MMG NeWS
Research and Innovation

Efficiency by MMG | Mecklenburger Metallguß GmbH | **November 2013**

Form follows design

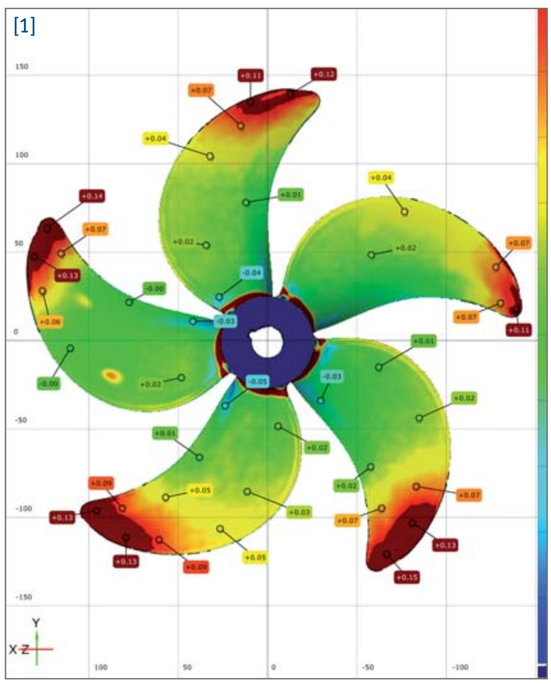
When talking about new ship designs or design improvements the propulsive efficiency is one of the most important issues. Improved numerical methods and an increased market-based pressure led to an improvement of the propeller design quality. The propulsive efficiency of modern designs nowadays stays at a high level confirmed by intensive model tests and full scale observations.

This verification of the design quality demands a high level of accuracy for model manufacturing as well as for the measurements itself. A basic requirement is the repeatability of the measurements – often verified by reference tests. Another important factor is the manufacturing quality of the models itself. Geometrical accuracy of ship models and propeller models comes more and more into focus as the significance of a specific design improvement is to be seen at abt. 1.5% efficiency gain. That means we are looking for smaller differences than some years ago. It is obvious that the requested measurement accuracy is quite challenging.

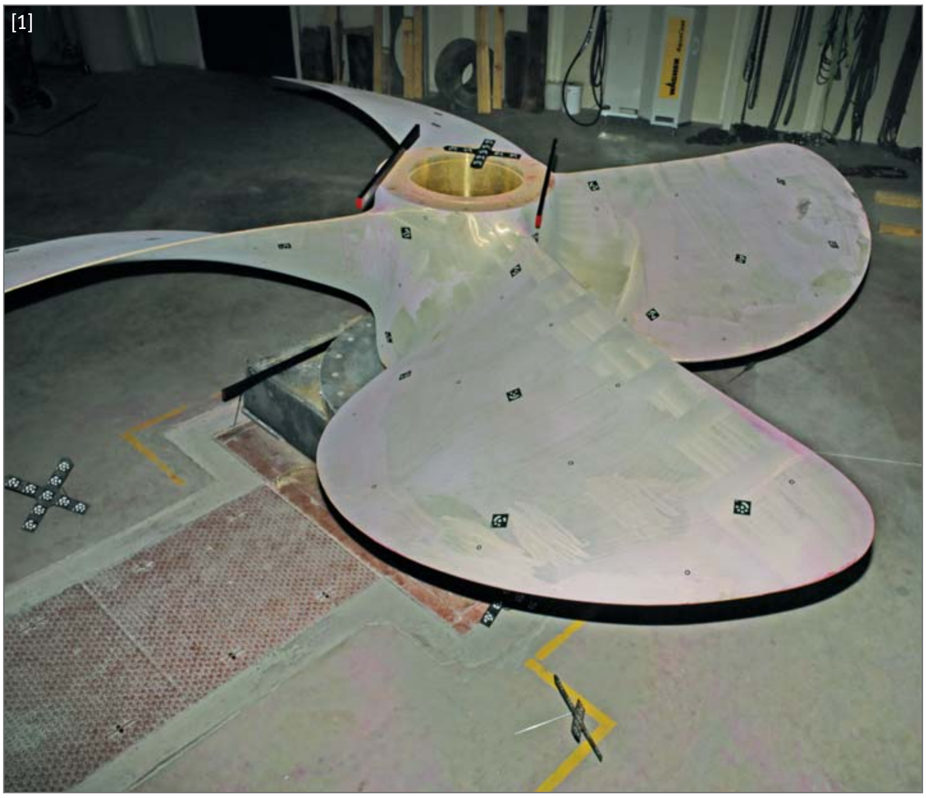
Due to this importance of high overall efficiencies there is much more focus on comparative model tests. For manoeuvring and propulsion systems like propellers and rudders but at least also for hull lines most of the ship owners introduce different designers in their Newbuilding projects. The design decision is based on the comparison of performance. The identification of the design differences within this process is done by comparative model tests. And despite the discussion about the achievable measurement accuracy itself the success or failure of the project in technical and at least in commercial sense depends on these judging measurements. This underscores the importance of reliable and accurate measurements.

