PROJECT MEET NEWS

Only One to the Seas of the World

Mitsubishi Marine Energy & Environment Technical Solution-System

3rd Issue February 2013

On the Occasion of the MEET NEWS "Slow Steaming" Feature

Responding to Increasing Slow Steaming Needs through Wide-ranging Solutions

Hirofumi Tamehisa
President & CEO,
Marine Machinery & Engine Division

The market environment last year proved to be an tought one for the shipbuilding industry. In particular, orders for container vessels and bulk carriers fell drastically and were at a 10-year low. On the other hand, global logistics preserve on a trend of growth, particularly in Asia. It is hoped that the market will continue to expand into the future. The building of new vessels is also expected to move towards recovery, hitting bottom in 2012-2013. The excess in freight capacity, however, has yet to be resolved, and furthermore, many destabilizing factors remain. This includes the financial instability in Europe and the slowdown of growth in China. We therefore do not believe that the kind of momentum that was seen several years ago can be expected. However, depreciation of Japanese yen, since end of last year, seems to support Japanese market.

Slow Steaming, a Need of the Times

In order to respond to harsh market, the shipping industry has been aggressively promoting the resolution of the issues of excess freight and the reduction of operating costs. Slow steaming is currently drawing the most attention as a solution.

Last year, MHI hosted large-scale MEET seminars in Korea and Germany. I attended both and felt a strong need for slow steaming among participants. As considerations toward the sustainability of the shipping industry – including the Energy Efficiency Design Index (EEDI) and the 2016 enforcement of IMO Tier III – attract attention, another reason why slow steaming is in the limelight is that it is also effective in reducing environmental footprints and is an operational method that is befitting the times.

Responding Slow Steaming Needs

MHI offers many solutions to Responding mounting slow steaming needs. The electronically-controlled UEC Eco-Engine enables high-efficiency operation even when operating at low speeds. Also developed and launched by MHI to great response are turbocharger cut-out systems – which turn off one of the turbochargers – as well as Variable Turbine Inlet (VTI) turbochargers that allow optimal and maximum efficiency during slow steaming. Furthermore, the MHI product lineup includes the MAP Mark-W high-performance fixed pitch propeller and other wide-ranging solutions for both new ships and the retrofitting of existing vessels. We believe that our greatest strength is the capability to propose solutions under the single responsibility of MHI and that it is our mission to continue providing such solutions to our many customers.

In this issue of MEET NEWS, we speak to Mr. Kiyotaka Yoshida, Managing Executive Officer of Mitsui O.S.K. Lines, and hear his views on slow steaming. At the same time, we introduce MHI solutions in a "slow steaming" feature. The MEET product introductions cover the Ultra Steam Turbine Plant (UST), and the UEC80LSE-Eco, both of them were recently completed the first order, and the MAP Mark-W high performance propeller that is suitable for retrofitting. In response to requests, we have also given a new idea to this newsletter, such as by increasing the number of in-depth technical articles.

It is our desire to continue providing you with useful information through MEET NEWS. Please feel free to contact us if you have any comments, opinions or requests related to this newsletter or any of our other communications with you.

Global leading Ocean-going Shipping Company

Kiyotaka Yoshida, Managing Executive Officer, Mitsui O.S.K. Lines, Ltd.

Proactive Adoption of Feasible Energy Saving and CO_2 Emission Reduction Technologies

First Encounter with MHI

—— Can you tell us any memories or stories you may have related to MHI?

Yoshida: Immediately after joining Mitsui O.S.K. Lines (MOL) in 1980, I was in charge of a semi-container vessel, in other words known as a multi-purpose vessel (MPP), being built at MHI's Shimonoseki Shipyard & Machinery Works. The ship's jib crane employed the thyristor Leonard system, what we would call an electronic or computerized crane today. It was revolutionary technology at that time—one that allowed four cranes to work in tandem simultaneously. Before then, up to two cranes were operated at the same time. It was a very memorable deck crane that realized highly efficient cargo handling. That was my first encounter with MHI.

—— That does sound very impressive. We carry out continuous technical development so that we can keep responding to the expectations of our customers. However, there may have been times when we inconvenienced our customers for the very reason that we are involved in state-of-the-art technology.

Yoshida: The MHI spirit is to continually develop epoch-making products. I know that the other side of the coin has been that many difficulties are experienced during the initial stages.

MHI's UE engines are based on own developed technology that is not dependent on other companies. MHI's ships also incorporate new technologies and designs, and MOL has benefited much because of this. Problems are an inevitable part of technical development, so one should never be discouraged by them. I think that MHI is a fabulous company that works dauntlessly to resolve problems and moves forward to the next step. Now, you are coming out with the Ultra Steam Turbine Plant (UST), Mitsubishi Energy Recovery System (MERS), Hybrid Turbochargers and Valuable Turbine Inlet (VTI) Turbochargers. I look forward to seeing MHI making the most of its past experience and accumulated knowledge in these efforts.

The "Senpaku ISHIN" Environmental Initiative

—— MOL is involved in the Senpaku ISHIN project in which environmentally-friendly vessels are developed according to the type of ship. Can you tell us more about this initiative?

Yoshida: Senpaku ISHIN has its beginnings in the 2005 World Exposition, Aichi Japan. At this Expo, a Nordic shipping company unveiled a green flagship concept vessel aming zero emissions into the atmosphere or ocean. This galvanized MOL, as a company that bears the responsibility to reduce CO_2 emissions, into creating a grand design for a vessel that is friendly to the environment.

We aimed not for an idealistic vessel of the distant future but rather a concept ship that could be realized in the very near future. It has resulted in the ISHIN-Ⅰ, -Ⅱ and -Ⅲ projects that we are working on today. ISHIN-Ⅰ is for pure car carrier, ISHIN-Ⅱ is for ferry and the themes of ISHIN-Ⅲ are for marine engines for large vessels and waste heat recovery systems. These are technologies that can also be applied to container vessels, LNG carriers and large bulk carriers.

