SVA items

SCHIFFBAU-VERSUCHSANSTALT POTSDAM GmbH No. 9 September 2004

Potsdam Model Basin powered by Propulsion

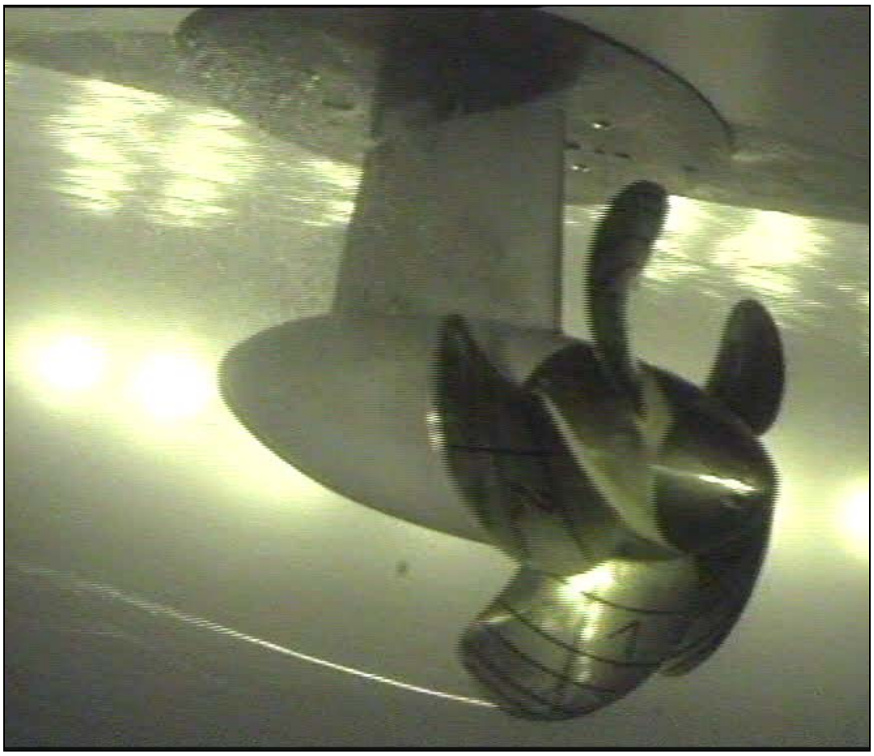
Hamburg SMM 2004

Potsdam Model Basin takes part in the largest Shipbuilding Industry Fair since 1994. In this time we changed from a national operating institution to an international one (Europe, Asia and America).

The philosophy of Potsdam Model Basin to be fast and flexible with a short overhead has benefits which are appreciated by the clients. Flexibility we get also from our network with different SME in the field of ship design and suppliers. Last but not least R&D is one of our base of high sophisticated knowledge. Knowledge means education and continuous R&D.

The services of Potsdam Model Basin bases on their three columns for more than 10 years, model testing (EFD), propulsion systems and computational fluid dynamics (CFD). These columns are not isolated because most technical problems nowadays are solved interdependently.

SVA focuses its presentation at the SMM in this year on propulsion of water vehicles. The spectra goes from paddle wheel over different kinds of propellers for specific needs to water jets. The main criteria is the permanent option for the highest efficiency. But nowadays there are additional requirements like noises and pressure pulses. Propulsion systems with a low signature level are needed on container and passenger vessel as well as for navy purposes. So the solution is a compromise between propeller efficiency and additional requirements.



The old fashioned paddle wheel is very efficient for shallow water conditions as well as the special designed surface piercing propellers for slowly running vessels.

In 2003 we got the task to develop a silent propeller for a fishery research vessel. It seems impossible to fulfil the needs and the solution looks like a submarine propeller .

For a propulsion prognosis without a final design propeller, propeller series are in a wide use. For fast ships these series are very old fashioned. We have developed a new series under consideration of the knowledge of the past fifty years. You can get the results for your needs for low nominal charge.

Podded propulsion is one of the challenges for the hydrodynamic community nowadays. Potsdam Model Basin has developed a lot of facilities and numerical tools for testing and design of podded drives and propellers to solve the existing problems.

All the tasks mentioned above are inspirited and driven by practice, resulting in project ideas and new research projects which give us the possibility to offer new services for our clients to fulfil their needs of the practice. So you see that SVA is powered by propulsion.

Join us in Hamburg **at SMM 2004 in exhibition hall No. 12 at stand 530**. We would be pleased to meet you there.

