SIEMENS
Ingenuity for life

Marine

Becker Marine Systems

Leading developer of innovative devices for marine industry uses Simcenter STAR-CCM+ to develop energy-saving Becker Mewis Duct

Product

Simcenter

Business challenges

Develop energy-saving devices that satisfy efficiency demands

Meet requirements for environmental regulations in maritime applications

Adhere to strict time schedules for development

Keys to success

Use CFD techniques to design, evaluate and optimize energy-saving devices

Use Simcenter STAR-CCM+ to fine-tune design iterations

Results

Developed popular Becker Mewis Duct energy-saving device

Delivered over 1,000 Becker Mewis Duct devices to satisfied customers

Realized instances of 5 to 6 percent in average annual fuel savings

Reduced CO_2 by 1,000 tons per year in some cases

Becker Marine helps ship owners realize up to 6 percent annual fuel savings by using Siemens Digital Industries Software solution

Energy-saving devices help meet marine industry demands

Energy efficiency is the single biggest concern facing ship builders and operators. Marine industry companies want to reduce vessel operating costs while meeting carbon dioxide (CO_2) and nitrogen oxide (NOx) emissions regulations. While fuel savings can be achieved by using modern, streamlined hull designs that efficiently direct water flow around the vessel and into the propeller, this scenario primarily applies to new ship designs. Most of the world's commercial trade shipping is dominated by older vessels that were designed without the benefit of computational fluid dynamics (CFD) tools and sophisticated design exploration techniques.

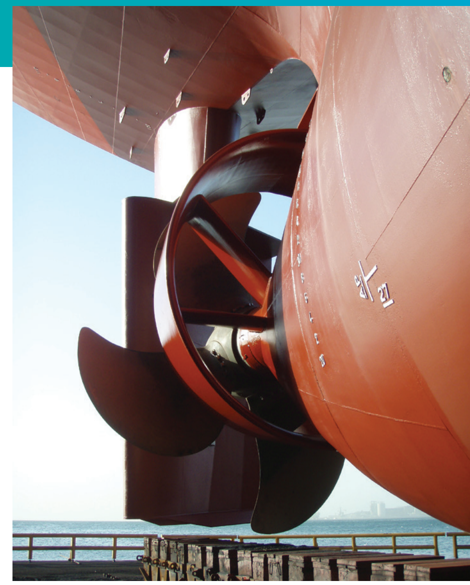
To help meet fuel economy and emission standard goals, companies often retrofit customized energy-saving devices (ESDs) to their older vessels. Normally these are stationary flow-directing devices positioned near the propeller, usually in front of the propeller affixed to the ship's hull; or behind the propeller fastened either to the rudder or the propeller itself. ESDs have also shown significant potential for improving propulsion performance even on more recent hull designs.

Example Becker Mewis Duct.

To understand the potential savings for a shipbuilder, a vessel that is listed at a dead weight tonnage (DWT) of 55,000 will use about 160 tons of fuel per day at normal cruising speed. Over the course of a year, a 5 percent improvement in fuel consumption would save over 2,000 tons of fuel and result in cost savings of approximately $500,000, so it's easy to understand why marine companies are anxious to apply measures that will enhance energy efficiency.

"From the moment we receive a new order, we typically have six weeks to find the required energy savings. This is a strict timescale, as the towing tank slot is reserved well in advance and cannot be moved."

Steve Leonard
Head of CFD and Research and Development
IBMV/Becker Marine



Becker Mewis Duct, "Bow Flora", 37,000 dwt chemical tanker from Odfjell.

Increasing vessel hydrodynamic efficiency

One of the most successful ESDs currently in operation is the Becker Mewis Duct® power-saving device, which was initially developed for full-form slower ships. Distributed by Becker Marine Systems GmbH & Co. KG (Becker Marine), the Becker Mewis Duct provides significant fuel savings at a given speed; or, alternatively, allows a vessel to travel faster at a given power level.

