst Laurin's customers shipping cargoes to and from the US.

Four-stroke attractions

The Laurin ships are also an example of how the realm of medium-speed, four-stroke engines is spreading into the market for tankers over 10,000 dwt. Wärtsilä, for example, is promoting the merits of its W64 design, the world's most powerful medium-speed engine, for use with larger tankers, amongst other ship types.

Wärtsilä Italia has secured a contract to supply a complete marine power system, based on the Wärtsilä 6L64 medium-speed diesel engine, for the first ship in a series of 40,000 dwt chemical/product tankers building at the San Marco shipyard in La Spezia, Italy for Italian owners. The system also incorporates an innovative "get you home" capability.

The engine has a 12,060 kW output at 333 rpm and will drive a controllable pitch Lips propeller of 6,200 mm diameter through a reduction gear to provide a ship service speed of 16 knots. Electrical power will be supplied by a 1,800 kW generator driven off the reduction gear, and three Wärtsilä 6L20 auxiliary engines, each of 1,020 kW output at 900 rpm.

Redundancy is provided by an auxiliary propulsion drive (APD) in which the shaft generator can be used as a motor to drive the propeller when powered by the diesel generating sets. This APD gives the vessel a speed of about eight knots.
So far, 11 Wärtsilä 64 engines have entered service since the first was handed over in 1999. The engine builder believes this unit will continue to find favour on Handysize and Handymax tankers due to its low nitrogen oxide (NOx) emission levels and particularly low fuel consumption. This, in turn, means reduced releases of carbon dioxide (CO_2) to the atmosphere.
A further emergency propulsion package supplied by Schottel is described in an accompanying article in this section.

Pooling resources
The competitive pressures that resulted in a series of mega-mergers among the ranks of the principal marine engine builders in the 1990s continue to drive the remaining participants together to explore ways to cooperate.
Last November Wärtsilä Corporation agreed to work with another of the leading worldwide engine builders, Mitsubishi Heavy Industries Ltd of Japan, on a specific project. The two are to pool resources and jointly design and develop a new low-speed marine diesel engine of 500-600 mm cylinder bore. Such engines are suitable for a wide variety of ship types, including large product tankers, Handymax and Panamax bulk carriers, container feeder vessels and medium-sized reefer ships.
Wärtsilä's own range of low-speed marine diesel engines, acquired through the merger with Sulzer, covers the power range of 5,000 to 80,000 kW. Mitsubishi also has its own portfolio of low-speed marine diesel engines in the power range of 1,120 to 46,800 kW, known as the UE type.
The Japanese engine builder has cooperated in the manufacture of Sulzer engines since 1925 and has been extensively involved in the building and testing of the first examples of new Sulzer low-speed engines as they were introduced. The new agreement with Wärtsilä takes this cooperation a stage further.
It is envisaged that the new engine will be built in Japan by Mitsubishi, Mitsubishi's licensees and Wärtsilä's licensees. In Korea and China, the engine will be built by Wärtsilä's and Mitsubishi's licensees.

Future directions
While the low-speed, two-stroke diesel engine will to hold sway in the tanker sector for some considerable time to come, other types of propulsion unit, not least the four-stroke diesel, will continue to gain market share, especially in the 30,000-50,000 dwt size range.
Propulsion system redundancy will also remain a key issue in the years ahead. There have recently been some innovative approaches to providing emergency get-you-home power in case of an accident which do not entail anything like the capital cost of twin engines, twin shafts and twin propellers.
Proper use of risk management methodology of the type used in the preparation of safety cases and formal safety assessments (FSAs) can help determine the most appropriate, cost-effective solution and allows a degree of flexibility in the choice of system. For example, results from the tanker risk management studies of a leading classification society indicate that in a dual engine room a single component in the cooling water system in each engine room, with appropriate crossovers, is as safe as having dual components.
The advance in diesel technology is also continuing, with researchers investigating the potential for a truly intelligent engine which would diagnose problems and make appropriate remedial adjustments while in service.
The introduction of even stricter emission control legislation in the years ahead is also in focus for engine designers. Emulsified fuel systems, charge air humidification and direct water injection hold promise as means of reducing engine emissions and

all are under investigation. For regions with particularly stringent requirements governing the control of NOx emissions, the use of selective catalytic reduction may be the only option.