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topics

Effect of shallow water on speed and performance

We just launched a newly designed 47' single-screw trawler-style yacht. Our speed prediction indicated that it should be able to reach 9.5 knots. However, it only ran 8.6 knots at full rated RPM, even though we added a 10% drag margin for the prediction. The trial was in water that was 10 to 15 feet deep. Could this be the problem?

The test depth of 10-15 feet is significant. For your vessel, the shallow water will increase your drag by more than 15%, so your 10% margin from the original prediction was a bit shy. However, this still does not account for all of the effects. In your case, the engine was reaching full rated RPM, but it was not using all of its available power.

The effect of shallow water on drag is relatively well known, but there will also be an affect on the wake fraction and thrust deduction – those “propulsive coefficients” that describe how the propeller “sees” the water. The effect on these propulsive coefficients actually becomes the major player here due to a couple of coincidences – a) the high deep water prediction of wake fraction for a single-screw boat, and b) a relatively high non-dimensional speed (e.g., $FN=0.4$). If this was a twin-screw vessel or it was operating at a lower speed, the shallow water effects on the propulsive coefficients would be much less significant.

Water will be accelerated under a hull that has limited under-keel clearance, so the wake fraction will be considerably lower than that predicted for deep water. (In this case, we back-engineered the trial data to determine the wake fraction is nearly zero.) Thrust deduction, on the other hand, is substantially larger than in deep water to account for the pressure zone on the hull in front of the propeller caused by the accelerated water. Depending on the hull type and water depth, thrust deduction in shallow water can be as large as 0.40 or more.

This faster water actually lightens the thrust and torque load to the propeller. The propeller is under-pitched for the faster water that it encounters and the engine's governor will limit the boat speed. In other words, the engine has more power to give to the boat, but it cannot spin the propeller any faster to use this power.

You can sometimes see an indication of shallow water effects with a plot of speed (speed over ground, not under-hull water speed) vs RPM. This plot will be more-or-less linear if there are no shallow water effects. Once shallow water begins to noticeably accelerate the water, you often see the curve shift away from this line to where it needs more RPM for the speed. The only way this increased RPM can occur is a) high cavitation (not our case), b) a reduction in pitch (again, not our case), or c) an increase in water speed (voila!).

So, to develop a speed prediction for the shallow water case, include the added drag from shallow water, reduce wake fraction, and increase thrust deduction. Of course, in deep water you'll need to go back to the original numbers.

products

Trade shows and events

You can discuss product capabilities with HydroComp staff at these upcoming trade shows:

IBEX, Miami [Oct 19-21]
PropExpert training, Las Vegas [Nov 3]
NMPA, Las Vegas [Nov 4-6]
METS, w/ DS&T, Amsterdam [Nov 15-17]
WMTC 2006, London [Mar 6-10]

Check your version

The following is a list of current program versions and dates. If you have a current MSU subscription, you can click on the appropriate link below to go to the update download page. (Note: users of SwiftTrial and SwiftCraft are on a perpetual subscription.)

NavCad 2005 [5.13.0103, Aug 2005]
PropCad 2005 [4.42.0141, Aug 2005]
PropExpert 2005 [5.14.0069, Sep 2005]
SwiftCraft 2005 [1.31.0049, Jul 2005]
SwiftTrial 2003 [1.02.0019, Oct 2003]

It is never too late to update your MSU subscription! Contact HydroComp to receive a version feature summary.

New product features

Below are a list of recent feature additions to HydroComp software:

NavCad

Aligned series prediction
Enhanced engine library
Supplemental calcs: squat & dynamic trim

PropExpert

Enhanced trans-cavitation analysis
Speed prediction validation
Improved shaft diameters calculations

PropCad

New class rules – Lloyd's, ABS
Support of user-defined distributions
Full 3D *Scan Converter* capability
HTML formatting of reports and offsets

HydroComp, Inc. is the leading supplier of software and services for marine performance prediction, propulsion analysis, and propeller design. For more information, visit www.hydrocompinc.com or one of the pages listed below.

