SVA items

SCHIFFBAU-VERSUCHSANSTALT POTSDAM GmbH No. 6 September 2002

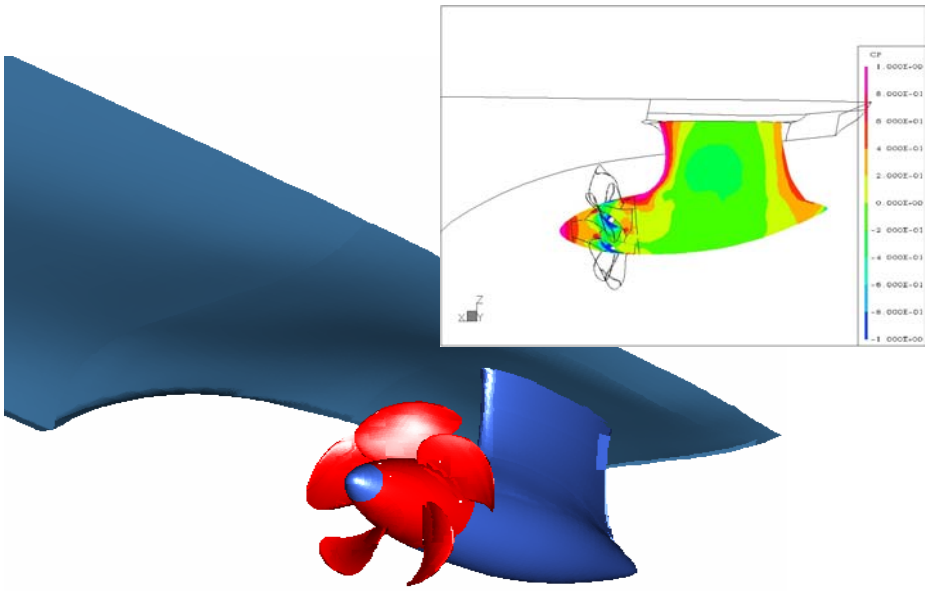
Podded Drives

Podded propulsion systems, combined with the diesel-electric power plant, are an attractive solution for several kinds of ships. The research and development work is focused on the design of the hull geometry and the hydrodynamic behaviour of the propulsion system.

There is a continual raising demand for podded drives which is powered by the successful use of these systems and their further development. SVA is involved in this development since 1995 through the hydrodynamic optimisation and model tests for podded drives, like DOLPHIN from John Crane-Lips BV, SSP from Schottel, AZIPULL from Ulstein Propeller AS or CRPod from STN. For getting a better knowledge SVA has carried out extensive theoretical, experimental and numerical works in the field of podded drives in connection with R&D and industrial projects in the last two years. For example the SVA has finished the work in the R&D project “Integrated ship design for ships with podded propulsion systems”, which was supported by the German ministry of economy.

For getting a better understanding of the physics and more exact test results it was necessary to develop new measuring devises for propulsion and cavitation tests with podded drives with pulling, pushing or twin propeller arrangement. Measuring values in general are the propeller thrust and torque, the longitudinal and transverse forces and the steering moment of the system.

Podded drives will be an important propulsion systems and so we will continue our work in this field to get the know how for solving the problems of our clients.



Design study for a podded drive

Hamburg SMM 2000

CFD and propulsion system

Time is going on and we are in the next century but the problems of the new one are the same as of the old because the people haven’t changed. The changes which were going on are the tools for solving problems.

In the two years since the last SMM we have us and our knowledge developed further in our niches especially. In the field of numerical methods SVA developed with the computer program KELVIN a powerful tool for naval architects for potential flow calculation.

In the field of propulsion systems was the development of new measurement devices one focus. Now we are able to measure for each propeller forces and moments as well as the forces and moments on the housing of a pod for all existing systems, tractor type, pusher type, tandem type and contrarotating type with the necessary accuracy which we need for propulsion prognosis and propeller design.

Nevertheless we do the normal job of a Model Basin and here we worked further for solving problems of our clients also.

We invite you to join us at the SMM 2000 in exhibition hall No. 10 stand 10032 and “test us” nevertheless you are a nonsmoker. My colleagues and I would be pleased to meet you and to discuss with you solutions for technical problems.

