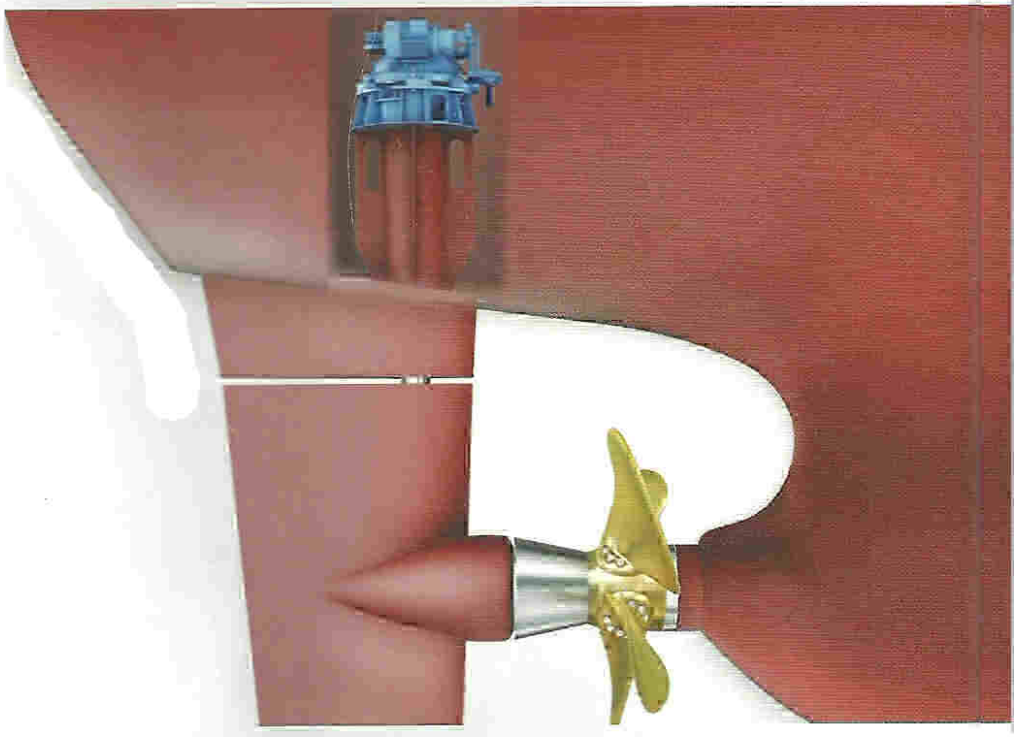
Suppliers are taking a dynamic approach to rudder design

Power and therefore fuel savings are being emphasised when it comes to rudder performance

Becker Marine has been researching the links between wake and propeller efficiency



The Promas concept features a propeller with hub faired into a twisted rudder

Tankers over 10,000gt are required to have a hydraulic steering arrangement that is duplicated and fitted with automatic changeover. This is because if one of the two hydraulic systems installed loses fluid and fails, the failure will be detected and isolated, with the second system activated automatically. These tankers also require duplication of the rudder actuator itself.

The required steering gear is a complex installation and essential for ship safety. But complete redundancy with two systems is not currently a mandatory requirement.

Jastram provides dual-actuator designs for all ships, regardless of the size and type. The Jastram automatic changeover system consists of a sensing unit that determines the origin of the leakage, and an isolation unit where the failed system, including the cylinder, is isolated.

The design challenge was to automatically isolate one cylinder without requiring it to be mechanically disconnected from the rudder stock, and to maintain a consistent rudder speed with only one cylinder in operation. Changeover is transparent to the operator, except for that the vessel has to be steered under reduced speed to compensate for the loss of steering torque capability with only one cylinder in operation.

The main advantage is the simplicity of the hydraulics (two cylinders, two pump sets and four hydraulic lines), at a time when installation and operational costs are of the essence, says Jastram. The complete changeover package is included in one manifold and has been installed successfully on a number of tankers.

The Schilling King Support Rudder (KSR) by Becker Marine Systems moves the main rudder profile thickness aft to house the bearing in a design that offers large tankers the advantages of the high-lift Schilling rudder profile and the manoeuvrability of a full spade rudder. A new concave streamlined fishtail improves flow separation characteristics. The design maintains [illegible] and reduces drag by approximately 25 per cent at normal cruising helm angles.

Becker's research shows that the wake field [illegible] vessels reduces propeller efficiency due to uneven water flow. Its Mewis Duct solution involves a duct with an integrated fin system positioned ahead of the propeller. This straightens and accelerates the hull's wake into the propeller and produces a net ahead thrust. The achievable power savings are estimated to be up to 10 per cent for large tankers.

Modern computerised navigation and positioning systems use rather general output signals to operate rudder controls. Predictions of the reaction forces from specific rudder angles fall short due to disruptive factors such as wind, speed or drift in a vast number of possible combinations that cannot be pre-determined. This means, for example, that the rudder of a 100,000 dwt tanker travelling at a speed of 14 knots under AP navigation moves continuously in a 5-degree range, resulting in a significant

Steering toward more fuel efficient operations

Overseas Shipholding Group (OSG) has contracted Raytheon Anschütz for retrofitting existing autopilot systems on their fleet of oil tankers with the newly developed Anschütz NautoPilot 5300. The first autopilot system was installed onboard *Overseas Fran*.

"With OSG, we have now had the chance to prove positive effects of NP 5000 on steering performance and fuel consumption in practice for the first time," says Olav Denker, Product Manager at Raytheon Anschütz.

