SVA POTSDAM MODEL BASIN items SVA POTSDAM MODEL BASIN tech

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Stronger – Bigger - Faster

Hamburg SMM 2008

Our future is in the sea and comes from the sea. The sea is our highway for transportation, important source of our food and delivers an essential part of our energy needs.

With the rising costs for all "sea products" offshore facilities come more and more in the focus of a broad investment, in order to fulfil the needs of human development and to overcome hunger, thirst as well as our energy demand. In this context Anchor Handling Tugs (AHT), Anchor Handling Towing Supply Vessels (AHTS), Offshore Supply Vessels (OSV) and Platform support vessels play an important part in these investments, since they are the working horses in this business. With the growing demands the vessels itself become **stronger – bigger – faster**.

The propulsion system for these working horses has to fulfil two mayor requirements in the most economically way; a high velocity and a high bollard pull. This very often results in ducted propellers.

So we come back to the roots of the Potsdam Model Basin because propulsion systems are one of the market niches we operate in and ducted propellers are in the focus of R&D and practice for more than fifty years in our institution.

The Potsdam Model Basin was and is involved in projects ranging from 180 t to 280 t bollard pull. Because the bollard pull can be easily measured, it is a standard test figure during sea trials and part of the contract consequently but is also vital for validation purposes.

To ensure a reliable prognosis from model testing we had to develop testing technologies, testing facilities as well as recalculation methods. On the next pages of this SVA items you will find some more information regarding the conducted R&D and the acquired experience of the Potsdam Model Basin. Nevertheless we need the feedback from practice, in order to validate our results and to widen the data base.

The SMM 2008 as the worlds largest shipbuilding fair is an ideal market place where we are looking forward to fruitful discussions with our clients and professionals interested in our work.

At the SMM 2006 we had announced the Voith Water Jet (VWJ), as a joint development with Voith, which is a kind of ducted propeller too. This year we are proud to present a further development step of the VWJ which is ready for the market now.

R&D and practice are the two sides of the same medal, which are essential for and cross-fertilize each other. The Potsdam Model Basin is highly involved in both fields and would like to invite and discus with you at the **SMM 2008 in exhibition hall 4, ground floor, place 530.**

Fashion changes Fashion?

Dear Reader, maybe you have seen it right away, maybe you have not noticed; the Potsdam Model Basin has changed its logo and the logo of its subsidiary consequently. The background for these changes is a consequence in the development of our business, which becomes more and more global, and not for reasons of fashion. The German name Schiffbau-Versuchsanstalt (SVA) means Model Basin in English language. Potsdam is the town where the model basin is situated and is part of the registered company name too. The things that will remain unchanged are the three letters "SVA". For these we have fought all over the time of existence of our institution in the past and so we will do in the future!

M.M.

R&D – Increasing design reliability of ducted propellers

Heinke, H.-J.; Hellwig, K.

In the Potsdam Model Basin (SVA) CFD-methods have been successfully applied for the calculations of ducted propellers in the last years. Focal points of the numerical investigations were the study of Reynolds number effects and the analysis of the thrust breakdown of the ducted propeller caused by cavitation at high thrust loading. The investigations have been completed with model and full-scale measurements.

The number as well as the size and power of tug boats, supply vessels, working boats and offshore platforms are rapidly increasing due to the growing international trade and the rising energy demand. An important design and application criteria for these vessels is the achievable bollard pull.

Analysis of bollard pull measurements with tug boats showed, that the influence of cavitation on the ducted propeller characteristics isn't adequate considered in the design process.

The bollard pull (bollard thrust) is proportional to the delivered power in the ratio FD ~ $P^{2/3}$. The tug boat, whose bollard pull measurement is shown in Fig. 1, didn't achieve the calculated bollard pull. Model test showed, for this tug boat a thrust breakdown of the ducted propeller caused by cavitation.

Extensive model tests and numerical calculations have been carried out within an R & D project to analyse the process of the cavitation induced thrust breakdown on ducted propellers at high thrust loading.

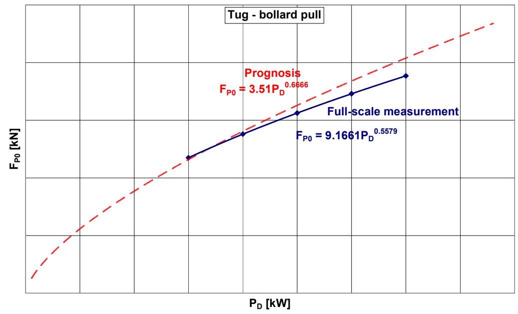


Figure 1: Bollard pull measurement with a tug boat

Model tests

Investigations in the cavitation tunnel with different ducted propellers showed, that already relative small cavitation appearance can be the reason for a thrust breakdown of the ducted propeller. Than thrust breakdown is a mainly result of the reduction of the nozzle thrust.