Hans-Jürgen Heinke
Head of Cavitation Tunnel

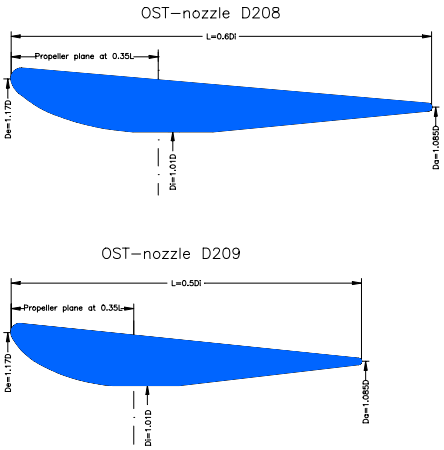
Ducted propellers

OST nozzle for fishing vessels

Fishing vessels need a propulsion system which achieves a high tow-rope pull at towing speed and which is able to guarantee a high speed for the free-running ship.

The SVA Potsdam has modified and tested the nozzle type OST*. The OST nozzles are characterised by a slender profile. The position of the propeller is at x_P/L_D = 0.35. The nozzle length has been varied with L_D/D_I = 0.5 and 0.6. These nozzles were combined with propellers from the Wageningen BB-series with four blades and pitch ratios from 0.6 to 1.4 and area ratios from 0.5 to 1.0.

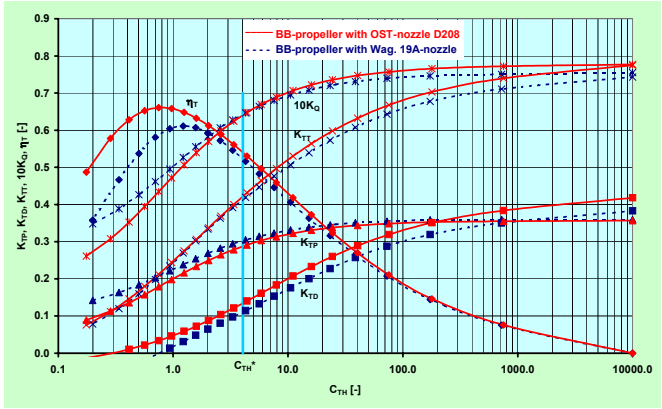
Systematic open water tests have been carried out. The results are used to develop a data base for a calculation program OSTNOZZLE, using polynomial coefficients.



OST-nozzle profiles

The program system has been used to calculate the performance of a propeller and different ducted propellers for a given design point with P_D = 1000 kW, n = 260 rpm and V_S = 13 kn. The comparison of the open water characteristics shows the highest total efficiency for the BB-propeller with the nozzle D208. The efficiency is 3% higher than the efficiency of the propeller with a Wageningen 19A nozzle and 5% higher in comparison with a propeller without nozzle. The bollard pull of a ducted propeller with a OST nozzle is also very high. The OST nozzle can be used for propulsion systems with a wide range of thrust loading coefficients.

For more information about the OST nozzles or interest on the polynomial coefficients please contact Mrs Heike Manke from the Towing Tank department (manke@sva-potsdam.de).



Characteristics of the nozzle propeller*

* Kompeleks dvizitel'nyi grebnoj vint – napravljaju scaja nasadka, Metodka rasceta I pravila proektirovanija, Standard OST 5.4129, Moskau 1975

Advanced calculations and complex model tests

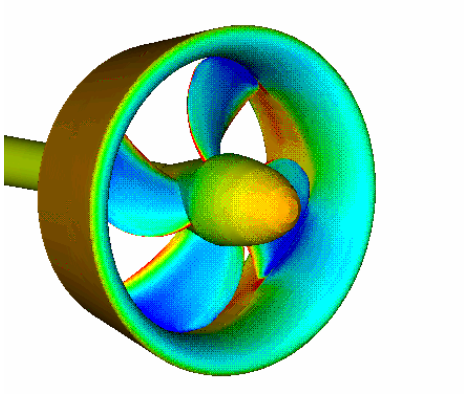
In connection with industry projects the SVA has tested and calculated a large number of propulsion systems with ducted propellers during the last years. Aims of the work were for example the increasing of the bollard pull of thrusters with nozzle propellers and the optimisation of the nozzle profiles.

For the design and analysis of ducted propellers a variety of lifting line and lifting surface programs is available in SVA. The drawback of these programs is that the influence of the viscosity can't modelled exactly and that the influence of additional bodies, like thruster housings cannot be taken into account.

To overcome these drawbacks, a series of computations of the viscous flow around ducted propellers have been carried out for model and full scale. In the computations, the geometry of the propeller blade and of the nozzle were considered without simplification. The gap between them was also included. The accuracy of the results of the numerical calculation is effected by the accuracy of the simulation of the flow in the gap, specially at high thrust loading coefficients.

