VTA Turbocharger

MAN Diesel Debuts VTA Turbocharger on Low Speed Marine Diesel

Variable Turbine Area brings new possibilities to large-engine turbocharging.

April 18 2007. The turbocharger business unit of MAN Diesel has recently released a progress report on its new, variable output turbochargers. The company reports that its new variable turbine area (VTA) technology will be developed for all the models in its TCR series radial and TCA series axial turbochargers, and that a TCA axial turbocharger with VTA technology is currently under test on a medium bore, two-stroke, low-speed engine intended for a marine application.

“With the advent of our VTA technology, we are bringing entirely new turbocharging possibilities to marine diesel engines,” states Dr. Alexander Rippl, head of turbocharger development at MAN Diesel. “Flexibility of air and fuel management will be key factors in meeting both the emissions legislation of the future and the expectations of our customers in terms of overall engine performance and fuel consumption. Using our VTA system, we can more precisely match the volume of charge air to the quantity of injected fuel at all points on an engine’s load profile. The result is reduced specific fuel consumption in combination with reduced HC and CO emissions and improved dynamic behaviour of the engine-turbocharger system. For example, in trials with a VTA-equipped TCA turbocharger on our two-stroke 4T50ME-X research engine, we have confirmed

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significant potential for reductions in specific fuel oil consumption (SFOC) at part-load, combined with significant improvements in load acceptance."

In detail, the VTA system consists of a nozzle ring, equipped with adjustable vanes, which replaces the fixed-vane nozzle rings fitted in MAN Diesel's standard TCA turbochargers. In this way, VTA technology can be readily retrofitted to turbochargers already in the field. By adjusting the vanes' pitch, the pressure of the exhaust gases can be regulated and the compressor output optimised at all points on the engine's performance map. In order to minimize thermal hysteresis and improve adjustment accuracy, each vane has a lever which is directly connected to a control ring. The control ring is actuated by an electric positional motor with integrated reduction gear whose development was an integral part of MAN Diesel's VTA solution. The adjustable vanes are manufactured in heat- and erosion-resistant alloy steel. Careful selection of fits and materials ensures operation under all conditions without sticking, especially in applications where engines burn heavy fuel oil (HFO).

Control of vane position is fully electronic with feedback or open-loop control with mapped vane adjustment. A comprehensive range of control signals can be used, including charge-air pressure after the compressor and exhaust gas temperature before and after the turbocharger. In this way, MAN Diesel states, it can offer control packages precisely tailored to a specific application, including both mechanically controlled engines and engines with electronic management. For retrofit applications, MAN Diesel will offer complete packages including the VTA nozzle ring, the actuator and the associated control system.

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First Applications

MAN Diesel has recently completed shop tests on a six-cylinder, 46-cm bore 6S46MC-C engine built by Croatian licensee Brodosplit. The HFO-burning 6S46MC-C features mechanically controlled fuel-injection and exhaust-valve actuation, and is one of two engines due to be installed in a twin-engine propulsion system aboard a 70,000-ton, shallow-draught tanker. The vessel is under construction at the Brodosplit shipyard for the Stena Concordia Maritime shipping line.

"The inclusion of VTA technology on the axial TCA55 turbocharger allows up to 0.5 bar in variation in compressor output pressure at part-load," notes MAN Diesel application engineer Andre Voges. "The shop tests included NO_x certification of the engine and the overall results from the test bench showed expected improvements at part-load in terms of fuel consumption, as well as considerable reductions in emissions of soot and unburnt hydrocarbons. Additionally, there was potential for improved engine response under load changes. It was also demonstrated that VTA technology gave a useful new dimension to the mechanically controlled engine. The effects are comparable to the use of variable-valve timing and electronic engine control."

As a further benefit, it has also been established in relation to the two-stroke engine that the additional charge-air pressure at part-load from the VTA turbocharger allows the electrically driven auxiliary blowers to be switched off at lower loads.