The Emerald Ace, a solar hybrid pure car carrier that has adopted many of the technologies of the ISHIN-Ⅰ project, is equipped with a hybrid electric power supply system that was jointly developed with MHI and the Energy Company of the Panasonic Group. The Emerald Ace, which has 768 solar panels as well as lithium-ion batteries that can store some 2.2MWh of electricity, went into service on June 29, 2012. Its performance is currently being monitored, and we have confirmed onboard energy savings of around 5%.

—— A 5% reduction in fuel consumption is a major benefit.

Yoshida: Yes, we see it as a significant reduction. This was yet another epoch-making vessel that has adopted various MHI green technologies.

—— MOL has been proactive in adopting environmentally-friendly technology in various vessels that are not limited to those in the Senpaku ISHIN projects. Representative examples include waste heat recovery in large vessels, hybrid turbochargers, VTI turbochargers and the high performance MAP Mark-W propeller.

Yoshida: We are proactively adopting technologies that contribute to energy efficiency and CO_2 emissions reduction. We are scheduled to equip a ship currently under construction with VTI turbochargers, but we are also considering retrofitting three existing vessels with the VTI turbochargers, bringing to four the total number of MOL vessels adopting this technology.

Expectations toward MHI

—— Current world trends are toward energy efficiency and environmental friendliness. At MHI, we are promoting "Project MEET," which is a integration of marine machinery and engines, thermal power products and green product technologies. What are your expectations for Project MEET?

Yoshida: MHI has a history of making challenging and epoch-making products, which is a characteristic that I respect very much. My anticipation is that MHI will continue to follow these lines. Furthermore, I would also like to see MHI carry out viable development as we have been doing with our Senpaku ISHIN projects.

I believe that the UST is a perfect example. I feel that the UST is sensible development that combines MHI's marine steam turbine technology with its experience in high temperature and high pressure engineering, which was cultivated through your involvement in thermal power generation. I would like to see MEET products looking not only at the distant future but also at the nearer-future, like five or ten years ahead.

MOL also believes that energy efficiency is the most important element for winning in global competition. A difference of two to three tons per day in fuel consumption has an impact of tens of millions of yen in a year. In that sense, we hold expectations for MHI's capacity for development.

The Spread of LNG-fuelled Vessels

—— These days, many engine manu factures are focusing on the development of low-speed dual fuel engines. As a shipping company, what do you see as being the issues related to the possibilities of such engines and the spread of their use?

Yoshida: We believe that there is no doubt that LNG will become a major fuel source going forward. We also feel that the issue of NOx and SOx regulations, and the uncertainties related to them in terms of the heavy fuel oil supply system, will have a strong impact on boosting the spread of LNG-fuelled vessels.

Refining low sulfur heavy fuel oil is not easy, and I have heard it said that the stable supply of marine fuel with a sulfur content of 0.1% or less would require great care. There is a concern of whether low sulfur heavy fuel oil can be supplied to the hundreds of thousands of vessels around the world. Furthermore, in Europe and the U.S., bunker prices tend to be lower for LNG than heavy fuel oil. As fuel, LNG is also currently cheaper than Bunker C and is also superior in terms of responding to NOx and SOx regulations. So, it is natural to consider LNG as the next fuel to be used. However, the timing of the spread of LNG use may change depending on what the supply systems and prices will be like for bunker fuel oil, low sulfur heavy oil and LNG.

—— How long do you think it will take before the use of LNG-fuelled vessels begins to spread?

Yoshida: I expect we have to think in the range of five to ten years. With the current economy downturn, orders would not probably begin until 2013-2014, with the completion of ships around 2016. That would also be around the time that the Tier III regulations come into force. So, the earliest would be three years from now. Depending on the case, it would probably be something that would be thought of in the five to ten year range.

Preparations are also required for when their use begins to spread. In terms of infrastructure. Rotterdam and Singapore are trying to construct LNG import terminals and attached supply facilities at the same time.

—— So things have begun to progress highly.

Yoshida: Ship-to-ship transfer of LNG is already being carried out not only in Europe but also in Japan. We executed it last year in Tomakomai (Hokkaido). In that sense, we do not foresee any technical issues. I think it will be realized once domestic laws are established in countries around the world.

Response to Slow Steaming

—— As the shipping industry's market conditions remain stagnant, I should think that there would be great pressure on shipping companies to reduce operation costs.

Yoshida: The maritime economy is such at present that the demand for shipping is growing but there is an excess of ships—the market experienced a major crash as a result. It is obvious that slow steaming needs to be incorporated amidst the existing competition for low freight charges.

Fuel consumption is proportional to the cube of vessel speed. This means that if you operate at 80% engine load, fuel consumption will be halved. This is an impact that is seen not only in the case of large vessels but also for small- and medium-sized ships as well. I see a need to aim for engine loads that are 30% or 40% of the nominal load, not 60% or 70%.

I think this will continue for five years or longer. Depending on how things go, it may remain that way without a return to full speed steaming. I think that there would also be the impact of the requirement to reduce CO_2 emissions, such as seen through the Energy Efficiency Design Index (EEDI) regulation and the Ship Energy Efficiency Management Plan (SEEMP) issue.

—— I recently heard from a shipping company that if you consider the reduction in fuel costs achieved by slow steaming, it is more beneficial to execute slow steaming even if it means that you have to increase maintenance frequency.

Yoshida: If you think in terms of total costs, the benefits achieved by slow steaming are significantly greater than the required maintenance and labor costs. One of the issues going forward will probably be the need to develop engines that can achieve stable operation under any speed. From shipping companies point of view, we look forward to seeing shipbuilding companies develop engines that are capable of flexible operation.

—— Thank you very much for sharing your valuable thoughts with us today.

Yoshida: Mr. Kiyotaka Yoshida
Managing Executive Officer
Mitsui O.S.K. Lines, Ltd.

Interviewer: Tomoo Kuzu
Director of Business Development Department,
Marine Machinery & Engine Division
Power Systems, Mitsubishi Heavy Industries, Ltd.

