Ship stabilization technology a feature used for energy efficiency

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Abstract. From this article the reader can find information regarding ship stabilization technology. Types of stabilization system, comparison between different types of gyrostabilizers, the technical features that differentiate modern marine gyrostabilizer products, advantages and disadvantages of active stabilizers. Shipping is one of the world's most polluting industries. More than 90000 ships which are crossing the oceans each year, using classical propulsion, are burning nearly two billion barrels of fossil fuels. As a result, is the belch out of large quantities of polluting emissions into the air, principally in the form of sulphur dioxide, nitrogen oxides and particulate matter, which have been steadily rising and endangering human health especially on the principle shipping routes. They create between 2 and 3 per cent of the world's total greenhouse gas emissions such as carbon dioxide, contributing to global warming. In order to decrease the amount of burning fuel for the navy industry, it appeared the ship stabilization technology, which helps the ship to reduce the rolling created by wind and waves, so it will reduce the quantity of burn fuel and last but not least will reduce the polluting emissions, in the same time for the owners increasing the economic efficiency of the ship.

Keywords. Stabilization, fuel, efficiency, rolling, gyrostabilizer, pollution.

1. Introduction

During voyages ships are influenced by waves on the surface of the sea. The influence can be presented as a simple sinusoidal function as presented in figure below and plotted with https://www.wolframalpha.com (a graph generator with function posted i=graph+sin+t)

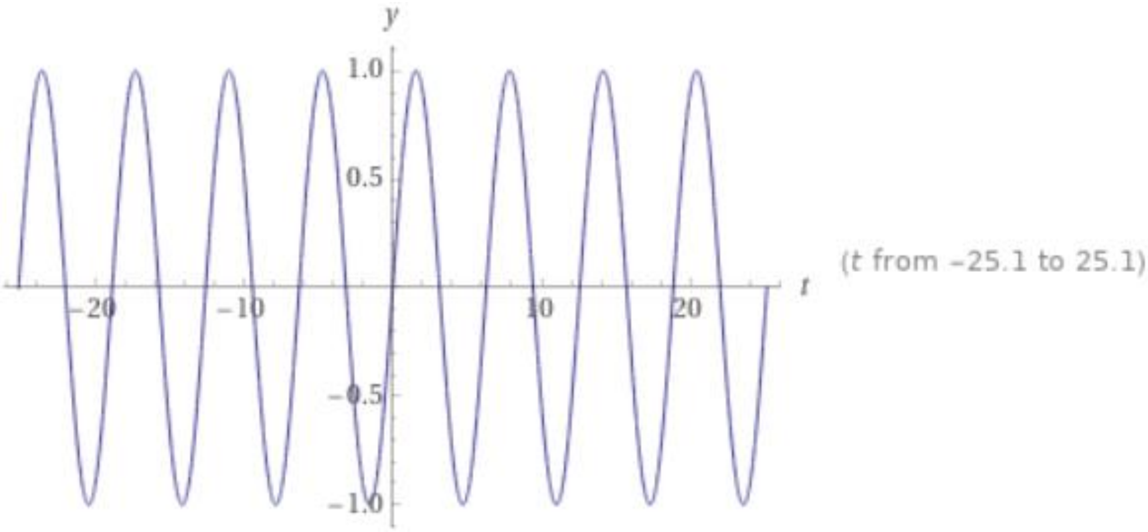

Figure 1. Excitation Graph
Generated: https://www.wolframalpha.com/input/?i=graph+sin+t

The stabilization technology is created to balance this external force with an opposite force in order to stabilize ship motions.
Stabilization technology in use is presented in figure below for a 80% damping ratio and the resultant amplitude is 0.2 meters.

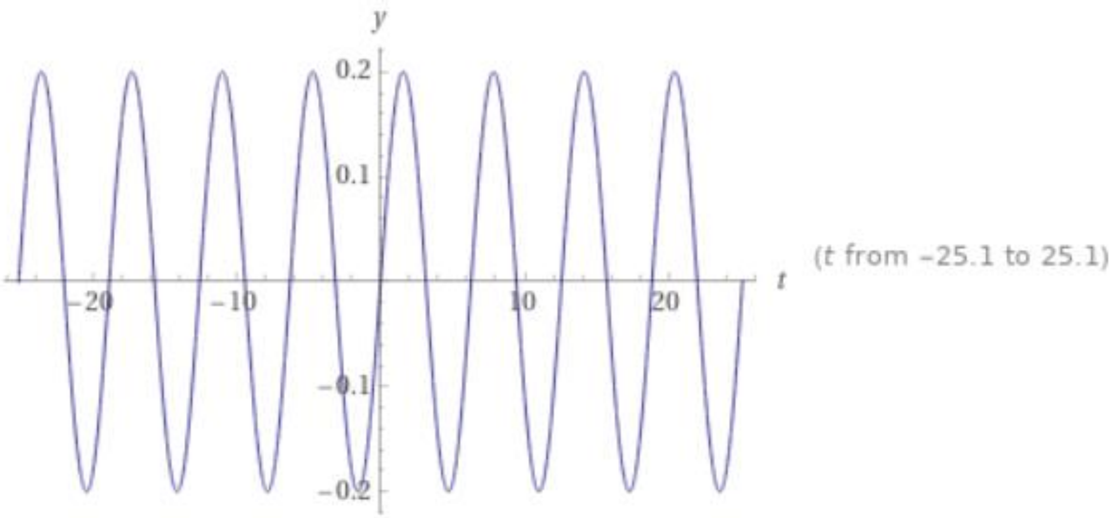

Figure 2. Excitation Graph – 80% stabilize damping damping
Generated: https://www.wolframalpha.com/input/?i=graph+sin+t+-+0.8*sin+t

As an example, we use a 80 % damping ratio as an example of stabilization system. And the function posted in the calculator is i=graph+sin+t+-+0.8*sin+t

2. Types of stabilization systems

There are two types of stabilization systems: passive and active.