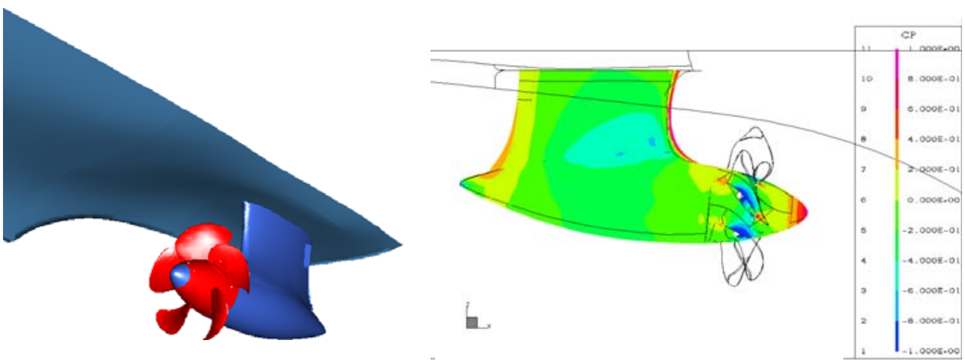
Investigations in the field of podded drives

The interest in use of podded drives as the main propulsion system of ships is still high due to the hydrodynamic characteristics and the advantages of the diesel-electric propulsion. Due to the tendency to higher ship speeds the development of podded drives for these speeds is necessary. Very important for the design and optimisation of podded drives is also the knowledge of the relevant forces and moments at different steering angles and working conditions. Within two research projects, funded by the German Ministry of Economy and Labour, investigations for fast ships with podded drives and about the loads at podded drives have been carried out.

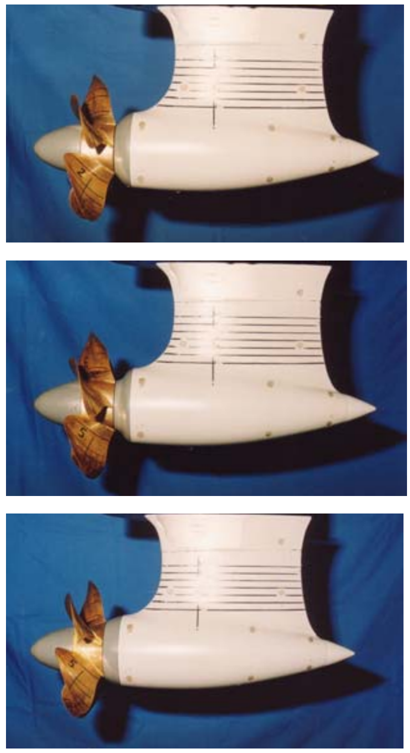
High-Speed Pods

The design of a streamlined gondola for a podded drive for fast ships is difficult due to the size of the electric motor inside the pod. The integration of the propeller hub in the gondola design is one way to create a podded drive with a low pod housing resistance. The disadvantage is a relative high hub diameter ratio. This results in problems with the cavitation behaviour especially at high ship speeds (V_S > 28 kts).

The best way to overcome the cavitation problems and to get a high total efficiency forof the high-speed pod is the use of a small gondola diameter. The necessary power for fast ships is high and thusso the diameter of the electric motor will be in the range of 50% of the propeller diameter atin this moment.
That's why an optimisation of the pull propeller hub and the transition to the gondola have to be carried out. A modification in this range causes great changes in the propeller forces and pod housing resistance. Also the resistance. Also and the propeller design has to be optimised for each hub – gondola geometry. Tests with different hub – gondola configurations have shown, that similar total thrust coefficients and efficiencies are achievable.



Basic design for a podded drive for fast ships with pull propeller



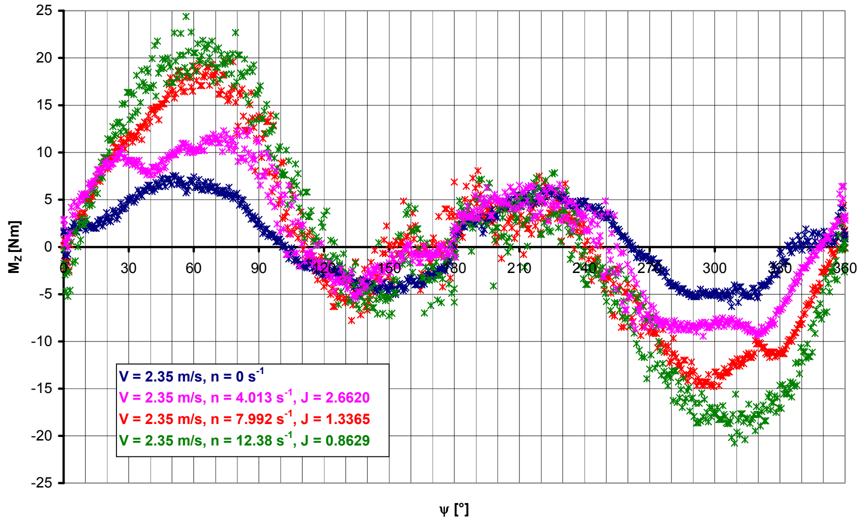
Modification of pull propeller hub and transition to the gondola

Pod Forces and Moments

The ships are normally steered by turning the podded drives within ψ = ±5°. As long as the ship manoeuvres in the limits of these small steering angles the forces and moments of the podded drive and the cavitation behaviour of the propeller will be very close to that under straight ahead sailing conditions (steering angle ψ = 0°). The change in force (or the variation in force) and moment becomes more significant at steering angles larger than ψ = ±10°. A critical ship manoeuvre for the podded drive is the crash stop, which requires to turn with turning of the podded drive around the steering axis.

