April 10, 2017

Webinar: PropExpert for Powerboats

Considerations for using PropExpert to size propellers for stern-drives and outboards

HydroComp PropExpert is a program for the selection and analysis of propellers for motor yachts and workboats. While it was developed with the inboard propeller in mind, PropExpert can also be used for small high-speed powerboats - both recreational and commercial. This webinar provides guidance on some of the more common pitfalls and concerns.

What is a powerboat?

Powerboats are typically high-speed, planing vessels that are powered by stern-drives or outboard motors. They're main objective is high-speed transit, they aren't meant to carry cargo or for towing. Most small recreational boats are powerboats, but also some heavier commercial craft fall into this category as well.

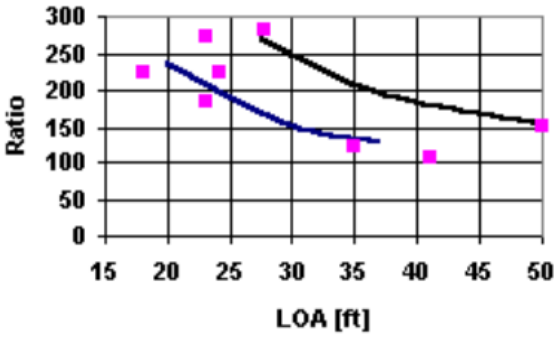
What considerations are there for analyzing powerboats in PropExpert?

There are several important factors for accurate performance predictions for powerboats. These include: an accurate vessel weight, appropriate hull-propulsor interactions for stern-drives/outboards, proper identification of outboard engine RPM and gear ratio, and correction factors for outboard style propellers.

Importance of accurate vessel weight…

The vessel weight is a critical parameter for an accurate prediction, especially for powerboats that are often lightly loaded. There are very few parameters used by PropExpert to predict speed and other vessel properties, so the true vessel weight is a critical parameter. Because the boats are typically small and light, this means that passengers, fuel, gear, and other cargo are not negligible. Be sure to use the actual operating weight of the vessel underway. Remember that "light ship" and "gross/net tonnage" are not vessel weight.

In PropExert, we have provided a non-dimensional relationship of weight and length – the *Ratio* field. The weight-to-length ratio can provide some guidance when entering the vessel weight. A review of popular powerboats has shown that typical ratios for powerboats are between 100 and 300. The recreational boats tend to be near the lower end, ~100-200, while commercial vessels are on the upper end, ~200-300. Additional guidance is available in HydroComp Report 116.

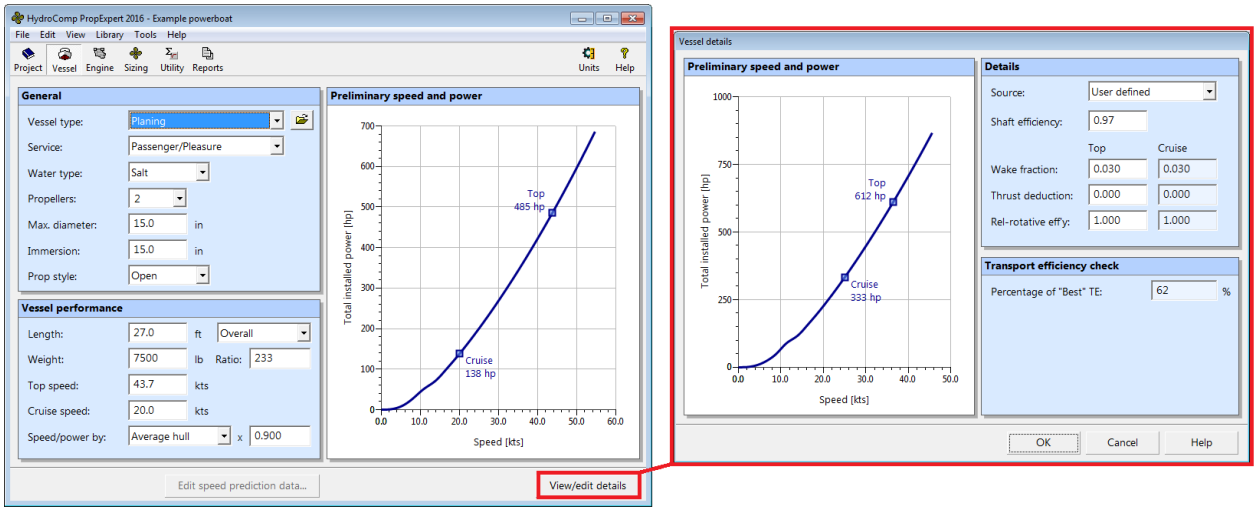


Hull-propulsor interaction…

All propulsion systems interact with the hull and affect the performance in some way. PropExpert – being developed for inboard, shaft-driven propellers – automatically assumes that the propulsion system is inboard and populates all analyses with inboard estimates for hull-propulsor interaction. Powerboat propulsion systems are driven by stern-drives or outboard motors, therefore we must over-ride PropExpert's estimates for inboard hull-propulsor interaction. The following values for wake-fraction, thrust deduction, and relative-rotative efficiency are recommended for stern-drives and outboard motors:

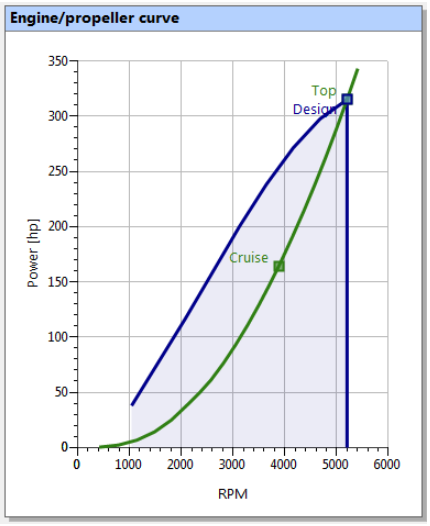
Shaft efficiency	*0.97*
Wake fraction	*0.03*
Thrust deduction	*0.00*
Relative-rotative efficiency	*1.00*

The hull-propulsor interaction coefficients are set from the Vessel Details page:



Engine…

The engine considerations are fairly straight-forward. Outboard engines operate at high RPM's (5k-7k RPM) and are often available in a range of rated RPMs and gear ratios. It is important to identify the rated RPM of the engine itself, but also the gear reduction built into the lower unit. PropExpert's generic gas and diesel engine curves are appropriate in most cases, although the true engine power curve can be entered as well.



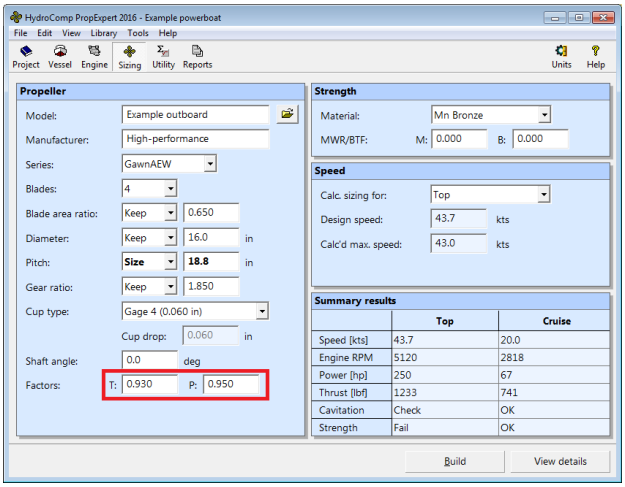
Outboard style propellers…

There are significant differences between inboard propellers and outboard style propellers. Outboard propellers have larger hubs to accommodate shaft splines and thru-hub exhaust. These propellers typically feature cup on the trailing edge, and may have face-camber and special pitch distributions. To model these propellers, we use the GawnAEW series in PropExpert as a basis, with some corrections to the Thrust (T) and Power (P) factors depending on the propeller type:

Stock propellers with flat-face
GawnAEW, No cup,
T factor = 0.99, P factor = 1.02

High-performance props with progressive-pitch
GawnAEW, Very light cup,
T factor = 0.93, P factor = 0.95

The T and P factors are entered from the Sizing page in PropExpert at the bottom of the propeller table.



Analysis and sizing…

After choosing the appropriate T and P factors, we can proceed to the propeller sizing. Often, we are just sizing for pitch. BAR is usually fixed for commercially available props off-the-shelf (i.e. 3 blade, 0.55; 4 blade, 0.65). Similarly, the gear ratio is dictated by the outboard or stern-drive – at best, we may have a few available ratios to choose from. Cup must be manually selected by the user.

Remember to check cavitation! Outboard/stern-drives are usually highly loaded, and excessive amounts of cavitation must be managed. For sub-cavitation propellers, try to keep the average cavitation below 20-25%. When the cavitation exceeds this range, the propeller begins to operate in a trans-cavitation regime with different thrust and torque behavior – this can sometimes make the sizing difficult to converge as PropExpert searches for the optimum propeller pitch and vessel top-speed. Fully-cavitating propellers may be difficult to size. In these cases, it may be best to run the sizing with **Pitch = *Keep*** and manually iterate through the pitch range to find the best combination of cavitation levels and top speed. Also, the **Calc sizing for = *User-defined*** can also be used to help the sizing solution converge.

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