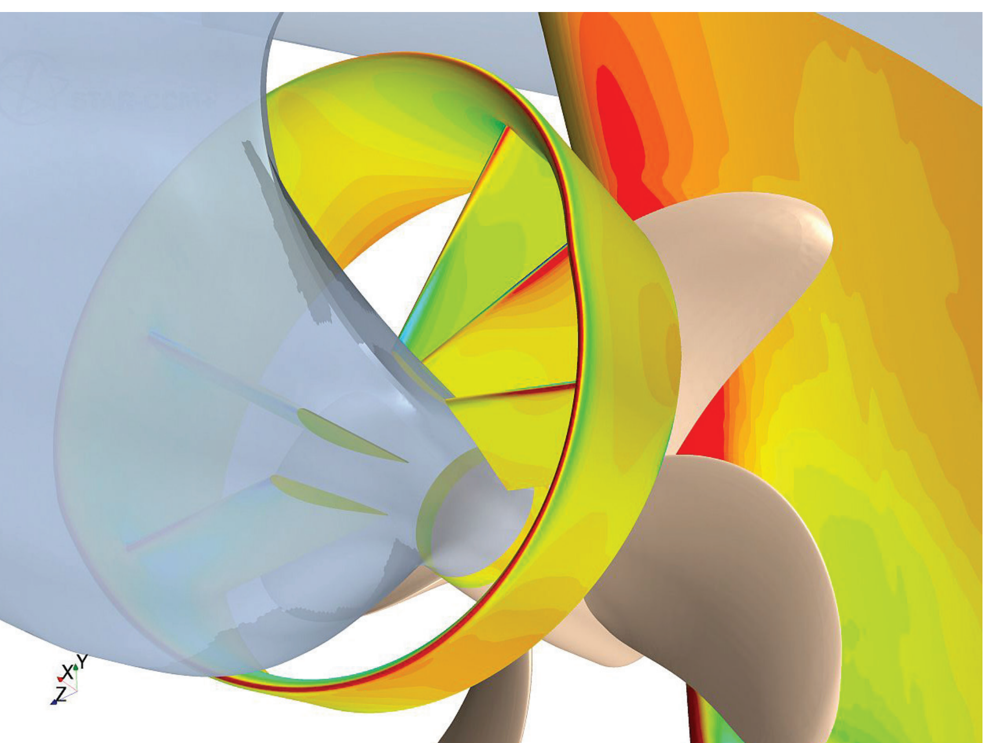
At first glance, the Becker Mewis Duct appears to be a simple piece of equipment consisting of a duct that contains a number of integrated angled fins. The duct both produces a net forward thrust and straightens and accelerates the hull's wake into the propeller. The fin system introduces a wake pre-swirl that reduces losses in the propeller slipstream, resulting in increased propeller thrust at a specified propulsive power level. These effects positively contribute to one another.

In order to function correctly and improve wake flow, the properties of the duct section as well as the orientation and design of each of the fins have to be specifically optimized for each new hull form. The Becker Mewis Duct harnesses energy contained in the frictional boundary layer of the hull and uses it to increase the overall hydrodynamic efficiency of the vessel.

The potential power savings largely depend on the hull-block coefficient and the propeller's thrust loading. Typically, power savings can be in the range of 3 percent for multipurpose ships and up to 8 percent for tankers and bulk carriers. Average fuel savings amount to 5 to 6 percent and can rise up to 8 percent when the duct is used in combination with a Becker rudder, a spade-type rudder with a flap. These fuel and power savings are independent of the ship's draft and speed. In addition, by using an ESD, NOx and CO_2 emissions can be reduced.

