...introducing Hull Vane®

Fuel saving devices for ships, sometimes called energy saving devices, are considered as something new, but some of them have been around for quite a while. Perhaps the most wide-spread and well-known fuel saving device is the bulbous bow.


A bulbous bow

The protruding bulb on the bow was first applied in the late nineteenth century, and gathered wider acceptance in the 1920's. On ships sailing at an appropriate draught and speed-to-length ratio, the bulbous bow is said to reduce resistance by 10 to 12 percent. These days, it's hard to find a containership, large ferry or cruise ship without a bulbous bow.

WAVEMAKING RESISTANCE

The bulbous bow works by creating a wave in front of the bow. When the through of that wave coincides with the ship's own bow wave, they both cancel each other out. The result is that the ship creates a smaller bow wave and therefore has less wave making resistance. The frictional resistance is increased because of the added surface area. That's why we see the bulbous bow only on ships with a relatively high speed-to-length ratio. Large tankers and bulk carriers sail slower and have predominantly frictional resistance, therefore there is rarely a bulbous bow applied to them.

Over the past century, a lot of hydrodynamicists have wondered if a something like the bulbous bow could also be used at the stern of the vessel. The US Navy has done model tests with a stern bulb for a naval cargo ship and for a destroyer with promising results. A different approach was invented by Dr. Peter van Oossanen, a Dutch naval architect and hydrodynamicist. The device has been developed over the years and is now patented and successfully brought on the market as "Hull Vane®". Instead of a bulb, the Hull Vane® looks like a hydrofoil, but it has a completely different goal than the typical hydrofoils used on fast passenger ferries and recent foiling sailing yachts.

HISTORY

Like a lot of improvements for regular cars that are initially developed for Formula 1 cars, the Hull Vane® has its roots in high-performance sailing. It was over the course of research for three America's Cup campaigns, spanning 20 years that the idea gradually grew into the current design. In 1983, Peter van Oossanen was working for the Marin research institute and was part of the team which developed the winged keel for Australia II. After he set up his own naval architecture firm in the same town in 1991, Peter's first assignment was the design

Dr. Peter van Oossanen, the Dutch naval architect and hydrodynamicist.

of the hull, keel and rudder for another America's Cup team. He had calculated that winglets on the rudder should result in forward thrust, and this was confirmed in model testing. In 1996, Peter devised a horizontal wing for the motor catamaran Nieuwe Maze, which is still sailing every day in the Port of Rotterdam with the wing between its hulls. In 2002, Peter was involved with another America's Cup campaign, and this was the first time that model tests and full scale trials were done with a separate freestanding Hull Vane® on a monohull. Both the model tests and full scale trials showed good results, including a resistance reduction of 8% under 20 degrees of heel, but the rules required that an appendage could only be attached to the centreline. This construction proved too weak and the Hull Vane® was not used in the competition. The focus then shifted to commercial shipping, and several research projects done with

FSIV Karina JII Shipyard De Hoo

model testing at the Marin research institute showed the potential and helped the understanding of the Hull Vane®. Van Oossanen invested early on in high-end Computational Fluid Dynamics software (Fine/Marine), which really gave the development a big boost.

