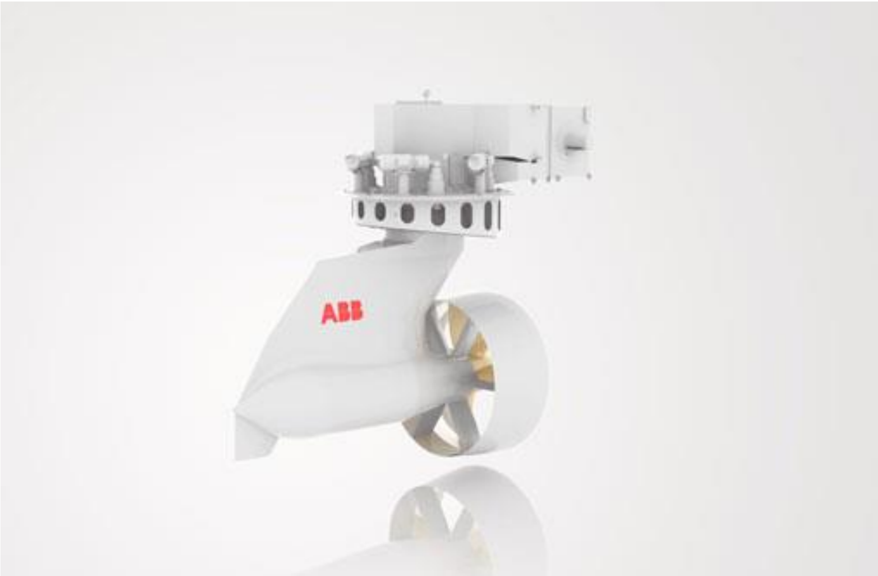
Developments in propulsion and maneuverability of cruise ships

Article assembled from references below by Steve Pink … November 2016 … Ref. WAA-AllHands

The past 25 years in marine industry propulsion has seen the inception and continuous improvement of gearless steerable propulsion systems with the electric drive motor located in a submerged pod outside the ship's hull. With 360-degree maneuverability, these podded propulsion systems are used to steer and drive a broad variety of vessels at the same time. Podded propulsion is further complemented by tunnel thrusters used extensively (in this case as bow thrusters) to increase the slow speed maneuverability of vessels developed over the past 50 years. This article reviews latest thinking.

The basic principle of Linear Flow Propulsor (LFP) technology is simple; the water flow behind the pulling nozzled propeller is straightened by guiding plates, reducing turbulence and energy loss. This principle has been a key area of investment and this research and development is now paying dividends.

The latest model of the shipping industry's leading podded electric propulsion system has introduced a nozzle and stator plates to direct water flow from the propeller, reduce turbulence & energy loss and provide the vessel with optimum thrust. The manufacturers (ABB) claim the new linear flow Azipod XL propulsion unit is up to 10% more efficient than previous versions.



The Azipod XL represents the biggest jump in the systems' fuel efficiency in recent years. To put it in perspective, if the newest model replaced all existing Azipod units it would save the shipping industry 2.2 million tons of fuel, and 7 million tons of carbon dioxide, over the next 25 years. It is a quarter of a century since the first installation of an Azipod unit, and in that time they have racked up more than 12 million running hours, saving 700,000 tons of fuel in the process.

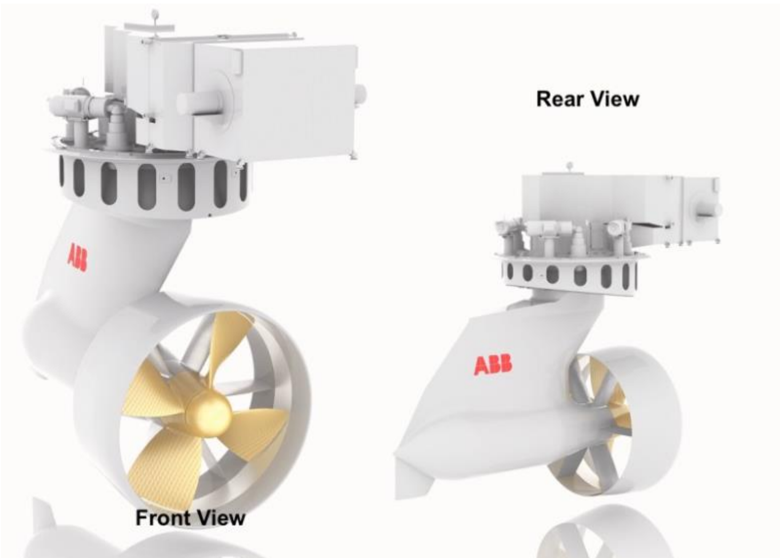
One of the strengths of the modifications is that they are relatively simple meaning there will be no compromise to Azipod propulsion's excellent availability record, currently standing over 99.8%. Azimuth propulsion works by drawing water into the propeller and pulling the vessel, therefore the addition of a nozzle will optimize the water flow as it leaves the propeller.

After the concept had been verified by Computational Fluid Dynamics (CFD) calculations, all the improvements were model tested extensively using scaled versions in laboratory conditions.