Following shop tests, the engine will be tested aboard the shallow-draught tanker during its sea trials and first voyages. To attain the best possible comparison, the

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engine with the VTA turbocharger will run alongside a second 6S46MC-C engine with a conventional turbocharger. A special theme of the tests will be simulating emergency running by operating the engine with the VTA turbocharger at high torque with the second engine shut down.

As well as the stated effects on engine performance, emissions and fuel consumption, VTA turbocharger technology also makes the process of matching the turbocharger to the engine much simpler. “In contrast to fixed geometry turbochargers, where a suitable nozzle ring with fixed vanes is chosen from a number of alternatives, there is only one VTA module per turbocharger size covering all matching possibilities,” Voges notes. “This has a range of vane-pitch adjustment slightly greater than the smallest and largest fixed-vane rings – for example, in the VTA system for the TCA 55 turbocharger used on the 6S46MC-C test engine, vane adjustment angles range from 15% below the smallest, fixed nozzle ring to 20% above the largest. The vane-adjustment range is matched to the charge-air requirements of the engine via the software of the electronic-control system. Thus, in essence, the matching process involves defining the band in which vane adjustments are possible by setting their minimum and maximum pitch to match the operating range of the engine. Within these limits, the vanes can be varied infinitely.”

At the time of writing, the test engine is in the process of being moved from the Brodosplit test bed to the vessel, in time for the start of sea trials in August 2007. Commercial deliveries of MAN Diesel’s TCA and TCR turbochargers with VTA technology are scheduled to start at the end of

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2008. MAN Diesel confirms that the systems will be offered in all sizes of TCA and TCR turbocharger.

Captions:

1. MAN Diesel has completed shop tests on a six cylinder 6S46MC-C low speed two-stroke engine employing a TCA 55 turbocharger equipped with VTA “variable turbine area” technology. The HFO-burning engine was built by Croatian licensee Brodosplit and is one of two engines for a twin engine propulsion system aboard a 70,000 ton, shallow draught tanker.

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2. VTA turbochargers from MAN diesel feature a nozzle ring with adjustable vanes. Seen here is the axial variant for the TCA axial turbocharger. The system is modular and occupies the same position as a fixed nozzle ring. It can be retrofitted to turbochargers already in the field.

3. View of a VTA-equipped turbocharger showing the microprocessor controlled positional motor used to actuate the adjustable nozzle ring vanes. Turbocharger matching is simplified to setting

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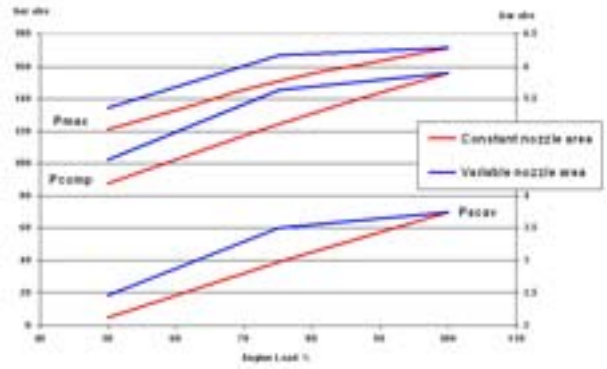
maximum and minimum vane angles via the control software.



4. Comparison of the charge air delivery characteristics of MAN Diesel turbochargers with fixed nozzle ring and VTA technology.

About MAN Diesel
MAN Diesel is the world's leading provider of large-bore diesel engines. The company designs two-stroke and four-stroke diesel engines, generating sets and turbochargers, for manufacture by MAN Diesel and its licensees. The engines have outputs ranging from 450 to 97,300 kW. MAN Diesel has approximately 6,400 employees, located in Germany, Denmark, the UK, France, the Czech Republic and China. The company's worldwide service organisation, MAN Diesel PrimeServ, consists of a network of own service centres, supported by authorised partners. MAN Diesel is a subsidiary of the German industrial group MAN AG which is listed on the DAX stock index comprising the 30 largest companies in Germany.

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