As the measurement accuracy could be increased by longer data logging times or repeated tests, the model accuracy is fixed, once the model is milled and polished. Due to this matter MMG introduced an in-house quality check for model propellers. The employed 3D measuring methods based on surface scanning technology are well-used for geometrical measurements at MMG. In order to increase the measurement accuracy special devices are used suitable for the size of a model propeller. Thus MMG can verify that the measured results gained by the model tests represent the geometry as designed.

Further as the model geometry accuracy is a driving factor for the model tests the importance of geometrical quality for the performance of the full scale product is obvious. The question raises: Does the international standard still cover the increased requirements? Following this question MMG uses state-of-art optical measuring methods in order to ensure: Final form follows design.



[1] Surface analysis of a model propeller



Quality improvement by optical measurements

As propellers are complex geometries the geometrical quality check gives some challenges. Conventional measurement procedures – used by almost all propeller makers – are based on tactile 3D coordinate measuring machines. Especially in case of larger propellers with more than 8 meters in diameter, those machines are often uniquely made for the special purpose. Hence, they are very expensive and not flexible in application. Even many of them are outfitted with a digital data logger, it is often a problem to integrate those measuring system into a CNC manufacturing process. Eventually these measuring machines deliver only a closely limited number of discrete surface points defined and given by ISO standard 484. This doesn´t allow a holistic description of the complete propeller surface but only a vague interpolation of it supported by the chosen points.

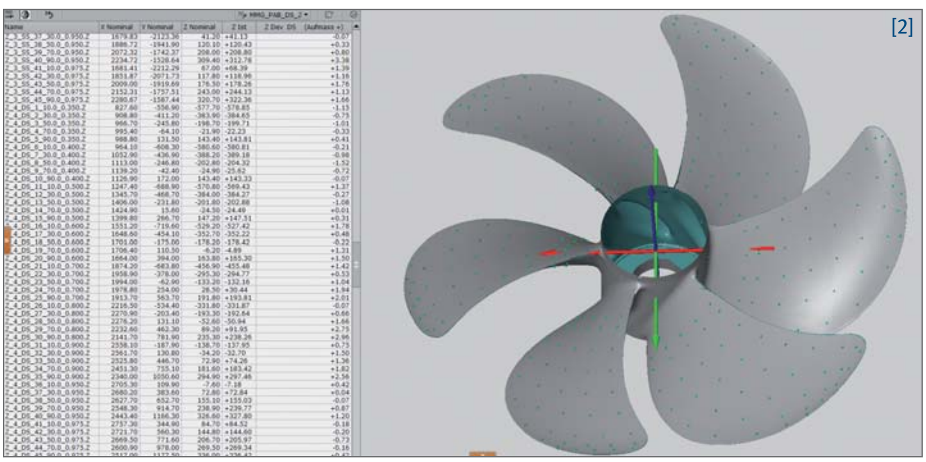
Measurements were taken by the method of 3D fringe projection (white light scanning) using optical measuring equipment supplied by the company GOM which consists of a combination of fringe projection and stereo camera configuration. Unlike the conventional measuring procedure using 3D-coordinate measuring machines recording discrete measuring points determined by ISO standard 484, the optical measurement results in a description of the whole surface (free-form surface modelling) which can be compared to the CAD model at each selectable point.

In order to make the new systems comparable to standard measurement and evaluation according the requirements of ISO 484 standard, the determined measuring points according to ISO 484 must be extracted from the surface model obtained by the optical measuring system and compared to the dedicated coordinates of the CAD model.