CFD AS DEVELOPMENT TOOL

Not only does CFD allow alterations to be done at an affordable cost, it also provides insight in the exact flow at a distance from the hull, and this without scale effects. In the towing tank, corrections have to be made for the excessive viscosity of the water at model scale, but CFD simulations are done at full scale. The CFD software helped to optimise Hull Vane® further and this lead to a contract in 2011 for a Hull Vane® with Heesen Yachts, a Dutch builder of superyachts. The Hull Vane® was integrated into the design of a 42 m motoryacht, which was launched in 2014 and proved during the speed trials that the performance predictions were correct. The Hull Vane® leads to a resistance reduction of 20 to 23%, making the yacht extremely fuel efficient. At the same time, another Dutch shipyard showed interest in the Hull Vane® for their new range of 55 meter Fast Intervention Supply Vessels. Shipyard De Hoop wanted to offer the Hull Vane® as an option on their vessels, and in July 2014 they decided to carry out full-scale trials with and without Hull Vane®. The shaft power and speed were recorded by an independent third party, showing the exact result. At 12 knots, the Hull Vane® reduced the power by 10% and this percentage quickly rose to 13-14% until it topped out at 15% at 21 knots. As the fuel consumption is very closely related to the main engine power, these percentages are also valid for the fuel saving. Van Oossanen Fluid Dynamics also optimised the bulbous bow for this vessel, and it's remarkable how few waves are generated, even when sailing at high speed. The fuel efficiency of the 55 m FSIV is unparalleled in the industry for this size, speed and loading capacity. Various research projects over the years showed that the Hull Vane® is equally suitable for larger vessels, where the benefits are even greater as propulsion power is more expensive on larger engines.

Defi Areva

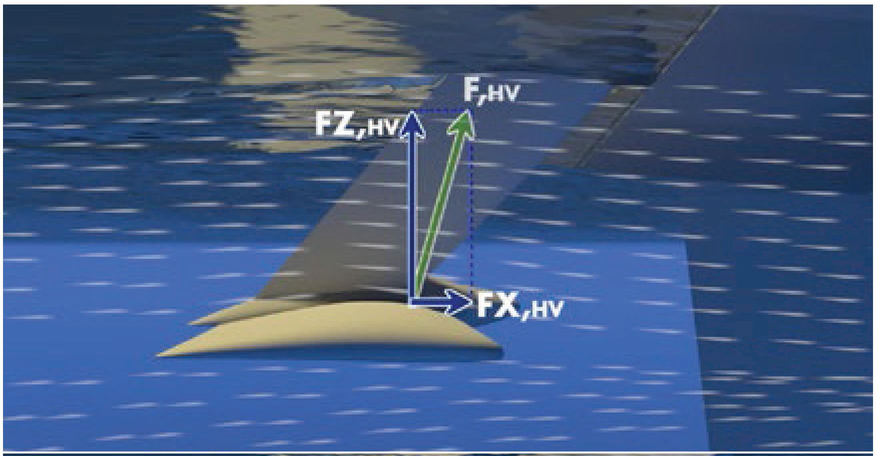
SO HOW DOES IT WORK?

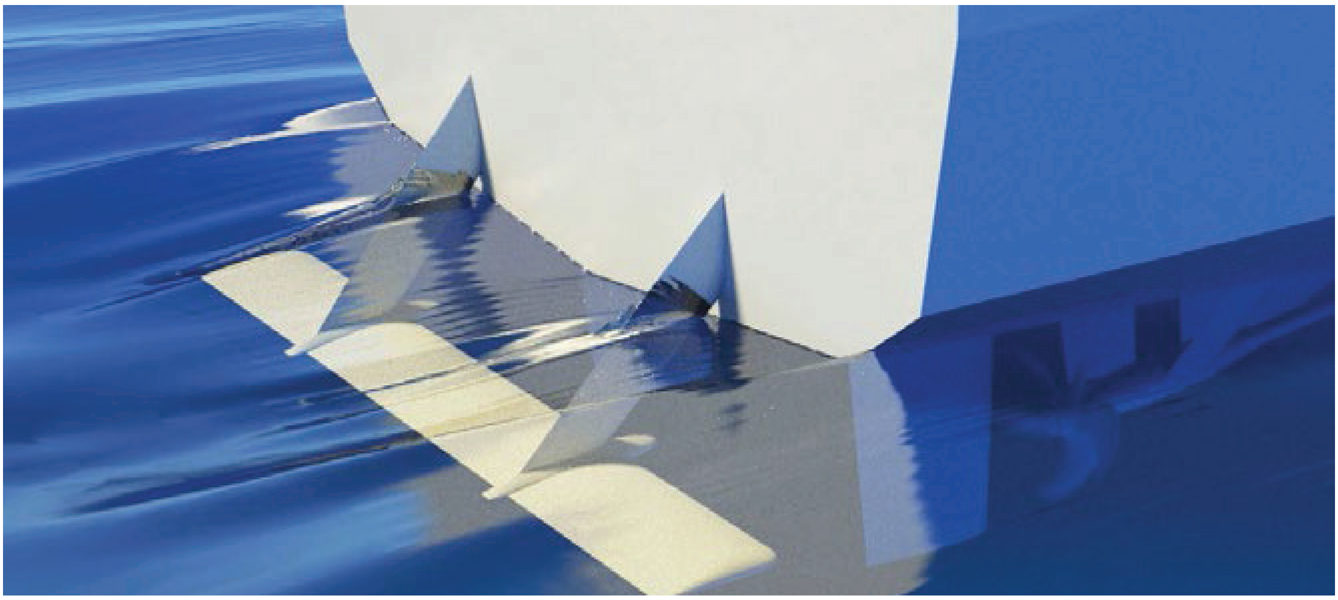
The performance of the Hull Vane® is linked to four different effects.