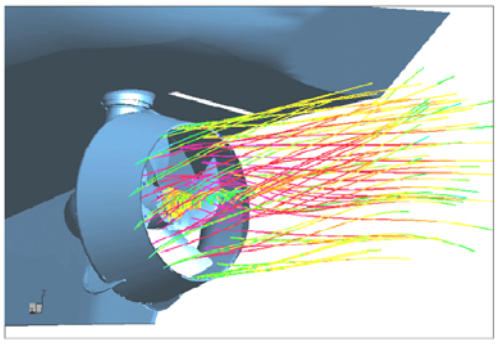
The application of RANS method for the prediction of the flow around nozzle propellers has many advantages. More detail information on the flow can be captured than in the experiment, e.g. the velocity and pressure distribution on the propeller blades and on the nozzle.

The next Figure shows the calculated pressure distribution on the propeller and nozzle at C_{TH} = 1200.



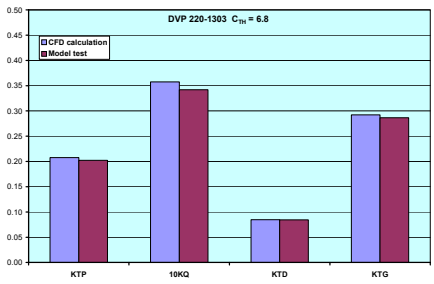
Calculated pressure distribution

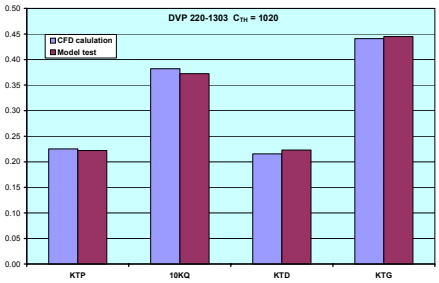
The computations have been carried out with the commercial CFD software package CFX-TASCflow with different turbulence models. The numerical computations can be conducted for the nozzle propeller alone in homogenous flow or with a ship. In the second case, not only the propeller flow will be focused but also the interaction parameter between ship and the ducted propeller, see in the next Figure.



Calculated streamline behind a nozzle

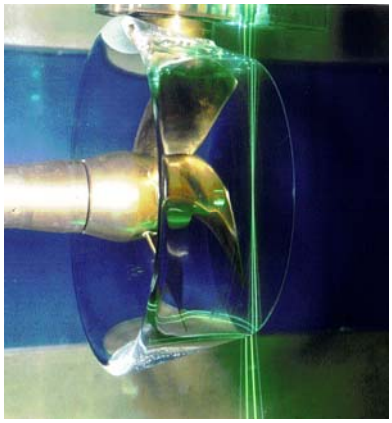
The combination of the experimental and numerical investigations is very powerful for testing and developing of new nozzle propellers. The experimental data can give a good overview on the forces and moments for the whole range of operational conditions. The numerical computations can be applied to focus the detail of the flow for selected loading conditions. The next figure shows a comparison of the calculated and measured coefficients for the thrust loading coefficients C_{TH} = 6.8 and 1020.



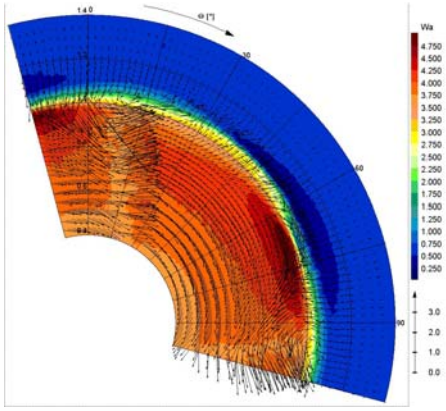


Calculated and measured nozzle characteristics

A modern Laser Doppler Velocimeter system (LDV) at the cavitation tunnel of the Potsdam Model Basin has been used to validate the numerical results of the velocity distribution around the nozzle propeller.



Velocity measurements in the propeller stream

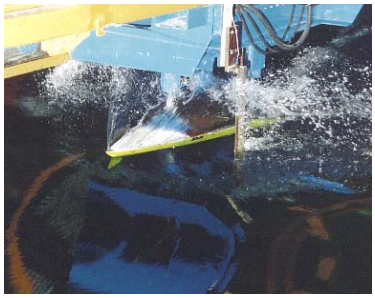


Theoretical and Numerical Investigations of Slamming Pressures

The prediction of slamming loads is of importance already in the stage of design due to the high degree of structural loads of ships with a great slamming probability in seaway such as patrol boats, fast mono hulls, catamaran ferries, container ships.