The Emerald Ace hybrid car carrier

Feature

MHI's Solution for Slow Steaming

Moves to lower fuel consumption by reducing the main engine load to about 50% or even below began in response to the surge in fuel prices around 2009. The this operation was first taken for large container ships, but recently, slow steaming is also being considered for other types of vessels, such as tankers, bulk carriers, pure car carriers and medium-size container ships.

The following is an introduction of the solutions being made by MHI toward slow steaming, including those for the UE engine.

UE Engine

Timely Information Provision through the Service Information System

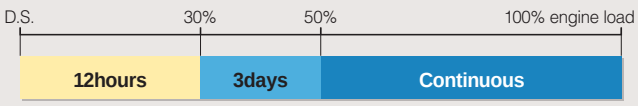
MHI issues online service information that summarizes slow steaming precautions in relation to UE diesel engines. The following is a brief summary of Service Information MSI-1155, which received a particularly large response from our customers.


三菱重工 サービス通報

Description of Major Engine Load Ranges and Principal Conditions

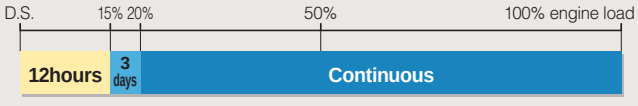
Cam Engines

50-100% engine load: Continuous operation possible
30-50% engine load: Operation at (at least) 50-70% engine load once every 3 days (for about 2 hours)
D.S※-30% engine load: Operation at (at least) 50-70% engine load once every 12 hours (for about 2 hours)



Electronically-controlled Engines (Eco-Engine)

20-100% engine load: Continuous operation possible
15-20% engine load: Operation at (at least) 50-70% engine load once every 3 days (for about 2 hours)
D.S.※-15% engine load: Operation at (at least) 50-70% engine load once every 12 hours (for about 2 hours)



※D.S.: Dead slow ahead (about 5% engine load)

Exhaust and Fuel Valves


New valve with a weld overlay of heat-resistant steel

In order to reduce the wear amount of exhaust valves, in addition to the conventional stellite material, a technique was established for welding heat-resistant steel to repair stellite exhaust valves, or exhaust valves made of special heat-resistant steel (Nimonic).

The UE engine's standard fuel valve with a sac volume smaller than those of the past has significantly reduced the amount of hydrocarbon (HC) in the combustion gas measured at each load point even at slow steaming.

HC ≒ unburnt combustible content ≒ Index of combustion condition

Performance at Slow Steaming

In order to obtain actual service experiences of slow steaming on engines, we cooperate with ship owners to monitor engines. In the case of a pure car carrier equipped with the 7UEC60LSII that is operated at about 20-30% engine load, the ring & liner (shown in the photo below) remains in a favorable state even after 9,000 hours of slow steaming. We have confirmed that the UE engine is capable of low engine load operation without any problems.

In addition, slow steaming substantially reduces the dosage lubrication of cylinder.

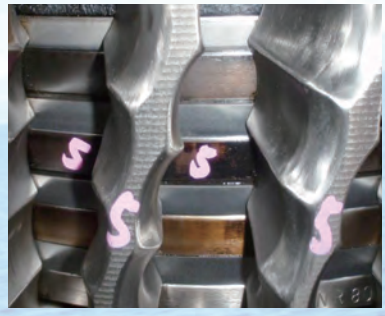


Photo of piston ring after slow steaming

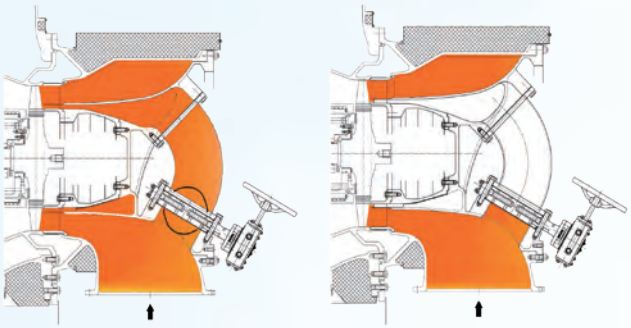
VTI Turbocharger

In general, operating a main engine at part load during slow steaming reduces the scavenging air pressure, thereby lowering fuel economy. However, the VTI turbocharger increases scavenging air pressure to be maintained even during part-load operation, improving fuel efficiency of engine.

With a VTI turbocharger, two-stage turbine nozzle is installed in the exhaust gas inlet area. During part-load operation, the size of the nozzle throat area at the exhaust gas inlet is narrowed to improve fuel efficiency at 2-3g/kWh. Because the structure of the VTI turbocharger is simple, we were able to maintain high reliability while achieving low costs and easy mentenance.

It is easy to retrofit a conventional machine by adding a nozzle and an on-off valve to the exhaust gas inlet area.