The measurements can be carried out in two stages. The first stage is the photogrammetric exposure of reference points indicated by stickers on the surface of the parts to be measured. Here MMG uses the TRITOP system by the company GOM. The second step is the scanning of the surface itself by means of fringe projection. The applied system ATOS III supplied by GOM uses the phase shift procedure previously noted to generate three-dimensional extensive measurement data of the surfaces. The sensor of the system projects different fringe patterns on the object surface that is acquired by two cameras. The ATOS system uses the reference points taken by photogrammetry for automatic transformation of the individual measurements into a complex surface model of the whole propeller. The combination of ATOS and TRITOP is needed to ensure precise measurements where the objects are larger than the measurement field of the ATOS 3D digitizer.

MMG uses this measurement equipment for geometry check of all casted products before and after the machining, casting patterns, model propellers, propeller hub bores and propeller shafting. Due to its flexibility the system can also be used for measurements on site.

Further advantages are given by a higher accuracy based on the non-tactile and self-calibrating procedure. Compared to the conventional systems the information density is much higher. This allows deeper insights, especially while checking the fairing and the blade section profiles.



[1] Measurement of final geometry [2] Accuracy analysis acc. to control points

MMG ESCAP® – a new energy saving cap

High fuel oil costs let ship owners and operators seek for additional measures to improve the efficiency even of their fleet in service. That has led to the demand for propulsion improving devices giving reliable savings at low installation costs.

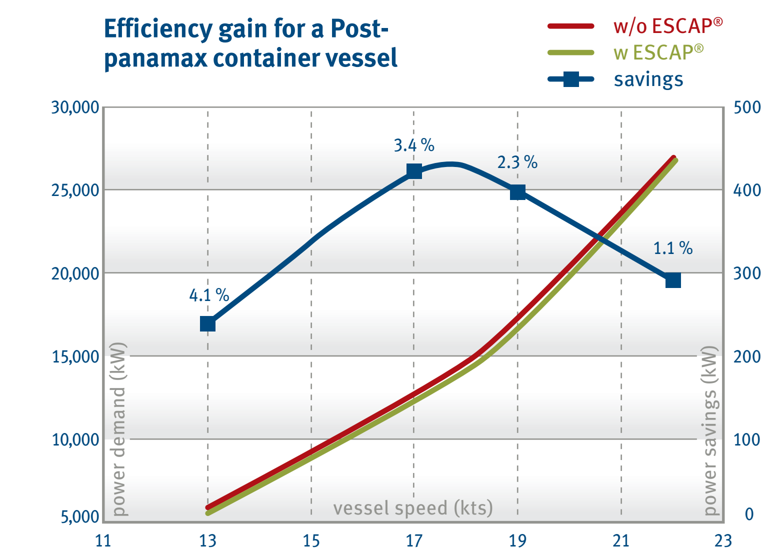
MMG has taken charge of these requirements and developed an own fin cap design based on extensive CFD calculations and model tests. As a result, MMG introduced its energy saving cap (ESCAP®) which focuses on improving existing propellers' performance as well as providing additional benefits in case of a desired propeller retrofit. But also for new buildings ESCAP® can be applied.

The development is based on in house numerical calculations which take place during the design and optimisation process. Every single ESCAP® is optimised in consideration of propeller flow and operational profile of the particular project.

The working principle is well known. As the propeller blade circulation leads to hub near vortices which result in the hub vortex the fin reduces the swirl and straightens the flow in this region. Due to this straightening of the hub flow the core internal pressure of the hub vortex is raised. This leads to a decrease in thrust deduction or in other words to an increase of the thrust. In addition, a positive torque will be produced by the fin which reduces the propeller torque since propeller and cap are bolted together to form a fixed unit. Moreover, by virtue of the increase in pressure aft of the cap the risk of hub vortex cavitation is significantly reduced.

From propeller theory a potential energy loss of about 3 per cent in the hub vortex can be identified depending on the loading characteristics of the propeller under consideration. Hence, power savings of 2 to 3 per cent can be expected. MMG ESCAP® combines the advantages of higher energy efficiency, low installation and maintenance cost and therefore a high return on investment. Further, to ensure a high quality product the MMG propeller cap design already announced in September 2012 is incorporated into the ESCAP® design.

