Cavitation on Small Commercial Propellers

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INTRODUCTION

Cavitation occurs when pressure surrounding the propeller dips below the water's 'vapor pressure'. This causes the water to produce bubbles or cavities of water vapor - typically at the face, tip, or back of the propeller.

Face cavitation usually occurs only on propellers with uncharacteristically low P/D ratios at high vessel speeds. A major threat to propeller corrosion, excessive face cavitation is caused by a negative blade angle of attack. This is generally indicated when the P/D ratio is less than , or close to, the advance coefficient, J.

Tip cavitation is typically indicated by excessive tip speeds. Tip cavitation generally does not affect thrust, but can produce noise and contribute to blade corrosion.

Finally, back cavitation appears in heavily loaded propellers, and is the principal cause of blade corrosion and thrust loss. Back cavitation is indicated by excessive blade pressure (too much lift) or cavitation percentage, as well as a blade area ratio less than the recommended.

CURES

The cure for cavitation depends on the type. For face cavitation, often the P/D ratio is too low for the RPM and ship speed. With tip cavitation, typically the RPM is too high. Most importantly, back cavitation generally indicates that there is too much power being pushed through the given propeller. So, reducing power, increasing diameter or blade area, changing air-foil to flat-faced blade sections (low RPMs only), or reducing the P/D ratio (possibly with cupping) may all help.

REQUIRED BLADE AREA

Blade area requirements and recommendations are generally based on cavitation concerns. Necessary amounts of blade area can be determined using a number of different criteria. In fact, the multitude of different ways of determining blade area seem to be causing no small amount of confusion. Just remember a couple of points - most of these criteria produce more-or-less the same recommended blade area regardless of the approach taken, and a little difference in blade area will not make or break an application.

Theoretical performance is not greatly affected by blade area. In general, a lower blade area produces high efficiency (and better performance). So, the goal in selecting a blade area ratio is to use as little blade area as possible, but enough to control cavitation. A majority of the commercial (stock fixed-pitch) propellers come in predefined blade area ratios, so the choice of blade area is usually easy to make.

There are three back cavitation checks - blade pressure, percent cavitation and recommended blade area ratio. Keeping in mind that a little difference in blade area ratio will not significantly degrade an installation, the user must look at all three criteria and make an informed decision if a particular blade area is adequate. If all three criteria are blinking madly and the pressure is up to 20 psi, there is 50% cavitation and the recommended blade area is twice what you have, then it is no real stretch to assume that you need more blade area! On the other hand, if the pressure and percentage cavitation is acceptable, and the recommended value is 10% higher than your value, you should be in good shape with the blade area you have chosen - particularly if you use a propeller model that has other attributes which help to limit cavitation, such as skew. For those situations between the two, judge accordingly.

THRUST BREAKDOWN

Some cavitation exists in virtually every installation. Fortunately, small amounts of cavitation exhibit no significant effect on performance.

Once a propeller reaches about 15% cavitation, the breakdown of thrust begins. There is little loss of the thrust-making capability of the propeller until about 30% back cavitation. Significant thrust loss can be expected to begin about 30% or so.

Of course, there are other detrimental symptoms of cavitation, like vibration, erosion and noise that degrade performance through secondary effects.

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