VTI : Variable Turbine Inlet



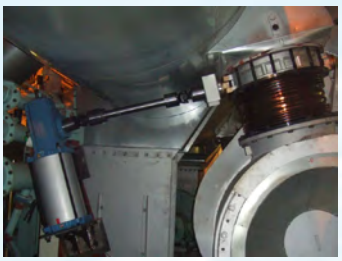
Open and closed nozzle throat

Turbocharger Cut-out Method

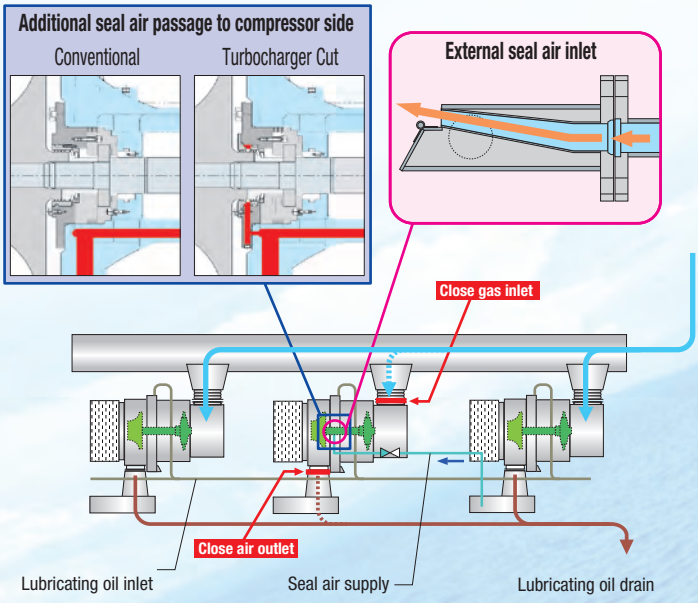
Turbocharger cut-out is a method of operating an engine with two or more turbochargers by cutting off one of the turbochargers when the engine is being run at part load. This increases scavenging pressure and improves fuel efficiency by several g/kWh. By installing an valve, it is possible to operate the turbochargers under various changes in engine loads, such as when carrying out slow steaming temporarily—not just continuously.

Furthermore, MHI also proposes a cut-out method that has no impact on bearings. By placing panel sheeting at the combustion air and exhaust gas inlets, turbocharger cut-out can be achieved without the need to extract the rotor.

Furthermore, by modifying the seal structure of the compressor on the turbocharger for cut-out and installing a special seal air inlet valve, it is possible to prevent oil leaks during turbocharger cut-out.



On-off valve

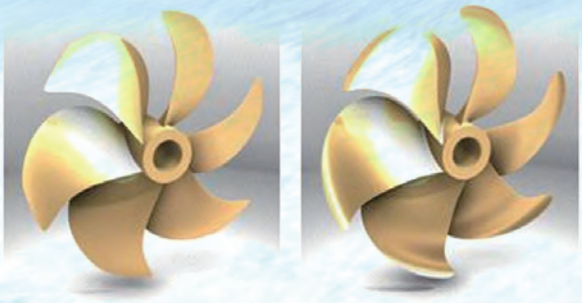


Turbocharger cut-out system diagram

MAP Mark-W

Many merchant vessels, such as bulk carriers and container ships, are equipped with propellers that have been designed for 100% MCR conditions. With the Mark-W series, MHI proposes a propeller suitable for vessels carrying out slow steaming. By replacing a propeller designed for 100% MCR operation – when the ship was built – with a Mark-W for routine operation at 70% MCR, it will be possible to improve efficiency by about 3% to 6%. Furthermore, when retrofitting a Mark-W, MHI also proposes to buy the propeller currently installed on the customer's vessel, thereby offering an opportunity for customers to reduce their initial investment.

▶▶ **Please see Page 8 for further details.**



MAP (conventional)　　MAP Mark-W

Qingdao Qiyao Wartsila MHI Linshan Marine Diesel Co., Ltd. (QMD)

Total Production of One Million Horsepower Achieved in Less than Three Years of Plant Opening

QMD was established in August 2006 as a joint venture between MHI, Wartsila and CSIC. After the plant opening ceremony in April 2009, it successfully completed the shop test of the 6UEC50LSE – the first UE diesel engine produced by QMD – in August 2009. To date, it has produced three 6UEC50LSE and three 6UEC43LSII engines.

As a QMD shareholder, MHI is a member of QMD's board of directors. At the same time, it provides marketing and technical support through the dispatch of personnel as the chief administrative officer (Vice President assigned to General Affairs) and head design engineer.

QMD boasts state-of-the-art machinery and equipment, is capable of in-house machining of large-scale key components and continues to maintain high quality production. It holds an MHI license for UE engines and is also a Wartsila licensee. Production is focused around medium- and large-size engines (cylinder bore of 50cm or larger) for ocean-going vessels. In February 2012, less than three years since plant opening, QMD achieved production of a total one million horsepower in marine engines. A lavish commemoration ceremony was held with many guests in attendance. Using this as momentum, QMD is carrying out sales expansion activities in order to further increase orders. MHI will continue to provide QMD with utmost support.

Rien Hoogerbrugge, Chief Executive Officer

QMD Plant (Qingdao, Shandong Province)

Yichang Marine Diesel Engine Co., Ltd. (YMD)

China's No.1 Manufacturer of Small- and Medium-size Main Engines

YMD, established in December 1970 as a main engine manufacturer, is a member of the China Shipbuilding Industry Corporation (CSIC). With a long history of over 40 years, the company possesses abundant know-how based on its rich manufacturing experience.

In June 2010, it successfully completed the shop testing of its first UE engine produced, and to date it has manufactured four 6UEC43LSII units. The range of YMD's production is focused around small- and medium-size engines with a cylinder bore of 50cm or smaller. It is China's No.1 manufacturer of small and medium engines, and the only manufacturer in China with licenses for the three major low-speed engine brands – UE, MAN and Wartsila.

MHI has established a good relationship with YMD, providing not only marketing and technical support but also assistance in relation to after-sales services. It includes onboard inspections, carried out jointly with YMD, of ships in actual service.

YMD is currently expanding its plant, and we are looking forward to a further increase in UE market share through the enhancement in YMD's production capacity.

Zhao Zonghua, President

YMD Plant (Yichang, Hubei Province)

Zhejiang Yungpu Heavy Machinery Co., Ltd. (Yungpu)

Manufacturer Meeting the Demand for Low-speed Engines in Chinese Domestic Vessels

Yungpu is an independent private company that was established in 2008 to serve the demand to replace medium-speed engines with low-speed engines. It targets small domestic vessels that operate in China's coastal waters and rivers.

Shortly after acquiring a UE license in December 2009, Yungpu received an order for its first UE engine (6UEC33LSII) under the strong leadership of its president, Chan Weiwen. As support for the production of the first unit, MHI provided technical support for assembly, operation, etc. Shop testing of the 6UEC33LSII was successfully completed in April 2011.

Yungpu's production range covers cylinder bore 33cm- and 37cm-class small engines. It holds licenses for UE and MAN engines. MHI and Yungpu maintain a good relationship based on the experience nurtured through production of the first UE engine unit. The two companies engage in lively exchanges of opinion related to the global specifications of main engines, with an eye on the future expansion of the UE engine business in China.