The analysis of cavitation tests with different ducted propellers leads to the following conclusions regarding the thrust breakdown caused by cavitation:

- A reduction of the nozzle thrust occurs if the tip vortex cavitation appears over the complete chord length of the blade tip.
- The blade outline (chord length at the blade tip) is an important design parameter to influence the thrust breakdown
- Nozzle profiles without diffuser affects an early thrust breakdown of the propeller (synchronistically with the thrust breakdown of the nozzle).
- Investigations about the influence of the nozzle profile are necessary (for example variation of the nozzle length).

The results of the cavitation tests with different ducted propellers are summarised in a diagram (Fig. 2). This diagram allowes to predict the risk of thrust breakdown in the early design stage.

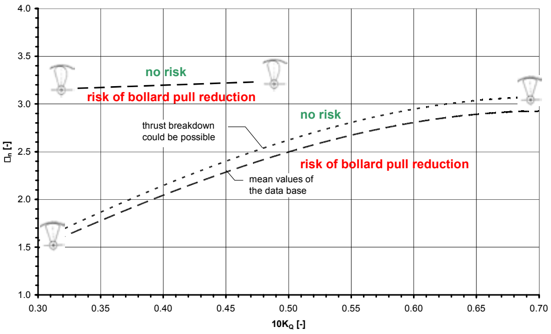


Figure 2: Estimation of the risk of bollard pull reduction due to cavitation

Calculation on the cavitation induced thrust break

Extensive CFD calculations have been carried out to find the reason for nozzle thrust breakdown due to the relatively low cavitation. The programme ANSYS CFX has been used for the viscous flow calculations. The geometry of the propeller, nozzle and shaft has been considered in the calculations. The Figure 3 shows the used surface model for one ducted propeller.

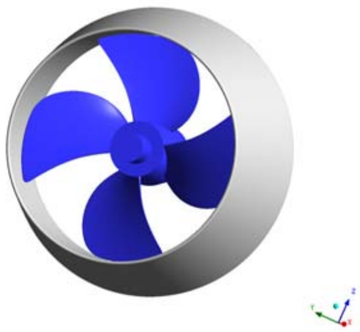


Fig. 3: Surface model of a ducted propeller

The SST turbulence model and the cavitation model in ANSYS CFX have been used for the two-phase calculation (liquid and vapour). First of all, the calculations have shown that it is possible to predict the cavitation behaviour and the thrust breakdown caused by cavitation. In addition the CFD calculations provide an opportunity to study flow details as shown in Fig. 4.

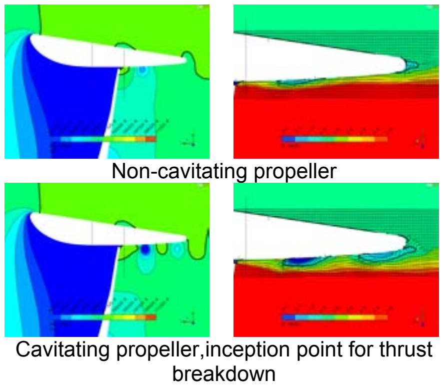


Fig. 4: Pressure and velocity distributions at different cavitation numbers

The cavitating tip vortex disturbs the flow in the diffuser of the nozzle. The result is flow separation and backwards flow. The thrust breakdown of the nozzle is related with the flow in the diffuser. It can be shown that the nozzle thrust decreases if the outflow area is reduced by flow separation. The flow separation in the diffuser also has the effect of increasing the propeller thrust and torque.

Influence of the cavitation on bollard pull of the AHT JANUS

The ocean-going tugs JANUS and URSUS (Figure 5) are in service for Harms Bergung Transport & Heavylift GmbH & Co. KG, Hamburg since 2007 and 2008. The tugs with a bollard pull of 220 t were built by Mützelfeldtwerft in Cuxhaven. The ducted propellers were supplied by SCHOTTEL-Schiffsmaschinen GmbH, Wismar.

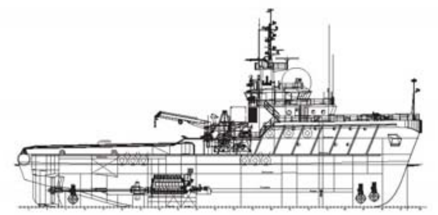


Fig. 5: AHT tug JANUS – side view [3]

The SVA Potsdam was commissioned by the project manager MAN Ferrostaal AG to carry out model tests with the tug. A first check of the design parameters (delivered power, diameter and number of revolutions) showed a risk of a thrust breakdown due to cavitation. The main focus of the propeller design was therefore the minimisation of the cavitation at bollard pull condition leading for example to a larger chord length at the blade tip.