For the prediction of the manoeuvring characteristic of podded drives different tests over a wide advance coefficient range are necessary for the free-running propeller e.g. blocked propeller and propeller with negative sense of rotation. All tests have to be carried out without and with cavitation.

A 6-component balance and a new z-drive dynamometer were especially designed and manufactured for open water tests and the measurements at different steering manoeuvres in the towing tank of the SVA and the large circulating and cavitation tunnel UT2 (TU Berlin).



Influence of the number of revolutions aton the steering moment offor a, podded drive with pull propeller

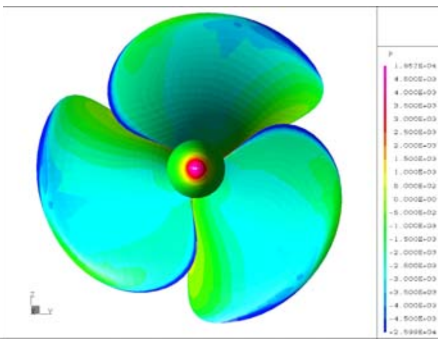
Selected test results:

Thrust and torque coefficients of pull propellers are increasing at steering angles larger than ±5°. Thrust and torque coefficients of push propellers are depending from the turning direction in connection with the direction of propeller rotation in the steering angle range $0° < \psi < \pm 35°$.

Longitudinal force coefficients of podded drives with pull propellers are decreasing for both steering directions. Longitudinal force coefficients of podded drives with push propellers are depending from the turning direction, similar to the propeller coefficients.

High-Speed Propeller Series

Propellers are still the most used propulsion system for fast ships. These propellers are combined with inclined shafts. The variation in the transversal velocity of the propeller in oblique inflow causes considerable changes in the profile angle of attack, which leads to cavitation especially if the propeller rotates downwards. A propeller series has been designed and investigated, to get data for the pre-design of high-speed propellers and for the propulsion prognosis in the early design state for fast ships.



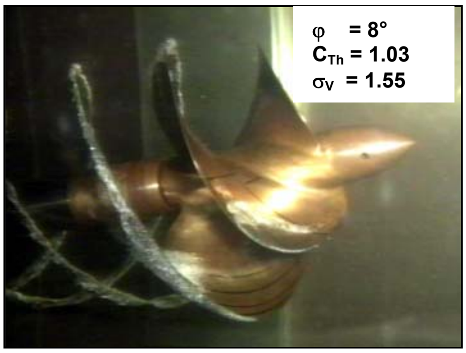
Pressure distribution of the suction side (HSP 3.110 with P/D = 1.4 at J = 1.085, shaft inclination 0°), calculated with CFX 5

Within a research project, funded by the German Ministry of Economy and Labour, a high-speed propeller has been designed and optimised in cooperation with AIR Hohen-Luckow. Lifting surface methods (VORTEX) and viscous flow methods (COMET, CFX 5) have been used for the propeller design.

Four propellers with different design strategies have been manufactured and investigated in open water and in the cavitation tunnelests. In addition the influence of a cup at the trailing edge onat the propeller characteristic and the cavitation behaviour hasd been tested. The cup effects an increaseing inof the propeller thrust and torque coefficients. Small cavitation phenomena at the suction side of the cup resultsed in an early thrust reduction of the propeller. That's why it was decided to design the propeller series without a cup.

The 3-bladed SVA high-speed propeller series consists of 12 models (4 propellers for each expanded area ratio of A_E/A_0 = 0.9, 1.1 and 1.3) with the diameter of D = 220 mm, hub diameter ratio d_h/D = 0.1818 and pitch ratios $P_{0.7}/D$ = 1.0, 1.2, 1.4 and 1.6.

The open water tests have been carried out in the towing tank and in the cavitation tunnel forat shaft inclinations φ = 0°, 6° and 12°. The influence of the cavitation onat the propeller characteristics hasve been tested in the cavitation number range $4.5 \leq \sigma_V \leq 0.75$. The propellers are characterised by a high efficiency and good cavitation behaviour. Eroding blade-root cavitation could be avoided.