First of all, the wing develops a forward thrust force out of the upward flow under the aft ship. This can easily be understood by looking at a glider plane: the wings of a glider plane see an upward flow and develop a lift force which is angled upward and forward, giving the glider forward speed. The same happens with the Hull Vane®.

The second effect is more similar to the bulbous bow. Unlike stern flaps, trim tabs or interceptor, the Hull Vane® has an upper surface, on which a low-pressure region is created. This low pressure reduces the stern wave produced by the ship, and therefore the ship has less wave making resistance. Due to the interaction with the pressure on the hull, the Hull Vane® requires a careful design using CFD.

The third effect resides in the vertical component of the lift: it lifts the stern and keeps the bow down at high speed. This is similar to the effect of other system developed for this purpose, such stern flaps, trim tabs, trim wedges or interceptors .





The fourth effect is again unique for the Hull Vane®, and is only relevant for ships sailing in waves: as the Hull Vane® is a big surface with a high flow velocity located far from the centre of the vessel, the Hull Vane® dampens the pitching motions and therefore also reduces the added resistance. Model tests and CFD simulations on the 42 m and 55 m show a reduction in added resistance – due to pitching - of around 30%. Apart from pitch damping, the Hull Vane® also dampens the rolling motion (as the wingtips have a lot of added mass when rolling), the heaving motion and the yawing motion. The yawing (rotation on a vertical axis) is reduced because the course stability is improved by the struts, similar to the application of course-keeping fins or keels. Because the struts are a high aspect-ratio surface with a high flow velocity (they are usually in the wake of the propellers), and because they are placed very far aft, they have a substantial course-keeping effect for their surface area.

