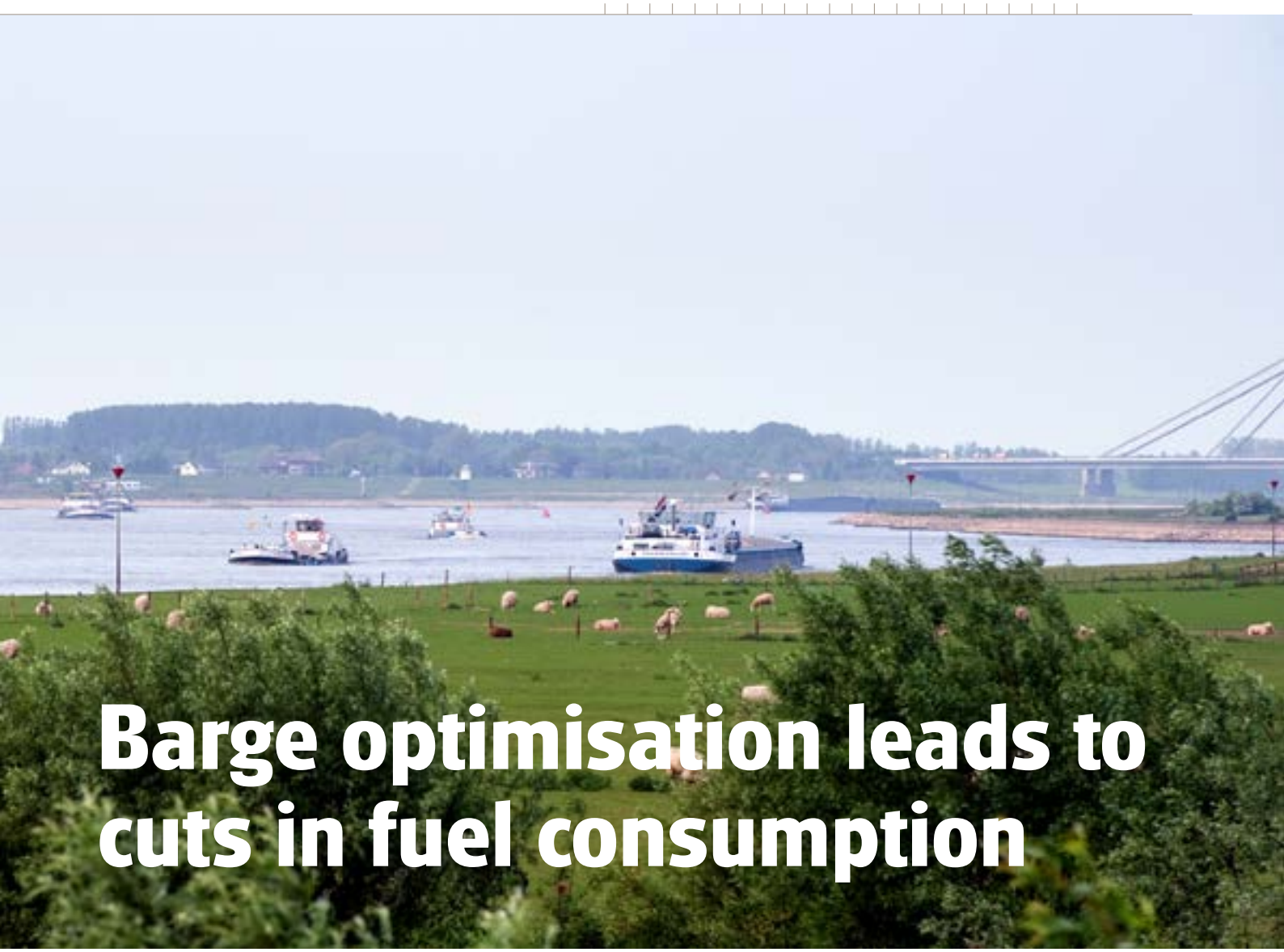


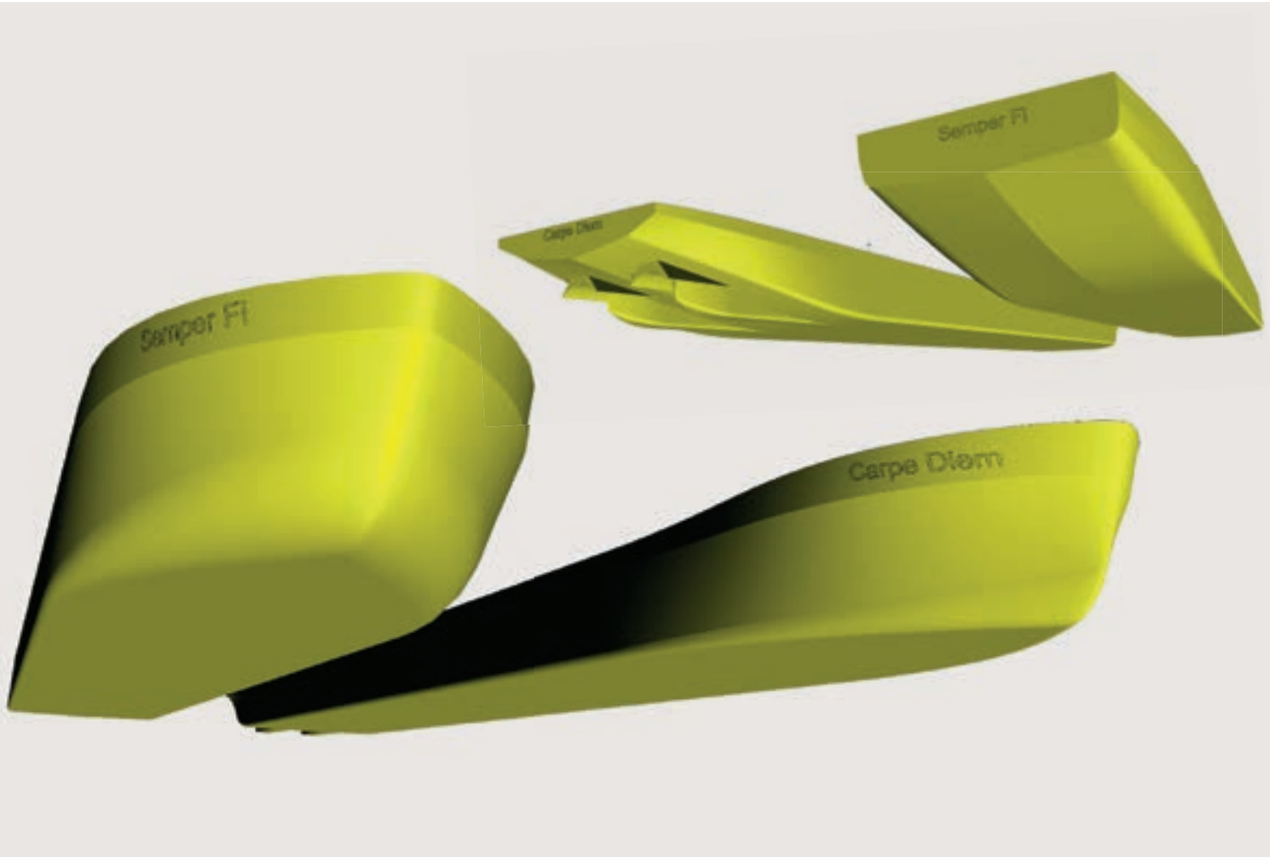
Barge optimisation leads to cuts in fuel consumption

MARIN has a specialist inland waterway transport team dedicated to improving the performance of inland vessels and this is currently focusing on shallow water vessel optimisation. Already tests show that impressive fuel savings of at least 10% to 20% are possible. Here is an update of MARIN's latest work in this field.

Karola van der Meij &
Meeuwis van Wirdum
inlandship@marin.nl

With a new generation of inland shipowners and the challenges ahead, there is expected to be increasing demand for the professional optimisation for both new and existing barges. From everyday practice MARIN can already see that possible improvements of up to 10% are no exception, depending on the operational profile of the vessel. As well as an improved environmental performance cost savings of more than € 40,000 can be made annually! In a recent case MARIN optimised a 135 m vessel with yearly fuel consumption of 650m^3. This resulted in a 10% reduction in fuel consumption representing an annual cost saving of around € 45,000.

Inland Shipping is widely regarded as a green and efficient mode of transport. But rapid developments in other sectors mean



Ship model used to test different rudder configurations

Here are some of the conclusions:

Bow shapes

Extremely curved waterlines around the fore shoulders cause large traverse wave systems, resulting in increased resistance. Smoothing the fore shoulders can overcome this problem and save fuel consumption.

