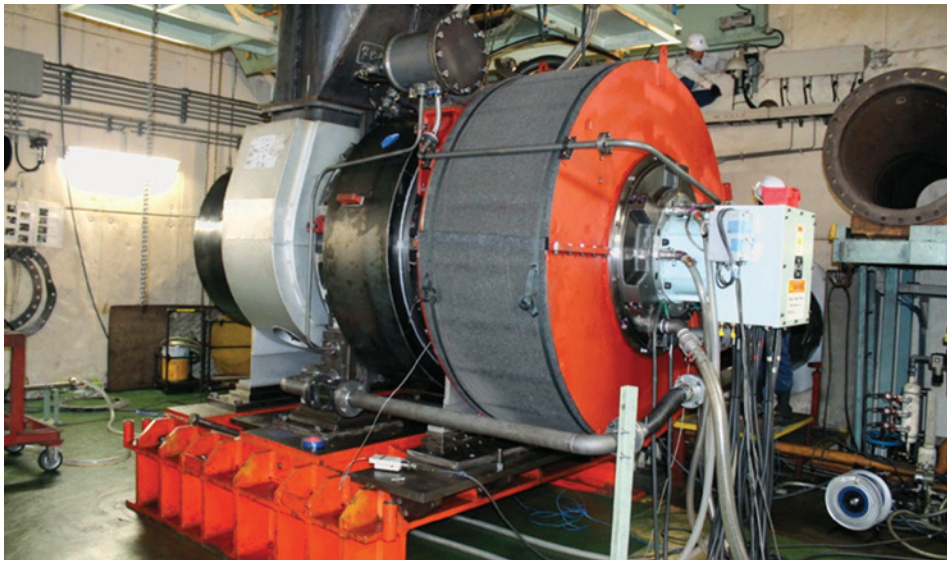
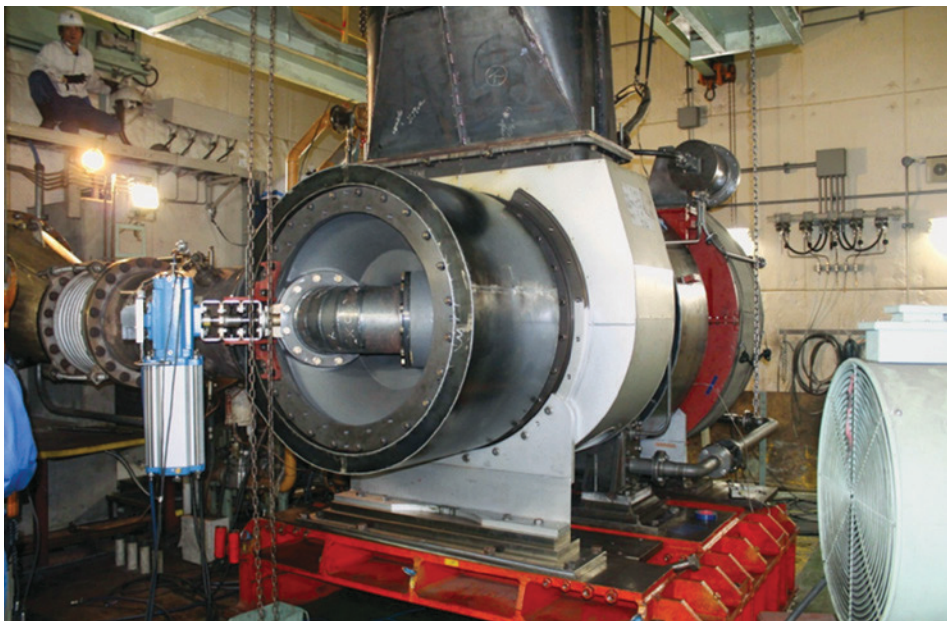
# Electric assist for MET turbochargers

Japanese turbocharger supplier MHI-MME is working with US-based Calnetxi to develop an electric-assisted turbocharger to save fuel





*MET66MAG-VTI turbocharger on a test bed*

In an innovation designed to reduce power consumption Mitsubishi Heavy Industries Marine Machinery & Engine Co (MHI-MME) has developed electric-assist turbochargers as part of its MET turbocharger range in collaboration with US-based Calnetxi Technologies.