The measurements in the towing tank gave a bollard pull of 225.6 tons. To check the influence of the cavitation on the bollard pull additionally measurements had been carried out at cavitation similarity in the large circulating and cavitation tunnel of the TU Berlin. The cavitation tests with the tug model showed an inception of the thrust breakdown close to the working point. The prognosis for the tug with cavitating ducted propellers results in a bollard pull of 221.1 tons.

The bollard pull measurements with the AHT JANUS in Stavanger (Norway), executed in October 2007 by Nolte & Szczesnowski, showed a bollard pull of 219 tons.

Fig. 6: 220 t AHT tug JANUS at sea trial

The comparison of the bollard pull prognosis and the full-scale measurements shows that the cavitation has to be taken into consideration for the prognosis.

Acknowledgement

The SVA would like to thank MAN Ferrostaal AG and Schottel GmbH for their cooperation during the design and optmisation process. SVA also acknowledge Harms Bergung Transport & Heavylift GmbH & Co. KG for cooperation in the sea trials and the final bollard pull test.

Literature

[1] Abdel-Maksoud, M.; Heinke, H.-J., Scale Effects on Ducted Propellers, 24th Symposium on Naval Hydrodynamics, Fukuoka, Japan, July 2002

[2] Heinke, H.-J.; Abdel-Maksoud, M.; Pierzynski, M., Korrelation Z-Antrieb mit Düsenpropeller, Schiff & Hafen, Heft 5, 2006

[3] Dünow, H.-H., JANUS and URSUS – Two new 220-t ocean-going tugs with controllable-pitch propeller Systems, SCHOTTEL Report No. 24/2006

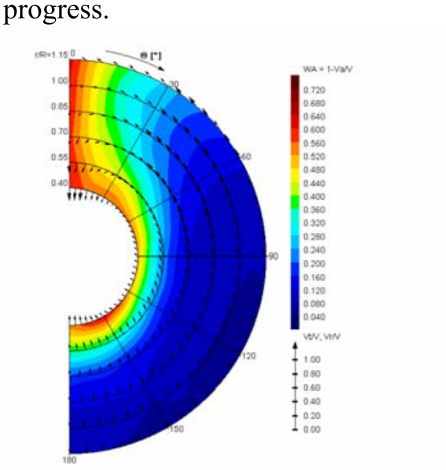
[4] Mertes, P.; Heinke, H.-J., Aspects of the Design Procedure for Propellers Providing Maximum Bollard Pull, ITS 2008, Singapore, May 2008

Influence of different service parameters on the wake field

In a current research project, supported by the German Ministry of Economy, SVA is investigating the influence of different service parameters of a ship on its wake field. The investigation is being made for ship speed, draught, trim and propeller position. Two different ship types were chosen for the investigations; a container ship representing the normal fullness of ships and a multi purpose vessel with a high block coefficient. The wake fields were measured as well as calculated by use of a RANSE solver.

The results for the container vessel are analysed already. Clear influences of speed and draught on wake could be found. It became also clear that there is no influence from trim.

The analysis of the other results is in progress.



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ANNOUNCEMENT 2nd SVA-R&D Forum

29th January 2009
(Schiffbau-Versuchsanstalt Potsdam GmbH)

"Theoria cum praxi"

Scale effects at estimation of the manoeuvring behaviour of submarine vehicles in model tests — Mr. M. Steinwand

Investigation of the pressure fluctuations of higher order at the after body under consideration of the propeller cavitation — Mr K. Rieck

HTS-working platform with HTS synchron machine for full electric ships — Mr H.-J. Heinke

Form optimisation under consideration of the characteristic of the wake field — Mr L.-O. Lübke

Improvement of design and prognosis for ships with wake influencing measures — Mr H.-J. Heinke

Formulation of a risk catalogue to avoid parameter excited rolling motions at modern container ships — Mr Dr. M. Fröhlich

Actual R&D projects – an overview — Mr Dr. M. Mehmel

Contact: heinkec@sva-potsdam.de

ANNOUNCEMENT – 15th SVA-Forum

April / May 2009
(SVA Potsdam GmbH)

"Tug boats – bollard pull as high as possible"

Concepts of tug boats, propulsion systems, tests and correlation

Contact: heinkec@sva-potsdam.de

Members of the Staff

Karsten Rieck

Project manager and head of the Numerical Simulation Department at the SVA Potsdam.

Karsten Rieck has graduated in naval architecture at the University of Rostock. In 1987 he joined the SVA where he has worked with potential and viscous flow calculations in several commercial and research projects.
His special field is the optimisation of hull form and propulsion systems using CFD methods. Since 2006 he is responsible for the CFD activities in the SVA.

In holidays Karsten enjoysy mountain biking and trekking tours. He is father of two adult daughters.

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