The vessel (8,000 ton chemical tanker) equipped with the first UE engine produced by Yungpu went into service in October 2011 and continues to accumulate a favorable service record. While publicizing these achievements, Yungpu also carries out UE engine sales expansion activities to further increase orders.

Chen Weiwen, Chairman & General Manager

Yungpu Plant (Ningbo, Zhejiang Province)

15% Improved Fuel Efficiency as Compared to CST

UST (Reheart Propulsion Steam Turbine Plant)

First Unit Completed and Unveiled

An event to unveil the UST was held on November 8 and 9, 2012, at MHI' s Nagasaki Shipyard & Machinery Works, where the implementation of the main boiler and main turbine was introduced.

More than 40 guests from Japan and abroad attended the event that included a presentation of the UST, which significantly improves fuel efficiency over conventional steam turbines. The presentation was followed by a lively Q&A session, with participating customers asking many questions on the advantages of the UST, such as improved fuel efficiency, superior environmental performance and low maintenance costs. We will continue to proactively introduce the UST and provide the latest technical information to our customers.

UST : Ultra Steam Turbine Plant
CST : Conventional Steam Turbine Plant


Presentation at the unveiling

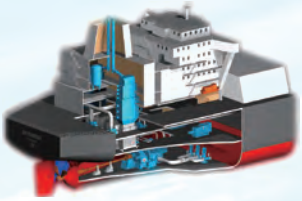

Display of the high-efficiency turbine

Development Concept

While keeping the characteristics – such as reliability, safety and low vibration or low noise – of CST propulsion plants, the UST propulsion plant has achieved a fuel efficiency improvement of approximately 15% by introducing various state-of-the-art technologies. It is gathering attention as propulsion machinery for LNG carriers, which must treat the boil-off gas generated from the cargo tank. Major points of difference from CST include increased steam temperature and pressure conditions, application of a reheat cycle and use of a high-efficiency turbine.

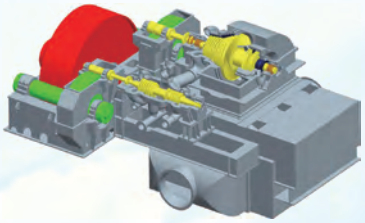
As of the end of 2012, fixed decisions have been made to equip six LNG carriers with the UST. The first unit is scheduled to go into service in early 2014.

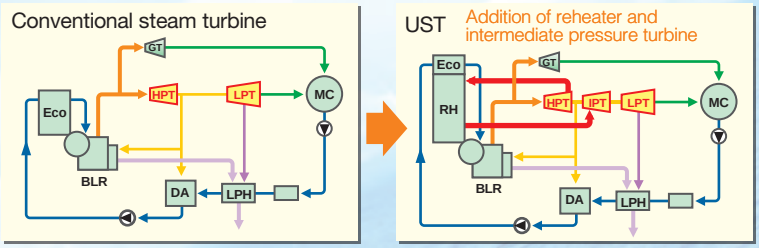
The UST is superior to other propulsion plants in terms of its environmental friendliness and economic efficiency. It can be considered as one of the major contenders going forward as an LNG carrier propulsion plant.



Major Points of Difference

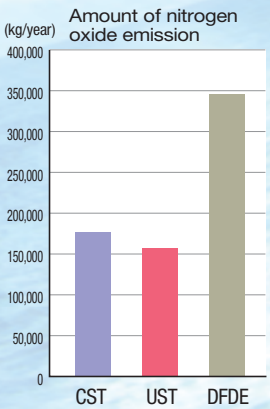
The pressure and temperature of the boiler steam conditions have been increased from 6MPa x 510°C for CSTs to 10MPa x 555°C. In terms of configuration, a reheater and an intermediate pressure turbine have been added to introduce a reheat-regenerative cycle as the UST's steam cycle. Furthermore, to realize high efficiency, the steam turbine comes loaded with MHI's cutting-edge technology, such as a 3D nozzle.


High-efficiency turbine



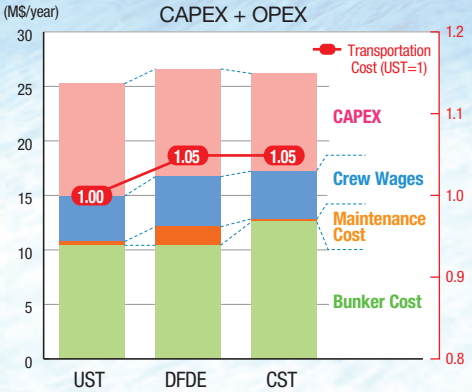
Environmental Responsiveness

The UST meets IMO Tier II and Tier III NOx emission regulations as well as SOx regulations. Furthermore, it was developed as a system that can respond to diversification of oil types, such as low grade oil, low-sulfur fuel oil and gas oil.



Economic Efficiency

A comprehensive evaluation of initial investment, fuel and maintenance costs shows that as a propulsion method for LNG carries, CST offers the lowest lifecycle cost as compared with DFDE and CST.



About 2% Efficiency Improvement over Conventional Propellers

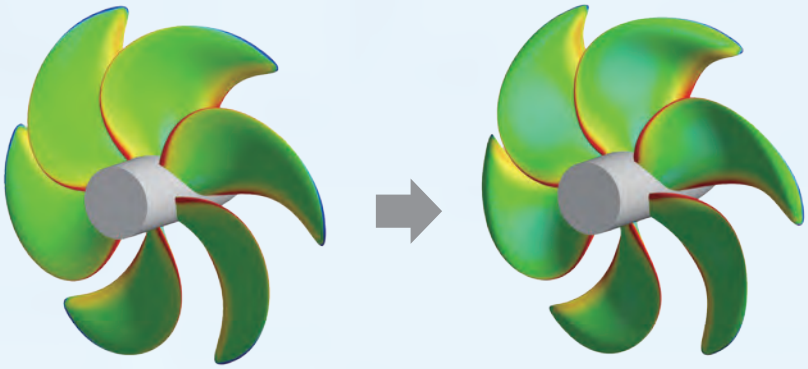
MAP Mark-W

A High-performance Upgrade of the MAP Propeller

Available for Retrofitting

Since 1904 when MHI became the first in Japan to begin propeller production, the Company has continued producing and developing high performance propellers on the basis of a proven track record, which now extends over 100 years. In 1983, MHI developed MAP, which was adopted for a large number of ships and earned high marks from customers. In 2006, the Company began development to further evolve the MAP. The result was the Mark-W, a higher-efficiency, low-excitation propeller launched in 2010.