With regard to the slamming prognosis by the use of model tests for fast ships there are following significant limitations in ordinary measuring techniques.

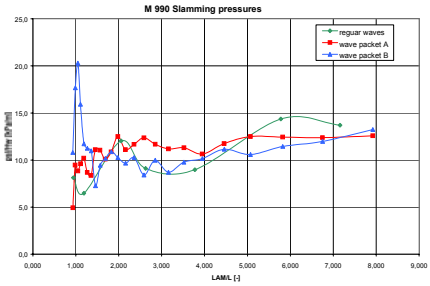
- Model tests in regular waves to predict the response functions and the recalculation to real sea states are only usable for delivering statistical mean values. For prediction of slamming loads that kind of model tests is restricted due to of non-linearities.
- In the case of model tests in irregular waves non-linearities will be considered, but that kind of tests are very time expensive. Especially for high speeds a great number of measuring runs are necessary to get a wide representative time window.



Slamming test in a wave packet, V = 6 m/s

Within a BMWI-Research Project, Reg.-Nr. 314/98, from 01.01.1998 to 30.09.1999, at SVA, theoretical and experimental foundations have been created for assessment the slamming behaviour of fast ships by the use of specific wave packets.

The results have shown, that the measurement of slamming loads by the use of specific wave packets with a minimum of the time for experimental investigations is possible.



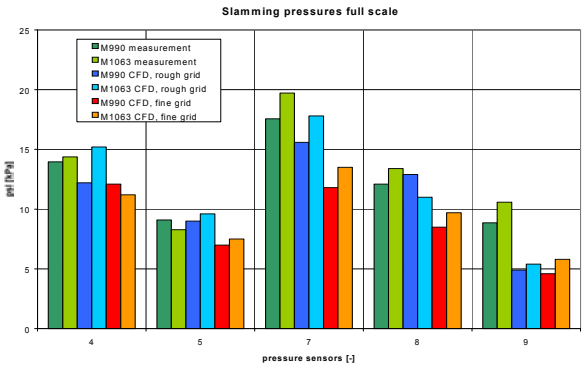
Response functions in wave packets and regular waves

For a patrol boat with wedge-shaped frames in the forebody it could be shown a linear dependence from the wave height. For that range a response function for slamming pressures measured in wave packets was defined. The agreement with response functions measured in regular waves was good.

For that type of ship there could be also shown a relative independence of the slamming pressure from the irregularity of a wave with defined wave height, because of the maximum pike pressures measured in a specific wave packet were similar to maximum pike pressures measured in a regular wave with the same maximum wave height.

Test results may be delivered for validation of methods for theoretical slamming prediction. The new measuring technique can be offered as a service of the SVA in connection to ordinary measurements in seaway. In addition to the wave packets the SVA can also offered model test in any irregular sea spectra.

The effect of linear wave height dependence could also be shown for the same ship within a other BMWI-Research Project, Reg.-Nr. 311/98, from 01.04.1998 to 31.12.1999, at SVA. In that project numerical calculations on the base of a developed CFD-tool for 2 scaled models in comparing with model tests were carried out. In general there was a useful agreement. That means that the recalculation of slamming pressures for such a ship type by Froudes-law is possible in principal.



Comparison slamming pressures between measurement and calculation recalculated to full scale

Member of the staff

Dr. Manfred Mehmel

Dr. Mehmel studied Naval Architecture at Rostock University where he graduated in 1973. Invited by his „doctor father" Prof. G. Schmitz he worked as a research student for 3 years in the field of manoeuvrability of ships. In 1977 he earned his Dr.-Ing. degree on the subject of dynamic yawing stability and steering a ship at stopping, one year before he was employed as a member of the scientific staff at SVA.

He worked for more than 5 years in cavitation research especially on the field of erosion and pressure pulses.
In 1983 be became the Head of Towing Tank and his working field changed to energy saving devices in propulsion.

Since 1990 Dr. Mehmel is director of SVA and is working as an active member of the Advisory Council of the International Tank Towing Conference.

He is married and has got 3 children. His hobbies are do it yourself and restoration of old furniture.

