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SEAKEEPER MITSUBISHI COMPARISON

Mitsubishi has recently posted on its website a chart comparing its products with Seakeeper's. We believe this chart deserves a point by point response.

Rating

The comparison begins with the assertion that Mitsubishi's "anti roll torque" is greater than Seakeeper's. After more than ten years of rating its gyros based on angular momentum (N-M-S) , Mitsubishi has now chosen to rate its gyros based on "torque". However, there is a reason that angular momentum (which is the equivalent of horsepower in an engine) has always been the accepted measure of gyro capacity. Angular momentum is the product of the fundamental gyro parameters – flywheel inertia and rpm. This determines the total amount of torque available *over time*. The faster the gyro tilts the higher the peak torque, but the shorter the time that peak torque can be applied. Because the wave energy which creates boat roll is not instantaneous, but is applied to the boat in a sinusoidal manner with wave periods of 3 to 7 seconds, the most effective use of the gyro's angular momentum is to spread the torque in a way that matches the wave energy. Seakeeper has studied this theoretically using motion simulations and experimentally on our 43 ft demonstration boat. We have concluded that applying a high peak torque does not optimize use of the gyro angular momentum or maximize roll reduction. Mitsubishi's recent decision to rate their gyros based on maximum torque without regard for the time element is utterly misleading and ignores the basic physics of boat roll.

Weight and Power

Turning to the Mitsubishi chart, it is clear that the Mitsubishi ARG-375T (7,500 N-M-S) unit is the most direct comparison to the Seakeeper 7000 unit. The Mitsubishi unit has slightly more angular momentum (about 7%); however let's look at the other parameters. The Mitsubishi unit is more than double the weight (430 kg vs. 910kg). As for power, the Mitsubishi consumes 5.5 KW during spool-up and 4.5 KW during operation most of which is heat generating air friction. In

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comparison, the Seakeeper unit uses a maximum 3 KW during spool-up and 2 KW during operation and that only in the heaviest seas. To make a stark comparison: Would *anyone* buy a propulsion engine or generator that was over double the weight and burned twice the fuel of a competitive product?

Applicable Range of Sea States and Control Methods

Mitsubishi's claim that its "simple passive damper" is the best solution for a range of sea states and is superior to Seakeeper's active precession brake is a claim that could only be made by a salesman not an engineer. The simple passive type of gyroscopic roll stabilizer used by Mitsubishi was patented by Otto Schlick in 1904! Elmer Sperry (father of ship autopilot) patented the active type of gyroscopic roll stabilizer in 1915 and went on to build a business supplying active gyro roll stabilizers to yachts and to commercial and military ships. Numerous technical papers and whole chapters of technical books have been written explaining the superiority of active gyros to simple passive dampers. Seakeeper's solid sate motion sensors, active precession brake, and variable gain control algorithm respond to different roll conditions, varying torque application over time to maximize roll reduction in every condition. The proof that electronic active motion control is state of the art is shown by its universal adoption in automobiles, aircraft and boats including fin stabilizers.

Cooling Method

No. 10 which addresses cooling is another example of Mitsubishi's outdated engineering. Does anyone in the boating world buy an air cooled propulsion engine, generator or air conditioner? And dumping 5.5 KW of heat into the boat that can only be removed by ambient salt laden air that is exposed to the motor and bearings of the gyro cannot be a good thing. Conversely, the critical components of the Seakeeper Gyro are enclosed in a vacuum chamber, which has to be the highest level of isolation from corrosion in the industry.

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Safety

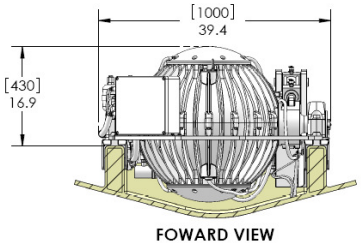
No. 11 does not address a significant safety risk. We do not put a cover over the gyro because it would complicate installation and access on most boats where a gyro was not included in the original design. The tilting gyro is no more of a safety risk than exposed rudder mechanisms which all boats have. If space allows, we are happy to supply an enclosure.

Maintenance

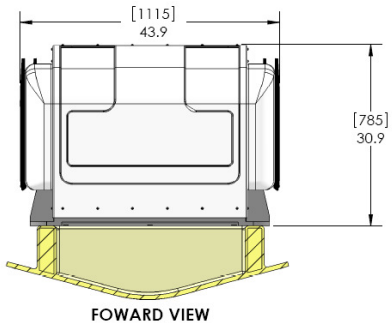
No. 13 is the only section where Mitsubishi addresses Seakeeper's vacuum technology and tries to paint it as a disadvantage. Yet the vacuum enclosed flywheel which eliminates air drag allows a gyro that is less than half the weight and half the power for the same angular momentum. And contrary to their claim, the vacuum chamber has demonstrated that it requires no scheduled maintenance.

Installation Method

Finally, no. 12 which relates to mounting arrangements. Anyone who has ever been in an engine room of a boat has noticed that the engines are mounted on beams which bear the weight and torque of the engines. Since an effective gyro has considerable weight and very high torque in both compression and tension, a beam mounting system which allows load spreading and large surface areas with bonding surfaces in tension and shear is the correct solution. See the illustration below for a direct comparison of the space requirements:



Seakeeper M7000 Installation



MitsubishiARG-375T Installation

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Summary

All of the items discussed above have a common theme. Seakeeper has spent eight years and many millions of dollars to engineer and produce a state of the art gyro that, particularly in terms of weight and power, makes effective roll elimination possible for any boat for the first time in history. The development was not cheap, and the product is not cheap to build. But vacuum chambers, high speed bearings, electronic active brakes, electronic fault monitoring, liquid cooling, and beam mountings systems are worth their cost and represent the level of function and sophistication that consumers should expect.

Mitsubishi has not done any of these things. The product they introduced over ten years ago is essentially the same 100 year old technology that they have today. Their claim to fame is “Simple”. So is a Model T Ford.