Cavitation behaviour of a propeller with cup

The open water test results were faired and plotted in the conventional way with the thrust coefficient K_{TP}, the torque coefficient K_Q and the open water efficiency η_0 as a function of the advance coefficient J, the shaft inclination φ and the cavitation number σ_V. A multidimensional Chebyshev approximation was used to calculate the polynomials of the thrust and torque coefficients as a function of the propeller pitch and area ratio, the shaft inclination and cavitation number. A computer program was developed on the base of the polynomial coefficients to calculate the propeller characteristic for given propeller data and to select the optimal propeller for given working parameters.

Push Unit for Shallow Water with Paddle-Wheel

The SVA Potsdam GmbH was commissioned by the Sächsische Binnenhäfen Oberelbe GmbH to test a pusher-barge system for shallow water with paddle-wheel regarding its technical parameters.

In the scope of technical investigations model tests were carried out. Two paddle-wheels with nine paddles were designed and manufactured by the SVA. Free running tests with the paddle-wheels by variation of the immersion depth, the eccentricity and the numbers of revolutions were carried out to determine the efficiency of the paddle-wheels. The hydrodynamic and propulsion characteristics of the pusher-barge-system were estimated by resistance and propulsion tests. These tests were carried out under deep and shallow water conditions to identify basic trends. In inland navigation the manoeuvrability of the vessels plays an important role. That's'why basic manoeuvring tests were carried out. The propulsion by paddle-wheels effects an economy of power of about 8 % regarding conventional push units under shallow water conditions.

The investigations showed, that the concept in the combination of a push boat with shallow going barge is a technical alternative in comparison with conventional pusher-barge-systems.

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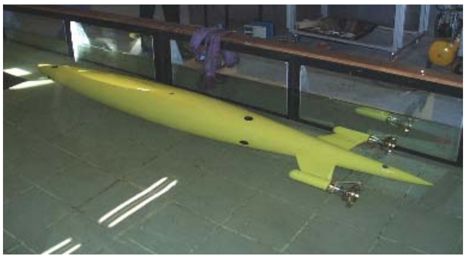
Determination of the Manoeuvring Behaviour of Submerged Bodies

In addition to the SUBPMM (Submarine Planar Motion Mechanism) test facility the SVA Potsdam has developed a further method to determine the manoeuvring behaviour of submarines, ROV's, AUV's and other submerged bodies with the financial support by the German Ministry of Economy



The experimental and mathematical requirements, in form of a systemidentification algorithm and a free running AUV model, are realised to determine the hydrodynamic coefficients required in the equations of motion in all 6 degrees of freedom. For this, basic free running model tests with a model or full-scale tests are conductable.

Furthermore, any manoeuvre can be tested directly with the free running model.

Based on the hydrodynamic coefficients, simulations of arbitrary manoeuvres, analysis of the hydrodynamic stability and the layout of autopilot systems are possible.

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ANNOUNCEMENT – 11th SVA-Forum

9th November 2004
(SVA Potsdam GmbH)

BMBF- R&D poject "Numerical simulation and propulsion"

Numerical and experimental investigations of inland vessels under consideration of propeller effects — Mr K. Rieck

Fast enlarged shallow-draught container vessels — Mr. R. Grabert

Calculation of the effective wake field of full-scale ships — Mr L. Lübke

Global optimisation of propulsion systems — Mr Dr. R. Schulze

Correlation of thrusters with ducted propeller — Mr H. - J. Heinke

Correlation tip vortex — Mr Dr. R. Schulze

Manoeuvring optimisation of single-screwed vessels with podded drives Mr M. Steinwand

The participation fee: 75 €. The fee includes the proceedings, refreshments and lunch.

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Members of the Staff

Dr. Andrés Cura Hochbaum

Dr. Cura has been appointed as Head of the Department Numerical Simulation of SVA Potsdam. He studied naval architecture at the universities of Montevideo and Hamburg and obtained his diploma in 1988. He stayed in Hamburg working for Prof. Söding and got the doctoral degree on the development of a RANS code for ship viscous flow prediction in 1994.

Dr. Cura joined the Hamburg Ship Model Basin (HSVA) in 1993 and has worked there until he changed to SVA Potsdam in October 2003. Among his activities at HSVA he developed and applied advanced CFD tools and performed and evaluated manoeuvring tests, lastly as head of the manoeuvring group.

His main research interests are the development and application of numerical techniques for the prediction of viscous flows and of ship motions in seaways and during manoeuvres. At present his department is working on several challenging research projects on these subjects.

Dr. Cura is member of the ITTC Manoeuvring Committee and chairman of the Manoeuvring Committee of the STG. He teaches Manoeuvrability of Ships at the Technical University Hamburg Harburg (TUHH) since 2002. He is married and has three children. He likes playing field hockey and meeting friends in his spare time.

Impressum

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