Impressum

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10 Years as a GmbH

All guestes and employees

On 1st June 2000 the Potsdam Model Basin celebrated its 10-year-old GmbH jubilee. Until today the already 1953 founded institution must circumnavigate numerous cliffs. Nowadays it is an efficient and international recognised research and consulting institute of the ship building industry.

As mile stones after reunification of the both German states following data can considered.
1990 – foundation out the Deutschen Maschinen- und Schiffbau AG – Holding; foundation of the Schiffbau-Versuchsanstalt Potsdam GmbH,
1993 – privatisation through management buy out recognised as non-profit GmbH
1996 – certification according to DIN EN ISO 9001, accreditation according to DIN EN 45.001.

The development of the Potsdam Model Basin was also connected with structural changes in the institute itself. Since the the turnover increased steady, in 1991 only 1,5Mio. DM, in 1999 it lies at 4,95 Mio. DM. This turnover were achieved by R&D-projects and by industrial orders.

In these 10 years about 80 R&D-projects were worked in the Potsdam Model Basin. We would like to say thanks in this connection to German ministry of research and technology, German ministry of economy, ministry of economy of Brandenburg and the Arbeitsgemeinschaft industrieller Forschung. Our industrial clients, about 800 orders in the last 10 years, coming from Germany and from abroad. In 1999 the export turnover amounted 18% of the total industrial turnover.

Today the services of the SVA Potsdam GmbH includes all fundamental fields of the ship hydrodynamic, design and optimisation of hull forms and propulsion systems, model tests for the estimation of hydrodynamic parameters of the ship hull and of the beginning of the nineties propeller as well as numerical simulation. In the last years research and development were concentrated on the development of propellers and propulsion systems as well as the application and further development of Computational Fluid Dynamic (CFD)-methods for ship design and the optimisation of propulsion systems. These aims to maintaining according to the competition conditions not only on the German market, but also internationally.

Until today in the Potsdam Model Basin there were manufactured and investigated about 1080 ship models and numerous form variants. About 400 propellers and propulsion systems were manufactured and investigated as model, some of them also in full scale.

Integrated Ship Design for Ships with Podded Propulsion Systems

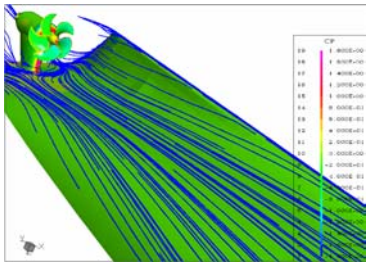
The fleet of operating vessels with podded drives grows up. Therefore in a R&D project the requirements of podded propulsors on aft ship design was investigated. With a twin screw ship and with a single screw ship model tests and CFD calculations were carried out.

Most advantage on twin screw ships is the omission of appendages. The inflow to the propulsors is very good. So no twin skegs should be arranged.

With the single screw vessel several stern forms were investigated as middle skeg, twin skeg, middle deadwood and side deadwoods. As the best solution for podded propulsion the middle skeg form was found out. Twin skegs and side deadwoods produce a very high resistance and there is no advantage in propulsion.

Also a big headbox to give plane disk for azimuthing the pod produces a high resistance. A better solution is a small had with the same profile as the shaft.

Problems may occur in manoeuvring on ships with high block coefficients. The conventional rudder behind the propeller gives good dynamically stability, not the shaft of the pod.



Stress coefficient on pod and aftbody

8th SVA-Forum

On 23rd March 2000 the SVA Potsdam held the 8th SVA-Forum under the title „KELVIN^{SVA} - pressure and velocity distributions". The topics of the 8th SVA-Forum concentrated on the representation of CFD-methods, especially on the presentation of the program system Kelvin^{SVA}, it's development and demonstration. This program supports the ship design and offers the possibility to check the ship lines direct in the ship yard. In addition the first of all experiences in use of this program system were discussed.

Mrs. Cramer and Mr. Krüger from the Flensburger Schiffbaugesellschaft presented applications of CFD-tools in modern ship yards. The application of modern numerical methods for direct load analysis in classifications, special used by Det Norske Veritas were showed by Mr. Nestegaard. Prof. Söding, Institut für Schiffbau Hamburg represented the program Kelvin^{SVA} methods and some results. Mr. Conrad from the SVA demonstrated the program KELVIN^{SVA} on the basis of selected exam-ples.

The optimisation of hull form using modern CFD-tools – example AIDA 2 were presented by Mr. Schulte, Aker MTW Werft GmbH, Wismar.

This papers, summarised in proceeding, you can get about SVA.