This new product is intended as an alternative to using an auxiliary blower and is claimed to reduce power consumption by 30 per cent compared with auxiliary blowers. It uses a high-speed motor supplied by Calnetxi (see panel).

The electric-assist MET turbocharger incorporates a compact electric motor to power functions that assist in driving the hybrid turbocharger. The electric-assist MET turbocharger's built-in electric motor is based on the high-speed motor-generator used in the hybrid MET turbocharger and has been made compact by stripping it to its motor functions.

The electric assist can accelerate the turbocharger or boost scavenging air pressure at any load continuously so the ship's crew do not have to be aware of when the auxiliary blower might start and stop automatically, which may cause a negative impact to the auxiliary blower motor.

Keiichi Shiraishi, senior manager for business management at MHI-MME, told *Worldwide Turbocharger Guide*: "Especially at low engine load, a relatively small power intake into the turbocharger makes significant improvements to the engine performance. This improvement is not only for two-stroke engines but also four-stroke engines with various benefits, such as reduction of smoke, improvement of acceleration and reduction of fuel oil consumption. Since exhaust-gas turbochargers were first applied on marine two-stroke engines in 1952, there have been no control devices for the turbocharger except the variable turbine. MHI-MME believes the electric-assist system for turbochargers has great potential to make diesel engines more efficient, flexible and reliable."

The electric-assist MET turbocharger is now available for the MET 83 and can provide up to 125kW of power into the shaft at optimal turbocharger speed. Additional frame sizes are under development. It reduces the maintenance costs for auxiliary blowers by limiting the need for their operation. It also reduces electric power consumption and improves engine performance at low load. Testing shows a 4 per cent improvement in efficiency with the use of the electric assist.

MHI-MME has developed a range of hybrid turbochargers that generate electric power from the turbocharger's rotation, using a high-speed permanent magnet synchronous generator. A power electronics system is used to ensure a stable supply of electric power to the shipboard grid system. It also functions as a motor to assist the turbocharger to provide additional air to the diesel engine.

The MET hybrid turbocharger is currently being sold and produced in two frame sizes: the MET 83 and the MET 66. The MET 83 generates up to 750kW at 9,500 rpm, and the MET 66 generates up to 470kW at 12,000 rpm.

MET Variable Turbine Inlet (VTI) turbochargers were developed to allow low-load operation for slow steaming and as an alternative to turbocharger cut-out. This is facilitated by a variable turbine nozzle in the gas inlet, with the

size of the nozzle throat narrowed to improve fuel efficiency by an estimated 2-3 g/kWh. MHI-MME says that additional fuel savings are made when these turbochargers are combined with the company's UE engines – to 3-5 g/kWh.

The VTI turbocharger includes a mechanism to switch the nozzle between two stages, enabling an operation similar to that of turbocharger cut-out. Reducing the nozzle area increases the pressure of the scavenging air being fed to the engine.

Mr Shiraishi said: "Turbochargers with the VTI design have been applied to two-stroke diesel engines on more than 30 ships. This is a simple, economical and reliable solution for turbochargers on engines burning heavy fuel oil. MHI-MME is the only turbocharger manufacturer with a built-in high-speed alternator, the so-called hybrid turbocharger.

The first mass-produced model of the VTI is the MET 48MB with an optimal frame size suitable for Handysize bulk carriers. The MET 48MB provides for a diesel-engine output range from 3,830kW up to 6,750kW at a pressure ratio of 4. The MET MB range extends from the MET 33MB up to the MET 90MB, which operates with a power output up to 27,700kW. The overall MET turbocharger range covers engine outputs of 400kW to 28,000kW with 14 frame sizes.