Using Simcenter STAR-CCM+ to design the Becker Mewis Duct

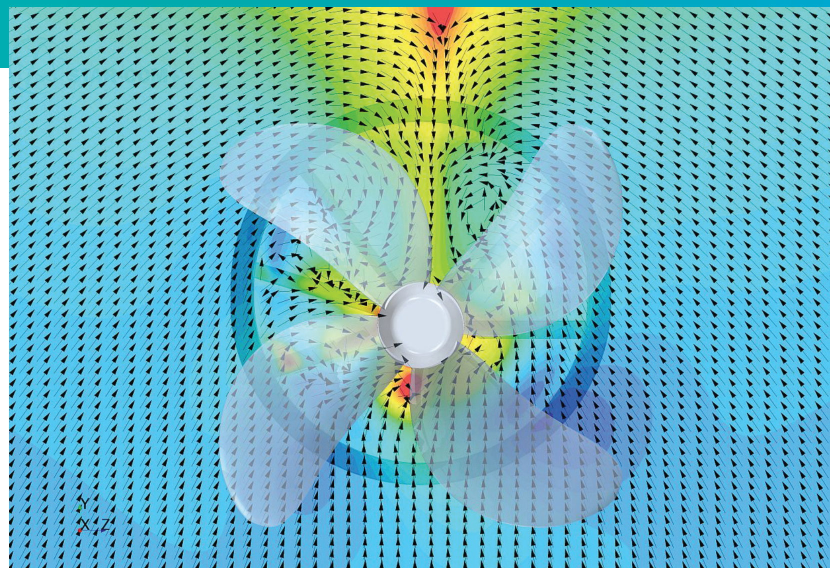
IBMV Maritime Innovationsgesellschaft mbH (IBMV), a wholly owned subsidiary of Becker Marine, is tasked with developing, engineering and launching innovative technology solutions for the maritime market. Steve Leonard, head of CFD and research and development at IBMV, led a team that developed the first Becker Mewis Duct. The team used Simcenter STAR-CCM+® software



Dynamic pressure distribution on the duct and rudder.

for CFD from product lifecycle management (PLM) specialist Siemens Digital Industries Software for this project.

Using Simcenter STAR-CCM+ enabled the IBMV development team to discover better designs faster. The initial Becker Mewis Duct was introduced to the market in 2008. The first full-scale installation was completed on the multipurpose carrier Star Istind of the Grieg Shipping Group of Bergen, Norway in September 2009. The estimated power savings for that ship has been about 6 percent.



Nominal wake behind the duct, colored by axial (longitudinal) component of velocity.

"The success of the Becker Mewis Duct is very dependent on the Simcenter STAR-CCM+ CFD process that we use to define the duct," says Leonard. "Without accurate CFD simulations, we cannot fine-tune each duct to the flow conditions specific to a particular hull. For each scenario, we use Simcenter STAR CCM+ to carefully adjust over 40 design parameters to create a unique duct. Although there are similarities, the duct that we design for each vessel is absolutely unique. No two ducts are ever alike."

Not only does Leonard's team have to deliver guaranteed energy savings, but it must adhere to a strict time schedule. "From the moment we receive a new order, we typically have six weeks to find the required energy savings," comments Leonard. "This is a strict timescale, as the towing tank slot is reserved well in advance and cannot be moved. If we can't improve the energy efficiency of a given vessel within the allotted time, then basically we have failed. There are no second chances."

The marine industry tends to be conservative, and self-propulsion tests remain the benchmark for proving the powering performance of vessels for most shipbuilding contracts. Few customers are aware of the intensive CFD efforts that go into designing and modifying their particular Becker Mewis Duct, as they are focused on the final fuel savings demonstrated during model testing. Any variation between CFD and towing tank predictions is thoroughly investigated using additional CFD calculations.

"If we can't improve the energy efficiency of a given vessel within the allotted time, then basically we have failed. There are no second chances."

Steve Leonard
Head of CFD and Research and Development
IBMV/Becker Marine

"The success of the Becker Mewis Duct is very dependent on the Simcenter STAR-CCM+ CFD process that we use to define the duct."

Steve Leonard
Head of CFD and Research and Development
IBMV/Becker Marine

Installing a Becker Mewis Duct.

The vast majority of CFD calculations are performed at model scale. To verify that scaling effects do not have a significant influence and also ensure good cavitation performance, the IBMV team runs a series of final full-scale calculations. This problem seems well suited for an automated optimization process in which a computer algorithm, not a human, chooses the next design configuration based on the parametric exploration of previous iterations. However, the Becker Mewis Duct does not lend itself to automated design exploration because it is almost impossible to reduce the flow around the duct to a handful of numerical parameters that can be used to fully define the next design iteration.