MHI received the first Mark-W order in 2010 for a bulk carrier that was being built, followed by an order for a pure car carrier. Today, a total of six vessels fitted with the Mark-W are in service, all of which have demonstrated the expected performance level.



MAP (conventional) MAP Mark-W

MAP : Mitsubishi Advanced Propellers

Development Concept

Economic Efficiency

Generally speaking, improving propeller efficiency negatively impacts cavitation performance. However, with the Mark-W, the modified shape of the blade tips enables improved propeller efficiency without sacrificing cavitation margine. While fuel efficiency is enhanced by approx 2% as compared with conventional MAP propellers, cavitation margine remain as before. Furthermore, the propeller weight and moment of inertia have been reduced by 3%.

Use in Combination with Slow Steaming

Through a design that matches slow steaming needs, the Mark-W can improve fuel efficiency by between 3% and 6% (when designed for 85-70% MCR conditions). Taking the following MCR conditions as examples for a 6,300TEU container ship installed with a MAP propeller, fuel consumption can be decreased as follows (Fig. 1) through the installation of a Mark-W propeller: (Case 1) 100% MCR = 3.0%, (Case 2) 85% MCR = 4.0%, and (Case 3) 70% MCR = 5.0%. The amounts of fuel saved in these cases are shown in Fig. 2. By designing a propeller that matches actual operation, it is possible to achieve fuel savings of up to between $700,000 and $1,200,000 per year, for example, when operating at 50% engine load.

Retrofitting

Many shipping companies are now carrying out slow steaming. The Mark-W, which improves efficiency at all engine loads for all vessel types and can be further optimized for slow steaming conditions, is also suitable for retrofitting.

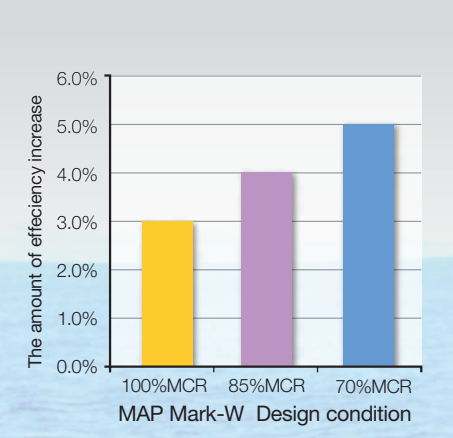


Fig. 1 Fuel saving efficiency in each design condition

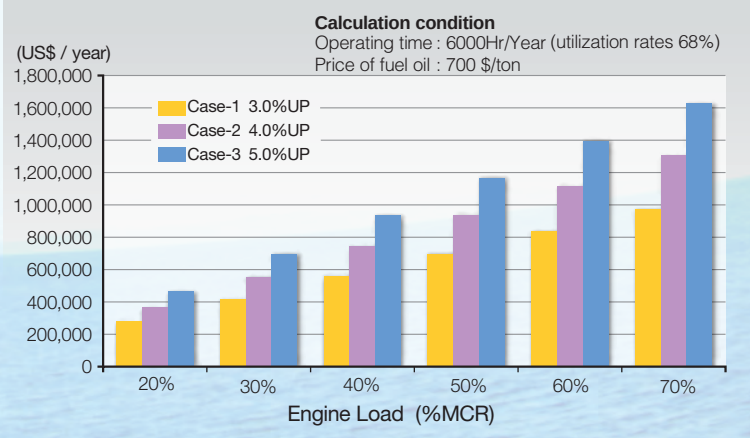


Fig. 2 Evaluation of economics

High Economic Efficiency and NOx Compliance

UEC80LSE-Eco

First UEC80LSE-Eco Completed

As the in the lastest series, UE engine with the largest cylinder bore, the UEC80LSE-Eco offers output and engine speeds that are perfect for very large ore carriers (VLOC; 225-330BC), very large crude oil carriers (VLCC; 300-320T) and even in a twin-engine, twin-shaft configuration for mega container ships. The first of this cutting-edge engine, developed to respond to steep rises in fuel prices and the strengthening of environmental regulations, was recently completed.

The first 7UEC80 LSE-Eco produced is being installed as the main engine for a very large ore carrier manufactured by Namura Shipbuilding Co., Ltd. It is scheduled to begin operation in June 2013 to transport iron ore from Australia.

The UEC Eco-Engine is equipped with an electronic control system. It achieves both green performance, such as the reduction of NOx and smoke, and high efficiency at the same time by controlling the engine according to changes in engine revolution, ambient conditions such as temperature, and the characteristic of the fuel being used.

Shop verification testing of the first unit has confirmed that high reliability has been secured through a reduction of the load on the combustion chamber through the aforementioned optimized control. At the same time, it has achieved economic efficiency through improvements in fuel efficiency and reduction of the cylinder oil feed rate. We will focus even further on the expansion of UEC80LSE-Eco sales as the future flagship engine of the UE series.

An after-sales service base is scheduled to be established next year in Australia in order to strengthen after-sales services for this region.

First 7UEC80 LSE-Eco produced

Development Concept

Economic Efficiency

Superior fuel efficiency over competitor engines was achieved through optimization of the Pmax, improvement of the exhaust passage, use of a high-efficiency turbocharger (MET-MB) and other items implemented for improvement of performance. Furthermore, it is equipped with an A-ECL to lower the cylinder oil feed rate.