[4]



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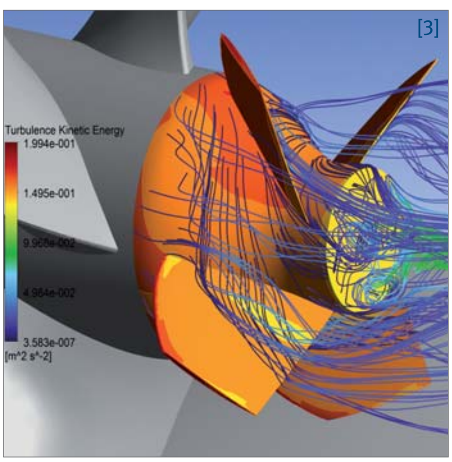
[3]



[3] Flow simulation of ESCAP® [4] Model test results [5] ESCAP® with MMG propeller

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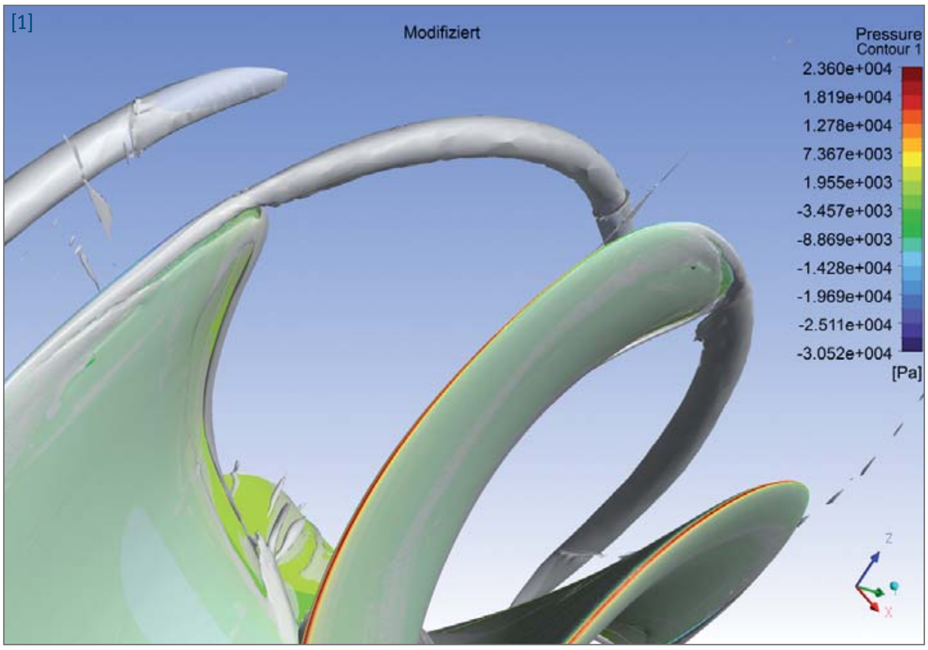

EraSK – Research on tip vortex cavitation

MMG together with University of Rostock (URO) and Energie-Umwelt-Beratung e.V., Rostock (EUB) aims to develop low noise and long term stable propellers. Therefore the companies became partners in a joint research project funded by EU which started in January 2011.

High power, which is to be converted by the propeller, and the inhomogeneous wake field, generated by the ship flow, lead to irregular loading conditions of the turning propeller blade. The vortex evolving from the tip circulation holds the risk of cavitation and possibly rudder damage. Goal of the project is to establish techniques and procedures to lower the high vortex strength on the rotating marine propeller in water. Thereby the load on the propeller blades shall be reduced and consequently the risk of erosion on the rudder shall be diminished. The approach is to apply appropriate surface textures locally as to reduce the energy density of the tip vortex.

Within the project University of Rostock studies the principle mechanisms behind the interaction of surface roughness and tip vortex flow. Since the scale between surface roughness and propeller geometry amounts to several orders of magnitude numerical computation using viscous field methods requires a lot of hardware resources and machine time. University of Rostock provides resources for such extensive investigations. Further, the university team performs wind tunnel tests to validate the numerical results. Energie-Umwelt-Beratung e.V. analyses technical opportunities to apply coatings which build relevant surface textures.

In this joint research MMG focuses on the enhancement of design tools and procedures as well as the development of manufacturing techniques and the transfer of the findings onto the full scale propeller.

The global aim of the research partners is to provide a technical solution to reduce the risk of damages due to erosive cavitation. Further, the investigations aim on lower acoustic noise emissions into the oceans. This project will run until the middle of 2014.

Publications

Scaling Procedure for Marine Propellers Symposium on Marine Propulsors, Launceston (Tasmania), May 2013

A Holistic Design Approach for Propulsion Packages Symposium on Marine Propulsors, Launceston (Tasmania), May 2013

Numerical Accuracy of Propeller Wake Calculations with ANSYS CFX ANSYS Conference, Rosengarten / Mannheim, June 2013

[1] CFD tip vortex simulation [2] Propeller milling [3] Wind tunnel test arrangement