SEAKEEPING

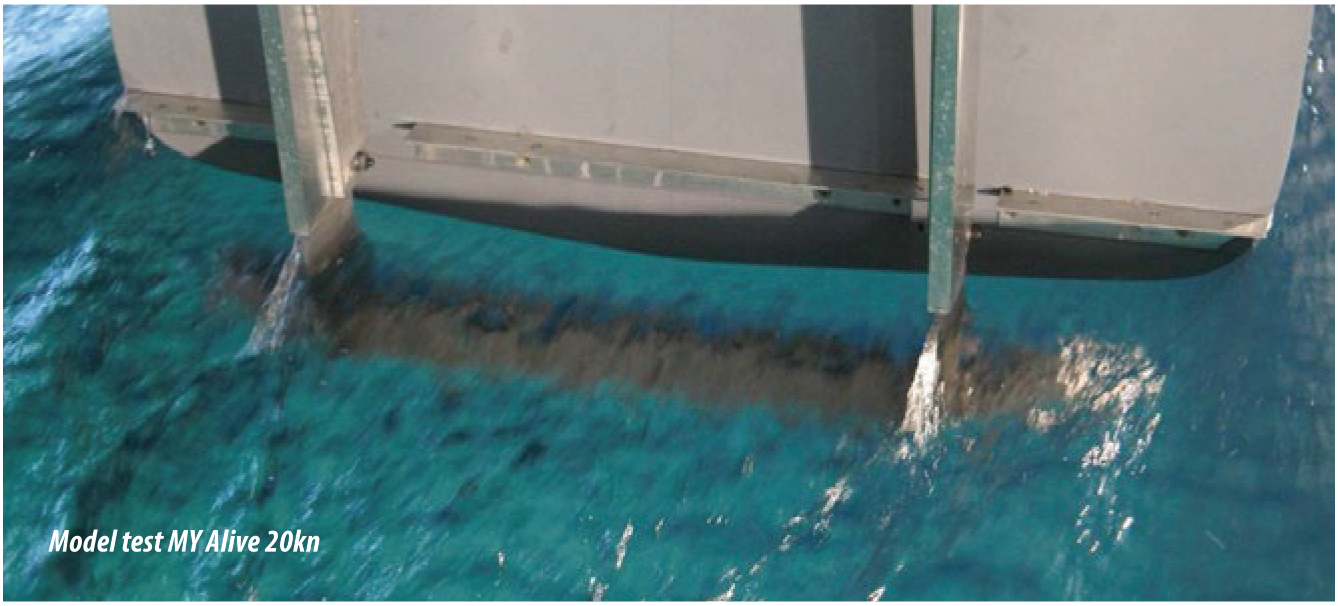
The reduction of pitching, heaving, rolling and yawing is not only a matter of fuel saving. This effect has gained a lot of attention from owners with vessels operating in severe weather. Both the vertical and horizontal accelerations are reduced, which not only reduces the likeliness of seasickness – particularly important to passenger vessels and superyachts – but it also makes certain operations on deck safer. For example navies and coastguards often use helicopters from the aft deck, whereby the operational limits are dictated by the measurements of an accelerometer on deck. It is therefore not surprising that the most interest in the Hull Vane® comes from the naval/coastguard, the offshore and the passenger shipping sectors.

APPLICABILITY

These are incidentally also the ship types on which the Hull Vane® is most applicable, as they combine a steel or aluminium hull and significant displacement (for seakeeping) with a relatively high service speed. While many large container vessels have resorted to slow steaming, the ships transporting high-valued goods and passengers still maintain a high service speed. This includes roro-ships, ferries, naval ships, patrol vessels, superyachts, medium-sized cruise ships and certain offshore vessels. The lower limit for application of the Hull Vane® is defined by a Froude number of about 0.2, which corresponds with a speed of 9 knots for a 50-metre vessel, 12 knots for a 100-metre and 17 knots for a 200-metre ship. Apart from the speed, the hull shape is also important. A wide, U-shaped stern is preferable to a very narrow V-shaped stern. The Hull Vane® and its savings percentage are different for each ship. The design requires a CFD study, which gives a very accurate performance prediction, as has been confirmed both by model tests and full scale trials.

RETROFIT OR NEWBUILD?

The Hull Vane® can be easily retrofitted to an existing ship, as it requires only a minor amount of internal reinforcements. The biggest benefits can be obtained on a newbuilding, as the hull lines can be optimised in conjunction with the Hull Vane®, leading to a better overall result. The advantage is also that the propulsion power and shaftlines can be adjusted to the lower power requirement. On large, high-powered ships the saving on propulsion power often exceeds the investment cost in the Hull Vane®. For typical retrofit installations the payback is often in the range of 1 to 3 years at current (low) bunker costs, depending of the savings percentage, the amount of sailing time per year and the type of fuel used. Because the resistance is reduced, the Hull Vane® is a future-proof investment. Regardless of the fuel used – whether it's HFO, MGO or LNG, the savings percentage will still be the same. For newbuildings, the Hull Vane® can usually be incorporated within the length of the vessel, but for retrofit installations, some protection above the waterline is advisable. This can be for example a simple bulbar construction or a small platform on the transom.