2.1 Passive stabilization system

Keel or ballast are the ship main passive stabilization system.

2.2 Active stabilization system

2.3 Is a controlled or not system active in stabilization.

There are more types of active stabilization systems:

2.3.1 Movable fin (Quantum XT);
2.3.2 Rotating type (Quantum's MAGLift) ;
2.3.3 Foil- based system;
2.3.4 Gyroscope-style stabilizer

Majority of active devices have a much greater effect than passive ones, but also consume power, use space and generate noise. They rely on an electronic sensor to detect roll angle, velocity and acceleration.

2.3.1 Movable fin - Quantum XT

The systems can eliminate at least 80 % of a ship's roll and that is why we presented the graphs with 80% damping in the first part of the article.

Figure 3: Quantum XT active stabilization system

2.3.2 Rotating type - Quantum's MAGLift

Is using the Magnus effect [2] to create lift in a rotating arm outside the ship body.

Figure 4: Quantum MAGLift – an active stabilization system

2.3.3 A foil-based system

It generates lift using a lonf arm outside the ship hull with a hydrofoil section.

Quantum's Dyna-Foil system, can be 150 % more effective comparing with a standard fixed fin of the same size. It can either be retracted into a pocket for minimum drag or rotated parallel to the hull. [3]

Figure 5**:** Quantum's Dyna-Foil system

2.3.4 Gyroscope-style stabilizer

The system comprises a spinning flywheel mounted inside the ship.

See picture below:

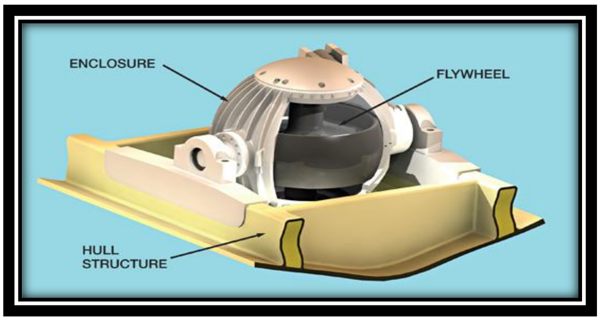

Figure 6: Gyroscope-style stabilizer for small ships

3. Comparison between different types of Gyrostabilizers in figures

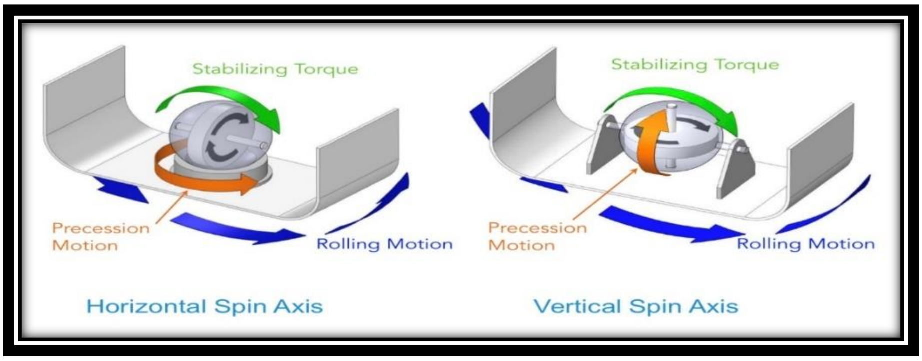

Figure 7: Gyrostabilizers with vertical spinning axis [4]

4. The technical features for marine gyrostabilizer products

4.1 Robustness

A feature of gyrostabilizers is the robustness of the base frame and the precession-motion-control system. As larger waves cause larger rolling rates, the torque induced in the precession axis continues to grow. In order to control the increased precession rates, the mechanism for controlling the precession motion must be able to over- come these ever increasing torques.

When the torque induced in the precession axis exceeds the capacity of the precession control mechanism, the gyro must either shut down to protect itself from damage or progressively de-rate to achieve the same. An under-sized precession control mechanism will result in premature shut-down as wave conditions build.

4.2 Zero speed stabilization

Represents the ability of the stabilization system to combat the rolling when the ship is not moving through the water – such as when lying at anchor. Whereas some systems rely on the lift generated as water moves past a foil or a fin, zero speed stabilization can generate its own righting forces.

5. Advantages and disadvantages of active stabilizers

5.1 Disadvantages of active stabilizers

- Noisy system;
  Active stabilizers are using energy and are noisy.
- High implementation costs;
  Costs can range from around \$300.000 up to \$5.500.000, depending on the system size and power requirements, but in time can be attenuated.
- Specially trained crew for maintenance;

5.2 Advantages of stabilizer systems

- Minimise tendency to roll in seas;
- Reduce fuel consumption;
  By increasing the sea keeping of a vessel, the efficiency increases.
- Reducing costs;
  By decreasing the consumption of fuel used, ship owners can save a big amount of money.
- Reduce polluting emissions;
  By reducing the fuel consumption, we also reduce the amount of polluting emissions: CO_2, NO_x, SO_x, PM.

6. Conclusion

Nowadays the reduction of air pollutant emissions generated by the burn of fossil fuel represents a challenge for the shipping industry.Shipbuilders are trying to develop different methods to reduce the consumption of fossil fuels. One of the methods could be the use of ship stabilization technology, which helps the ship to reduce the rolling created by wind and waves, so this will reduce the quantity of burn fuel, in the same time reducing the quantity of polluting emissions.

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