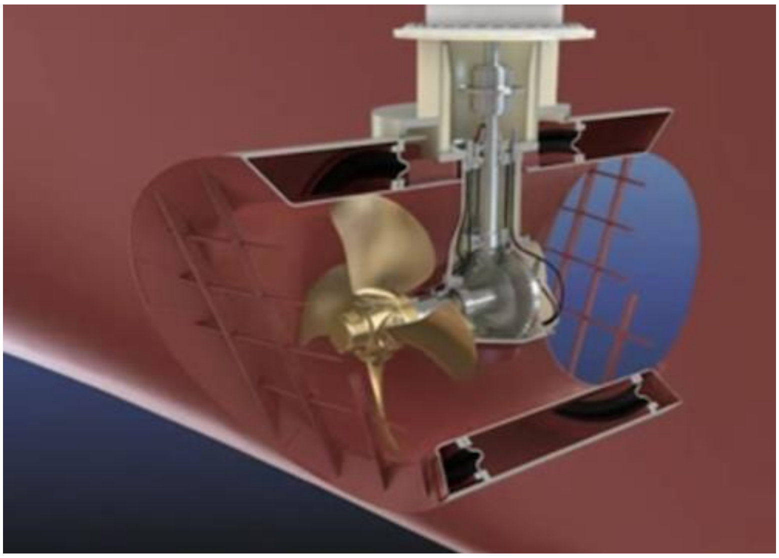
The initial idea was that Azipod XL should provide same benefits to the customer as the current Azipod XO, but with even better efficiency. This presented several technical challenges for the engineers; for example, preserving the possibility to maintain the shaft seals underwater, without dry-docking, requires careful engineering and testing in a model environment. Ultimately, in the case of shaft sealing, the selected solution was an improvement on the XO solution. In Azipod XL, the shaft seal can be replaced even faster and quicker underwater, thanks to additional static seal arrangement for maintenance.

Azipod propulsion is widely used in the cruise industry and on many complex specialized offshore vessels. With improved fuel efficiency and bollard pull of the Azipod XL could increase its competitiveness into new sectors such as tugs, ferries and LNG tankers. The Azipod XL concept can be designed to give high bollard pull thrust at lower speed and still have good characteristics at higher speeds. This improved performance along with better fuel efficiency and 360-degree maneuverability makes the Azipod XL attractive to a wider range of vessels.

Smart sensors installed in the units send data to ABB's Integrated Operations Centers, allowing ABB and the ship operator to gain insight into important aspects of the Azipod unit that are vital for maintenance. ABB's Voyage & Energy Management suite provides onboard staff with tools to forecast conditions that can jeopardise shipboard operations, plan the most comfortable voyage (considering weather and hydrodynamic conditions) and identify the most economic power configuration.



Tunnel thrusters are used by ships to provide low-speed lateral manoeuvrability when docking and high thrust while at a standstill.
From a design point of view, thrusters are designed as per the bollard pull condition referring to the amount of force a tug can apply to a bollard when secured to a pier.
Tunnel thrusters are similar to azimuth thrusters used in podded propulsion, except that these thrusters are placed inside a tunnel (an opening from one side of the hull to the other) either in the forward (bow) or aft (stern) of the ship. Also, the whole setup is immovable meaning, the impeller in the tunnel can create only sideways force.



Kamewa Ulstein Super Silent Tunnel Thrusters / Youtube

The major purpose of tunnel thrusters usage would be during the berthing, especially for very large ships such as VLCC and Cruise ships, in heavy wind and tide conditions. They shorten the manoeuvring time and reduce the cost of towage. Thrusters can either be operated manually or with the help of Dynamic Positioning systems which makes it even more efficient as the latter can operate on their own by just setting the position through the feedback mechanism.

Tunnel thrusters are found on ships as –

1. Bow Thrusters

Credits: Brosen/wikipedia.org

2. Stern Thrusters

Stern thrusters are just like the conventional propeller tunnel thrusters. They are used for increased stability and better turning ability with traditional in-line shafted propulsion.

Image credits: nieuwsbladtransport

Having a tunnel thruster installed is definitely advantageous, but there are two sides of every coin. Tunnel thrusters have got their disadvantages ...

1 They can sometimes affect the efficiency by increasing the resistance to forward motion through the water. However, this is mitigated by proper fairing of the aft of tunnel aperture.
2 Ship operators should take care of the impellers and the tunnel, either through the use of protective grate or cleaning, to prevent fouling.
3 They consume a lot of power and require a separate DG set to power the impellers, thereby, increasing the fuel consumption.
4 Installation, repair and maintenance cost can sometimes be a problem as they are quite expensive and complex systems to handle with.

However, there are advantages …

1 Installation cost compensates the working efficiency.
2 They may seem to consume a lot of power (hence, fuel), but at the same time they also save a lot (fuel) by avoiding unnecessary manoeuvring, which is quite unavoidable without tunnel thrusters.

During vessel design, it is important to determine whether tunnel emergence above the water surface is commonplace in heavy seas. Tunnel emergence hurts thruster performance, and may damage the thruster and the hull around it.

Consider some of the thruster design parameters which increase technical benefits …

1 … The tunnel diameter should be as small as possible so as to minimise the mounting space and increase hull efficiency.
2 … Tunnel thruster should be designed for maximum thrust.
3 … High efficiency should be obtained by adapting the propeller design to the tunnel diameter, and to optimise the flow towards the propeller.
4 … Standard blades of backward skewed design with rounded tips should be designed. This results in optimum thrust efficiency while obtaining a more gradual change in the cavitation volume.
5 … The propeller should have a large blade area so as to keep cavitation volume as low as possible. This results in maximum thrust output at minimum noise and vibration levels, giving optimum comfort in the accommodation.

References:

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