"Recently, MHI-MME also developed a hybrid turbocharger combined with VTI, the MET66MAG-VTI, for the main engine of car carriers. The VTI enables operators to increase alternator output at part load by closing the control valve to increase charging air pressure. Furthermore, the alternator in the turbocharger can work as a motor at low load and accelerate the turbocharger rotor shaft, hence conventional auxiliary blower operation is not necessary anymore. Electric power consumption to the hybrid turbocharger for motoring is about 30 per cent lower than using an auxiliary blower. On the car carrier the hybrid turbocharger MET66MAG-VTI functions as a waste heart recovery system at normal cruising speed and motor function at low load. Sea trials using this system were completed successfully in April," Mr Shiraishi said.

Following these trials the builder Shin Kurushima Dockyard will install the same turbocharger model on two further car carriers. A total of six MET66MAG-VTI hybrid turbochargers with electric assist and VTI have been ordered.

The VTI version can be retrofitted to conventional turbochargers in the MET MA and MB ranges by replacing the gas inlet casing and nozzle with a gas inlet casing incorporating the valve and nozzle designed for the VTI turbocharger. A MET VTI system was retrofitted to the main engine turbochargers on the Maersk Tankers very large crude carrier (VLCC) *Maersk Ingrid*. According to MHI-MME it has achieved a reduction in fuel consumption of 1.6-3.2 per cent in the load range of 10-50 per cent mcr.

Mr Shiraishi said that MHI-MME is also working on improving the aerodynamic design of the compressor and turbine to increase efficiency. "MHI has various turbo machineries such as gas turbines, gas compressors and small turbochargers. The marine machinery division of MHI-MME has started regular discussions for exchanging latest design knowledge with the gas turbine division and small turbocharger division for designing higher-efficiency turbochargers." **WTG**

# Calnetxi boosts Mitsubishi turbochargers

Calnetxi Technologies' motors are a key component of the MHI-MME electric-assist turbochargers. Herman Artinian, vice president of business development at Calnetxi, said that Calnetxi's advanced power systems enabled the turbocharger to perform independently of the engine exhaust conditions. This means the compressor performance is decoupled from the exhaust turbine performance, and can therefore provide the necessary air/fuel ratio for optimum engine performance under all load, speed, start/stop and ramp-up conditions.

The turbocharger motor generator assist the turbocharger during startup and low-speed operation (slow steaming) to create the necessary boost to optimise engine performance, and generates power from excess exhaust energy during steady-state, constant-speed operation. Testing has been performed at various engine manufacturer test stands and for four-stroke engines, an efficiency gain of over 5 per cent has been recorded at partial-load conditions (a 25-35 per cent range). For two-stroke large engines, an efficiency gain of over 2 per cent has been achieved. Field trials are being planned.

According to Calnetxi, the benefits of this configuration include: an optimal air/fuel ratio under any given engine condition; a smaller engine can be used for the same power output; production of electric power from waste heat; elimination of turbo-lag; reduced emissions; minimum space requirement for the motor generator system, which can withstand high temperatures; low-cost integration of the motor generator system; and reduced fuel consumption.

Kristen Frey, director of marketing at Calnetxi, told *Worldwide Turbocharger Guide*: "We have been working together with MHI-MME since 2005 to improve the energy efficiency of marine vessels without impacting vessel operation or performance through highly efficient and cost-effective pressure and heat recovery systems. These systems enable the vessels to get more energy from less fuel, thus reducing operating costs, as well as help meeting international maritime environmental regulations. The products have a long lifespan, require no major engine modification, require minimal maintenance and are extremely reliable. Existing MHI-MME products with integrated Calnetxi Technologies include the MET Hybrid Turbocharger and the Electric Assist MET Turbocharger. We will continue to improve our motor-generator design and controls, and expand the availability of the technology to other product families and frame sizes."

Calnetxi is creating new controls software to completely eliminate the need for auxiliary blowers for both the hybrid and electric-assist systems. The existing turbochargers will operate via electric motor, eliminating the need for an auxiliary blower. This functionality will also reduce electricity consumption by over 22 per cent. Calnetxi is also looking at potential gains through the use of magnetic bearings. The turbocharger motor generator assist technology will also be used in other industrial applications, such as four-stroke diesel engines in power generation.

*Calnetxi Magnaforce motor generator for the MET 83 hybrid turbocharger*