Reliability

In addition to perfectly reflecting the technology and know-how accumulated through the development of UE engines into the development and design of the UEC80 LSE-Eco, all improvements made on ships in service are fed back. Furthermore, points of improvements based on customer requests as well as those based on the assumption of production to be carried out by overseas licensees have also been included, resulting in a highly robust engine.

Environmental Responsiveness

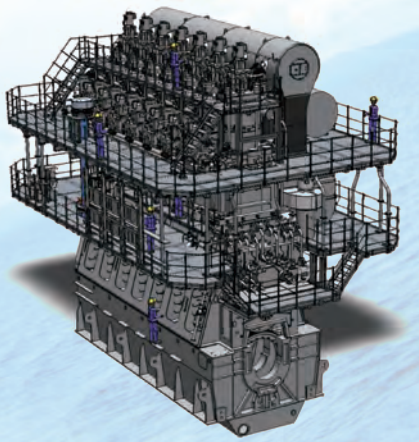
In response to the strengthening of environmental regulations (IMO-NOx Tier II, Tier III and SOx regulations), the UEC80LSE-Eco has been developed as an engine compatible with a wide range of oil types, such as low-grade oil, low-sulfur fuel oil and gas oil.

Compactness

The UEC80LSE-Eco has a more compact design – 1 frame less the entire length of the machine room – than that of competitor engines.

Serviceability

Based on shop testing of the UEC85LSII, UEC60LSII-Eco and the testing machine 4UE-X3 as well as information related to ships in service, the serviceability of each part has been improved and the maintenance interval extended, resulting in an engine with low lifecycle costs.



7UEC80LSE-Eco 3D

A-ECL : Advanced Electronically Controlled Lubricating system

Development of Technology in Response to Accelerating Environmental Regulations

Execution of Full-scale EGR System Tests for UE Engines

EGR is one of the technologies for responding to the IMO Tier III regulation requiring a significant reduction of NOx emissions within an ECA. EGR reduces the generation of NOx by changing the combustion state within the engine through the recirculation of part of an engine's exhaust gas back to the engine.

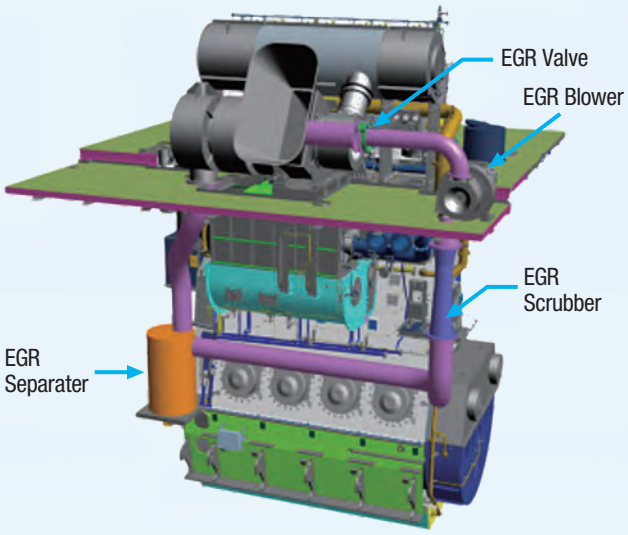
MHI's EGR system is a low-pressure loop system that returns low-pressure exhaust gas from the engine's turbocharger outlet to the turbocharger's air inlet. After conducting basic tests at the MHI's Research & Development Center, we are now carrying out pilot tests using the 4UE-XE fullscale test engine.

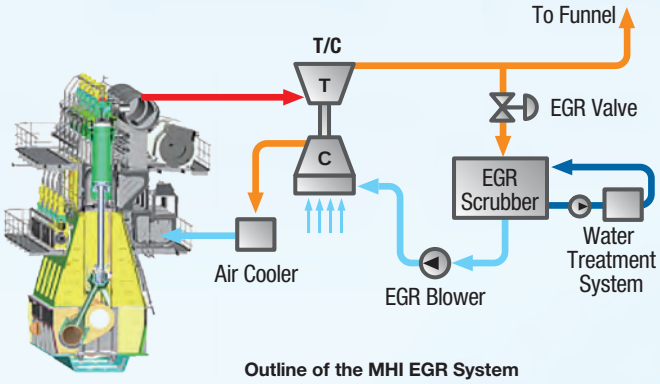
In the pilot test, the amount of NOx decreased as the EGR ratio (the ratio of the exhaust gas returned to the intake) was gradually increased. We confirmed that it is possible to reduce NOx emissions to a level that complies with Tier III regulations, something that had been thought difficult to achieve using only EGR technology.

It is also possible to configure the system to meet SOx emission requirements at the same time through the combined use of a SOx scrubber that cleans all of the exhaust gas. MHI is jointly developing this exhaust gas scrubber with Mitsubishi Kakoki Kaisha, Ltd. which has an established track record in IGS scrubbers.

By carrying out overall optimization of the system, including the water treatment system, we will strive to create a compact system, establish optimum operating parameters, etc., so as to satisfy environmental requirements while maintaining primary engine performance.