Instead, a team of experienced naval architects and hydrodynamicists is tasked with visually inspecting all data that is automatically generated at the end of each Simcenter STAR-CCM+ simulation process. By using the Simcenter STAR-CCM+ simulation data, the team can identify adverse flow features through the duct, fins and propellers and suggest a corrective action for the next design iteration.

The IBMV team has worked on hundreds of ESD ducts and applies its knowledge and expertise to define an initial design that offers a solid foundation for further improvements, enabling them to obtain optimal energy savings within approximately 10 design iterations. A well designed hull can result in less energy waste in the wake and, therefore, less opportunity for large fuel savings via an ESD. Leonard fondly recalls the team's solitary one-and-done duct design, in which the initial design iteration delivered the required energy savings. In reality, this is a victory for the IBMV process, as the initial design was configured by an engineer who used knowledge from hundreds of previous duct design studies when choosing the parameters for this particular duct.

Conclusion

IBMV has delivered over 1,000 Becker Mewis Ducts, clearly demonstrating the value of engineering simulation, in particular CFD, in the marine design process. Using CFD can help companies make informed decisions while also providing a constant stream of data to help shipbuilders improve real-world vessel performance.

Without intensive design exploration driven by experienced engineers using Simcenter STAR-CCM+, it would be impossible for Becker Marine to deliver finely tuned energy saving devices that offer guaranteed performance while adhering to a strictly controlled schedule. By using Becker Mewis Ducts, customers have realized millions of dollars in fuel savings. The ESD has also played a significant role in reducing harmful CO_2 and NOx emissions in the shipping industry as a whole.

Solutions/Services

Simcenter STAR-CCM+
siemens.com/simcenter

Customer's primary business

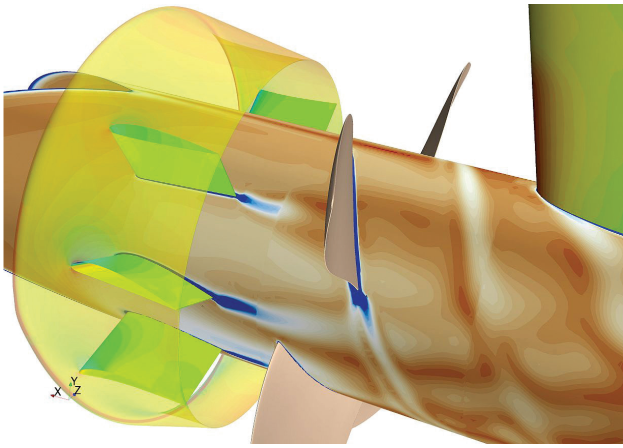
Becker Marine Systems is the market leader for high-performance rudders, maneuvering solutions and energy-saving devices for all types and sizes of vessels, including yachts, container ships and large cruise ships. With headquarters in Hamburg, Germany, the company employs over 200 specialists worldwide at offices located in Germany, China, Singapore, Korea, Norway and the United States.
becker-marine-systems.com

Customer location

Hamburg
Germany

For example, when a Becker Mewis Duct was developed for the AS Valeria, a bulk carrier that weighs in at 57,000 DTW, the IBMV team used Simcenter STAR-CCM+ simulation capabilities to predict fuel savings of 5 percent, which was confirmed in sea trials; and they used further CFD capabilities to help achieve a reduction of 1,002 tons of CO_2 per year.

Becker Marine has a high level of confidence in its duct and is prepared to offer a full refund on any device that does not deliver against an agreed-upon fuel savings target during model testing. With this type of guaranteed performance, most ship owners find investing in a Becker Mewis Duct to be a low-risk decision, as return-on-investment (ROI) is typically achieved within a year of the Becker Mewis Duct installation. The investment is also significantly cheaper than investing in a new eco-ship.



Vorticity magnitude on a cylinder section inside the duct showing the effect of the rotating propeller.

> *"For each scenario, we use Simcenter STAR-CCM+ to carefully adjust over 40 design parameters to create a unique duct."*

Steve Leonard
Head of CFD and Research and Development
IBMV/Becker Marine

Siemens Digital Industries Software

Americas +1 314 264 8499
Europe +44 (0) 1276 413200
Asia-Pacific +852 2230 3333

siemens.com/software

60106-C5 7/19 M