NP 5000 helps optimise rudder movements with its integrated Eco-Mode. In Eco-Mode, the autopilot automatically adapts to the current sea-state and weather. Instead keeping a heading with frequent rudder actions with high amplitudes, the rudder's sensitivity to periodical yawing movements caused by roll and pitch is reduced. Subsequently less rudder action is required, which leads to lower levels of speed reduction and thus less fuel consumption.

The first voyage of *Overseas Fran* with NP 5000 was from Skagen to New York. To investigate the actual effect of NP 5000 on rudder steering, the heading and rudder plot of this voyage was compared with the results of the last voyage on the same route with the old autopilot system, under similar weather conditions during both voyages.

Capt. Dmitry Shatrov, Master of *Overseas Fran*, explains: "We can see on our print-out that rudder movement is more economic and gentle with the new autopilot system."

The effect of Eco-Mode is further supported by the new integrated heading and rudder plotter, which provides a graphical indication of heading changes and the resulting rudder angles. This graphic display instantaneously indicates the steering performance of the vessel due to the effects of changes to parameter settings such as rudder, counter rudder and yawing. The operator benefits from simplified adjustments of the autopilot's settings to gain optimized steering performance, which further minimizes rudder action and thus increases fuel efficiency.

"The newly installed autopilot system has a user-friendly interface in which you can easily adjust autopilot functionality in the prevailing circumstances, weather condition and required steering accuracy. So that we can navigate the vessel more gently and economically, taking into consideration fuel savings and safety", Capt. Shatrov concludes.

The relevance of optimised rudder movements for fuel savings has already been highlighted by IMO as a "best practice" for efficient ship operation when developing a Ship Energy Efficiency Management Plan (SEEMP). "Since we all know that less rudder movement significantly contributes to reduced fuel consumption and emissions, we have developed and implemented unique features such as the Eco-mode and the heading and rudder plotter into the new NP 5000 autopilot series", Mr. Denker explains.

In addition to its fuel-saving potential, NP 5000 is also equipped with advanced functions for high precision course keeping, for example for safe navigation in challenging sea areas near coastlines and shallow sea areas, platforms or archipelagos. Besides heading control and track control the new autopilot features a course control mode. When steering in this mode, the autopilot automatically compensates for drift and keeps the vessel on the defined course over ground line. An optionally integrated acceleration monitor provides a warning if a pre-defined cross acceleration limit is exceeded.

increase in fuel consumption. A similar situation occurs with operation in DP mode, but at much greater rudder angles, requiring even greater fuel consumption and intensive, unsteady operation of the prime mover and steering gears.

Becker is addressing these issues with the development of the Becker Intelligent Monitoring System (BIMS), a force measurement arrangement capable of determining rudder lift and drag, and an interface for processing the sensor signals and transferring force data to the positioning system. The improved performance in manoeuvrability will lead to more reliable and safer operation in DP, fewer manoeuvring motions with lower fuel consumption, and reduced emissions. Further savings in fuel consumption can be achieved when one main engine on a twin-screw vessel is being operated in standby mode. Using shaft generators as a PTI device is conceivable as a back-up solution where full main engine power is not required for DP operation. Several prime mover manufacturers are thinking about using shaft generators for propulsion, powered by auxiliary diesels. Further testing will be required to determine whether these arrangements are capable of providing sufficient performance for DP manoeuvring with auxiliary power and all main engines on standby.

The initial analysis of force and wind data from North Sea operation provided an insight into the complexity of the data involved, considering ocean movements, vessel motion, etc. It also showed that standard methods of prediction derived from smooth and constant conditions are of limited value. BIMS is an innovative tool to monitor actual conditions and apply optimum helm angles. The system was developed by Becker Marine Systems in close co-operation with M.A.C. System Solutions, and also with Kongsberg Maritime as KBIMS for DP applications. BIMS is able to display rudder forces anywhere with network access. Three display modes are available. The first displays totals for lateral force and drag values (e.g. for adjustment, load determination, etc.) This mode can also be used to indicate that rudder force is low and only little response is expected under current conditions. The second mode displays a graph showing force application over time in chronological sequence. This mode makes it possible to visualise force maxima and to adjust the optimal rudder angle and RPM (propeller thrust), ensuring optimal rudder performance, especially in emergency situations. The third display mode indicates the optimal rudder angle for a specific speed and rudder force actually applied in relation to maximum force.

Wärtsilä's Energopac rudder/propeller combination uses Becker's KSR design. Where the system replaces another sophisticated propeller-rudder arrangement, Wärtsilä claims a 2 per cent power decrease. When replacing a conventional propeller and semi-spade rudder configuration, an 8 per cent efficiency gain is expected.

Hatlapa Marine Equipment supplies the Poseidon range, an electro-hydraulic system based on twin rams and four cylinders. Torque delivered by the largest package exceeds 7,500Nm. Pumps can be specified with constant delivery or as controlled variable speed units. The optional Safematic automatic isolation system maintains operation on two pumps and a single cylinder on failure.

The Van der Velden Commander ram steering gear and Timon flap achieve high maximum lift and excellent manoeuvrability, says the company. The simple slide-bar flap linkage is easy to maintain and construct, so this manoeuvrability comes at a competitive price. A slim profile design ensures that drag is low.

Rolls-Royce supplies rudders, actuators and rotary vane steering gear. Its RS rudder range features a cast cone and has a robust link mechanism and hinge system designed to withstand the high forces experienced by tankers. The largest RS rudder is suitable for 50,000 dwt vessels.

The Promas concept features a propeller with hub faired into a twisted rudder fitted with a Costa bulb. Attractions include 4-8 per cent improvements in propulsion efficiency and the opportunity to purchase a package from a single supplier. The technology is seen as especially attractive for product and chemical tankers up to 50,000 dwt. ***TST***