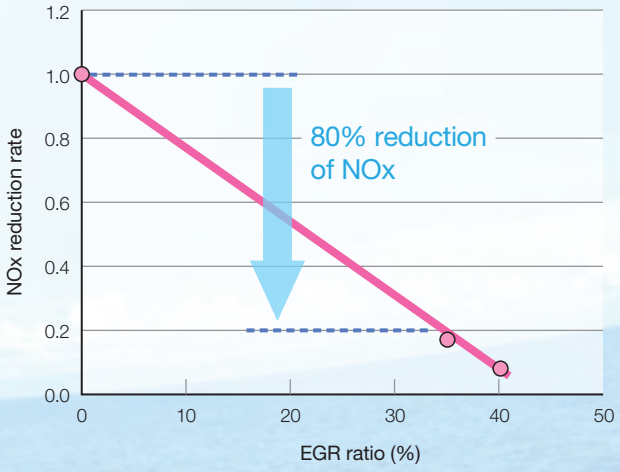
EGR : Exhaust Gas Recirculation
ECA : Emission Control Area
IGS : Inert Gas System





Outline of the MHI EGR System

4UE-X3 EGR testing facility (Kobe Shipyard and Machinery Works)



Graph of Actual Measurements: EGR Ratio and NOx Reduction Ratio

Joint Venture Company to Be Established with China's Qingdao Jieneng Steam Turbine

MHI reached a joint venture with Qindao Jieneng Steam Turbine Group Co., Ltd. (QJST) — a leading Chinese manufacturer of small-scale steam turbines — to establish Mitsubishi Heavy Industries Qing Dao Steam Turbine Ltd. (MHI-QJST) The joint venture company will market and design small-scale land-based steam turbines and marine steam turbines. Through the granting of an MHI license, MHI-QJST will become China's first marine turbine supplier.

MHI will have a 51% stake in the joint venture, while QJST will hold 49%. The new company will be headquartered in Qingdao and will engage in the marketing and design of land-based steam turbines with outputs ranging from 50MW to 200MW as well as marine steam turbines of 10MW or less. It will aim to expand sales targeting container ships, very large crude carriers (VLCC) and LNG carriers built in China. Business is scheduled to begin in March 2013.

Turbine production plant

Qingdao Jieneng Steam Turbine

Deck Crane License Granted to Korea's SPP Machine Tech

MHI reached an agreement and signed a contract with Korea's SPP Machine Tech Co., Ltd., to grant a license for the production and sale of deck cranes. This license agreement follows the 2008 contract with China's Jiangsu Masada Heavy Industries Co., Ltd.

SPP Machine Tech is highly regarded by the market as the leading company in Korea boasting a 40% domestic share of marine deck cranes. Meanwhile, Jiangsu Masada Heavy Industries has expanded its market share in China to 15% in the three years since signing the license agreement with MHI.

The recent agreement was the result of the coming together of MHI's desire to efficiently enter the Korean market – a major shipbuilding nation – and SPP Machine Tech's eagerness to add MHI deck cranes, which have an established reputation in the market, to its product lineup. We will aim to further increase our shares in deck cranes.

Licencing and signing ceremony with Korea's SPP Machine Tech

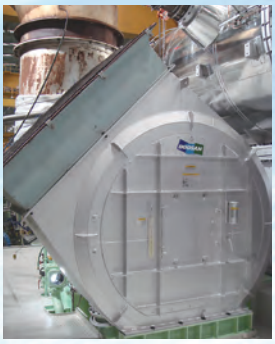
The First MET Turbocharger Produced by Doosan Engine Completed

Doosan Engine Co., Ltd., to whom MHI licenses the production of MET turbochargers, has completed production of its first unit.

The completed first unit will be installed on the 8S80ME-C9.2 main engine powering the Triple E, which is a 18,000TEU container ship being built for Maersk Line by Daewoo Shipbuilding & Marine Engineering Co., Ltd. There are 20 such container carriers scheduled to be built at this shipyard, and Doosan Engine is scheduled to produce MET turbochargers for the subsequent ships as well.

Doosan Engine is a core business of the Doosan Group, a leading conglomerate in Korea, and the world's second largest manufacturer of diesel engines.

MHI has licensed the MET turbocharger to all low speed marine diesel engine manufacturers in Korea (Hyundai Heavy Industries, Doosan Engine and STX Heavy Industries). By proactively building a global production framework, MHI aims to achieve a global market share of over 50% for the MET turbocharger.



MET Turbocharger manufactured by Doosan Engine Co.,

MET Turbocharger installed at engine manufactured by Doosan Engine Co.,

A wide range of green and energy-efficient technologies introduced
MEET Seminar Hamburg

Hamburg, September 5, 2012

SMM 2012, one of the world's largest international maritime trade fairs, was held at Hamburg in September. In addition to exhibiting a booth, this year we also held a MEET Seminar in order to further enhance understanding of MHI's green and energy-efficient technologies. The presentation was revised to further reflect the needs of ship owners, and we introduced technologies that respond to current demands for slow steaming and environmental regulations.

At the reception held after the seminar, MHI added in an introduction of Japanese culture including Kagami-wari (the ceremonial opening of a barrel of sake) and a Japanese Taiko drum performance.

MHI will hold MEET seminars around the world again this year and continue proposing optimum solutions to our many customers.

Scene from the seminar

Reception held after the seminar

News from MHI Offices Abroad

Mitsubishi Heavy Industries Engineering & Services Private.LTD.
Power Systems Business Unit. (Singapore Office)

Katsuhiko Tatsumi, General Manager, Marine Machinery

The Singapore Office was opened in April 2011 as the after-sales service base for Mitsubishi diesel engines for large ships. The office is located in Bugis in the east side of downtown Singapore. Nearby is the tourist destination Arab Street, which is known for the Sultan Mosque. The view from the office windows includes the giant Ferris wheel built by Mitsubishi Heavy Industries and the skyscrapers of the financial district.

My primary responsibilities include dealing with inquiries from customers concerning the UE engine as well as providing technical support to MHI authorized repair agents (ARAs).
Because Singapore is one of the world's busiest trading ports in addition to being a key stop in shipping routes, I have many opportunities to go out for on-board surveys and work on anchored and moored ships. For a time, I spent every Friday night at container terminals or onboard a ferry to make offshore repairs, with the fireworks displays over Sentosa Island in view. Because Singapore is a tropical country, the temperature in the engine room was often over 40°C, and I always had to make sure to bring plenty of drinking water and energy drinks with me when we carried out our onboard work.

Many of our customers are located within 30 minutes of our office. My aim is to provide accessible, community-based services as a consultation office for any matter related to marine engines.

The beautiful view of the Singapore cityscape from the office

(From left) Geraldine Goh (Acting Manager), Katsuhiko Tatsumi (General Manager) and Kho Chew Ming (Senior Admin. Executive)

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