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topics

Performance differences in fresh and salt water

Are there any rules regarding performance of a given vessel operating in Salt water vs Fresh water? Logic would seem to dictate that since a vessel floats lower in Fresh water, that the boat would go slower, the load on the engines would be higher, and therefore the propeller pitch should be lower.

Great question, but your conclusions may be *exactly opposite* of what will really happen. You are correct that a boat in Fresh water will run at a slightly deeper draft due to its lower density. However, Fresh water also has lower viscosity, meaning less friction. Drag on a boat is comprised of two lost energies – a) that from moving the water out of the way (making waves), and b) skin friction. As water type changes, however, each of these parts are going in opposite directions. For example, going from Salt to Fresh water you may have more wetted surface, but you also have less friction for that surface. So, the net effect of changing from Salt to Fresh water is typically minimal.

Let's see if we can give you some sense of proportion using a 250' (76 m) fisheries patrol boat running at 20 kts. Going from Salt to Fresh water we see 1.6% increase in draft and 0.5% increase in wetted surface area, but a 0.3% reduction in total drag. The total drag for this boat was roughly two-thirds wavemaking and one-third frictional. On a slower vessel with large surface area (such as a tanker), friction will dominate and the effect of changing from Salt to Fresh water will probably result in a small increase in drag rather than a reduction. Nevertheless, you can see how the net effect is typically of little consequence.

(As an aside, many people observe an increase in drag due to shallow water effects and incorrectly attribute it to running in Fresh water.)

Water type also affects propeller performance, but this too is very small. For example, simply due to the lower density of Fresh water, you would expect a very small increase in pitch – something like 1% or less. However, if your boat is of the type and speed that it will also see a small reduction in total drag when running in Fresh water, then you might see a potential increase in pitch of 2% at most to fully load the engine at its slightly higher top speed. This would be no more than 0.75" pitch increase for a 36" pitch (or, 20 mm for 1000 mm pitch).

WMTC 2006 presentation – Inboard Propeller Cavitation

HydroComp's Technical Director, Don MacPherson, and former HydroComp engineer, Chad Turmelle, will be delivering a presentation and paper entitled "Inboard Propeller Cavitation: A Practical Guide and New Performance Model" at the **World Maritime Technology Conference**. The conference is being held 6-10 March 2006 in London.

This paper is a follow-on update to a paper delivered to the New England Section of SNAME last May. **This new paper will include new analyses for the effect of cupping, water quality, and shaft angle.**

people

PropExpert training seminar at 2005 NMPA Convention in November

We are pleased to announce that our next **PropExpert training seminar** will be held in conjunction with the 2005 convention of the National Marine Propeller Association (www.nmpa.net) in Las Vegas on **November 4, 2005**. This one-day seminar is suitable for new and experienced users of PropExpert, as well as for anyone interested in learning propeller sizing.

You do not need to be a PropExpert user or a member of the NMPA to attend the seminar or the convention. **Please contact HydroComp to register for the seminar or to receive more information. Don't delay – time is running out!**

Presentation and seminar services

Do you need a speaker to discuss topics of powering and propulsion to your clients? To your staff? Then perhaps a presentation by Don MacPherson, HydroComp's Technical Director, is just what you need.

Mr. MacPherson is a frequent technical speaker on Marine Performance and Propulsion subjects, making these topics accessible and interesting. Venues have included talks to customer and dealer meetings, corporate training seminars, technical conventions and symposia, and also to civic organizations.

Since 2001, Don MacPherson has conducted over two-dozen presentations and seminars for companies such as Caterpillar, Cummins, VERICOR, and Radisson Seven Seas. A few sample topics include:

- *Understanding Marine Propellers*
- *Inboard Propeller Cavitation*
- *Ships of the 21st Century*
- *Reliable Speed Prediction*
- *Fundamentals of Marine Propulsion*

Call us to discuss your presentation and seminar requirements.

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