Model test MY Alive 20kn

CERTIFICATION

As the Hull Vane® is an external appendage, it is not subjected to class approval. However, classification societies do require an evaluation and drawing approval of the internal strengthening at the connection points, to make sure that the forces acting on the hull do not damage the ship's structure.

OBSTACLES

While the design is high-tech and requires specific expertise, the construction of the Hull Vane® is fairly simple, and can be compared to a rudder. The Hull Vane® is usually built of steel and has no moving parts, and therefore no maintenance or replacement costs. In this respect, it can again best be compared to the bulbous bow or the bilge keels: a relatively small additional investment in the beginning, leading to a lifetime of fuel savings or added comfort respectively. The construction itself is similar to a rudder. From the CFD calculations, all the loads in the structure are known, and the Hull Vane® is designed to avoid vibrations and fatigue issues, a.o. by using Finite Element calculations.

ADOPTATION

If Hull Vane® works so well with no risks, why did the development and market penetration take so long? Bruno Bouckaert, sales director of Hull Vane® explains:

"There are many reasons. One of them is that people are simply too busy with their day-to-day work to take time to look into this. Many in the shipping and shipbuilding world are risk-averse, without taking the time to properly evaluate the risks, so anything new is received with scepticism, often for good reasons. Many professionals have had negative experiences with inflated claims of fuel savings, which is why we are conservative in our estimates, unless they are backed up full-scale trials."

"Another issue is known as split-incentive: ship owner, technical manager and charterer are often three different companies with different interests, and ships are often traded every few years. In my opinion, efficiency improvement adds value to the ship for the rest of its life, not just until the next resale. All these reasons combined have resulted in the fact that ship owners often have an extremely low pay-back period in mind, regardless of the future risks, fuel prices and remaining lifetime of the ship. The barriers we encounter are often not technical but linked to the way the marine industry is organised. Nevertheless, I am convinced that on certain ship types – such as patrol vessels – the Hull Vane® will be as common as the bulbous bow is now on container ships. It just takes some time."

OPV

Hull Vane BV has recently done a CFD study for the Dutch navy on the Holland-Class oceangoing patrol vessels (108 metres). The expectations were low, because these vessels have an operational profile which includes an enormous amount of slow-speed patrolling, in which fuel savings are minimal or can be negative. 67% of the time is spent sailing at a speed below 10 knots. It is however in the other 33% of the time that 83% of the fuel is consumed. Based on this information, the Hull Vane® was optimised for 17.5 knots, and the performance then calculated at 5 knots, 12.5 knots, and the top speed of 22 knots. The hull was slightly modified by reducing the depth of the trim wedge, as the Hull Vane® will provide the vertical lift needed for trim correction at top speed. At the optimisation speed, the resistance was reduced by 15.3%. Over the entire year, the fuel consumption will be reduced by 12.5%. Operational benefits were also quantified, such as a reduction of 13% of the vertical accelerations on the helideck in a typically encountered sea state, an increase in range from 5.000 nm to 5.850 nm and a safer launching and recovery of RHIBs from the stern slipway due to a reduced area of backwash. The navy will shortly conduct model testing for independent verification and will also consider Hull Vane® for their future new builds.

PATENTED

The Hull Vane® is now patented worldwide, designed and sold exclusively by Hull Vane B.V., which belongs to the Van Oossanen group, along with their naval architecture and computational fluid dynamics divisions. It is supplied as a finished product, including hull inserts. It is available to all ship owners, shipyards and naval architects. It is a perfect example of how CFD has accelerated innovation in ship design and only one of the possible efficiency improvements in the toolbox of Van Oossanen Fluid Dynamics. The Hull Vane® has won the Maritime Innovation Award in November 2015, where it was praised for its winning combination of simplicity and effectiveness. It's a relatively small investment to reduce emissions from a ship, which is paid back many times over in fuel savings and which improves the comfort and operability on board.

The Hull Vane® can be easily retrofitted to an existing ship, as it requires only a minor amount of internal reinforcements. Here a vessel is being fitted without having to be dry-docked.