Tunnel design

Since inland vessels are sailing at low Froude numbers, the wave making resistance is a small part of the total resistance. However, more can be gained by reducing the viscous resistance. Inland vessels have typical aftbodies with propeller tunnels designed to sail in shallow water. With its partners, MARIN is investigating how the tunnel design can be improved to reduce resistance.

Rudder design

A typical rudder applied on an inland vessel is a fishtail rudder. Recent measurements in MARIN's Shallow Water Basin showed that replacing these fishtail rudders with more streamlined bodies can reduce the power consumption by up to 16%. As not only resistance, but also manoeuvrability is very important, all conclusions will be carefully checked before considering this as a viable retrofit option.

that inland shipping has to make sure it can stay one step ahead if it is to retain this reputation. Hence there is expected to be more demand for the professional optimisation of inland waterway vessels. Optimised vessels are greener and crucially they have significantly reduced fuel consumption and operational costs.

However, optimising barges is a challenging task. Constantly changing operational profiles, areas of service, water levels and the ever-existing interactions with riverbanks and beds provide an almost unsurpassed level of complexity. With this plethora of variables it is more important than ever to build and maintain a proper database of full-scale measurement data to validate theories and calculations.

Development of shallow water tests Model test results performed in deep water have been validated extensively by full-scale trials. This has resulted in an extensive database of validation material. Model tests performed in shallow water, however, have been less common up until now. Therefore, it is clear that new validation material is needed.

Over the past years MARIN has been developing corrections and procedures for model testing in shallow water. Recently, full-scale measurements were performed to validate these corrections, increasing the amount of available validation data and each addition adds to the quality of the next optimisation process.

Greenstream tanker tests At the beginning of 2011 model tests for an inland tanker built by Peters Shipyards were performed for three draughts and two water depths. As it is important to validate the results of initial scale model tests with full-scale measurements, MARIN was very pleased with Peters Shipyards' offer to do these measurements on board of its new vessel. MARIN can then validate and improve its knowledge on optimisation for shallow water conditions.

Then in March 2013 MARIN performed full-scale trials on the futuristic Greenstream tanker and validated the results of the model tests previously performed in the Shallow Water Basin. The model test results were extrapolated and corrected for tank wall effects.

Full-scale trials were performed at Vuile Gat, the Netherlands and the same water depths that had been tested at model scale were used. In addition, three draughts were tested. The initial speed trial results were compared with the speed power prediction from the model tests. Comparisons showed that the prediction corresponded very well with the full-scale results and this confirms the validity of MARIN's extrapolation method for shallow water model tests.

Full-scale speed trials were also performed in deep water. A speed-power prediction was made based on the correction method of Lackenby (1965). Trial results showed that the correction of Lackenby was too large but MARIN's new shallow water correction method proved to be much closer to the trial results.

Is retrofitting viable? Several projects are developing viable options to improve the performance of existing inland vessels such as the EU project MoVe IT! and Joint Industry Project SAVE. In both projects hydrodynamic improvements are being investigated for self-propelled barges as push barge convoys are part of the research activities. Based on full-scale measurements the performance of the vessels has been defined. The goal of these measurements was to be able to compare the performance of different inland waterway vessels.

Some of the issues addressed in these projects included the optimisation of rudder designs and configurations, tunnel designs and reduction resistance by the optimisation of bow designs. By means of measurements, advanced calculations such as CFD methods, and in some cases model tests, MARIN found interesting changes in individual situations that could significantly reduce fuel consumption. It is clear that the Return on Investment for all modifications would have been far more interesting if they had been considered in the design stage. However, even as a retrofit option, they provide interesting options for the optimisation of existing vessels as well.

Optimised vessel Semper Fi has 20% lower fuel consumption In 2005 Wilco Ooms, Director of Carpe Diem Inland Shipping, had the idea to develop an innovative and energy efficient inland vessel and he asked MARIN's advice about how to achieve the lowest possible resistance. MARIN started analysing the hull lines of his 'old' vessel, Carpe Diem. The first modification was to remove the gondolas and tunnels in the aft ship to be able to accommodate two thrusters. The aft ship was further optimised by viscous flow calculations and the bow by means of potential flow calculations to improve the wave making resistance. The effect of shallow water was taken into account in all the calculations. The new vessel, Semper Fi, is now in operation and has 20% lower fuel consumption than his other vessel!

* Raven, H.C.; "A computational study of shallow water effects on ship viscous resistance", 29th Symposium on Naval Hydrodynamics, Gothenburg, August 2012.