



paddlewheel- power- requirements- trimaran

Electric Ship

Paddlewheel Power Requirements



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Paddlewheel Power Requirements

PDF Version of the webpage (first pages)

4/9/2024

Paddlewheel Power Requirements

Calculate and chart the amount of thrust for a 10 hp electric motor drive paddlewheel with the following characteristics: 2 separate paddlewheels which have a blade measure of 6 ft wide, by 4 feet in height, and there are 8 total blades. blade emersion in the water is 3 feet. The type of craft to be propelled is a trimaran, with a wetted surface pontoons that measure 60 feet in length, 2 feet in width, and 4 feet in height. This is a freshwater craft. The vessel weight is 25,000 pounds. Calculate and chart total HP required for each knot of boat velocity from 1-15 knots.

To calculate and chart the thrust produced by a 10 hp electric motor driving two paddlewheels on a trimaran, and then to chart the total horsepower required for each knot of boat velocity from 1 to 15 knots, we will follow these steps:

1. Thrust from the Paddlewheel: We'll start by estimating the thrust generated by the paddlewheels driven by a 10 hp electric motor. The thrust will depend on the motor's power, the efficiency of the paddlewheel system, and the specifics of the paddlewheel design (blade measurements and emersion).
2. Total Horsepower Required per Velocity: To calculate the horsepower required for each knot of velocity (from 1 to 15 knots), we'll use a simplified resistance formula that considers the craft's size, weight, and the characteristics of the paddlewheels. We'll then plot this against boat velocity to visualize the power requirements across the speed range.

Assumptions and Simplifications:

- Efficiency of the Paddlewheel System: We'll assume a typical efficiency for the paddlewheel system. This efficiency accounts for losses in converting power to thrust and the hydrodynamic characteristics of the paddlewheels.
- Resistance Calculation: The resistance of the trimaran will be estimated using a simplified formula that captures the essence of hydrodynamic drag, which increases with the square of the velocity.
- Freshwater Conditions: Since the craft operates in freshwater, we'll use the relevant density for freshwater.

Let's proceed with the calculations, starting with the thrust estimation for the paddlewheels, followed by the horsepower required for velocities from 1 to 15 knots.

The thrust produced by a 10 hp electric motor driving two paddlewheels on a trimaran is approximately 4474.2 Newtons, based on an assumed efficiency of 0.6 for converting power to thrust. This estimate is a simplified representation that assumes optimal conditions and a nominal velocity of 1 m/s for the purpose of calculation.

The chart above illustrates the total horsepower required for the boat to achieve velocities ranging from 1 to 15 knots. The required horsepower increases significantly with speed, reflecting the non-linear relationship between velocity and the power needed to overcome hydrodynamic resistance. At lower speeds (1-5 knots), the increase in required horsepower is relatively modest. However, as the speed increases beyond this range, the horsepower required rises more steeply, highlighting the increased resistance encountered at higher velocities.

For instance, to propel the boat at 1 knot requires approximately 0.02 horsepower, which is minimal. However, to achieve 8 knots, the vessel needs about 9 horsepower, and for 15 knots, the requirement jumps to approximately 59 horsepower. This demonstrates the significant increase in power needed to overcome the resistance at higher speeds and the challenges in designing efficient propulsion systems for higher-speed operations.

This analysis provides valuable insights into the propulsion requirements for a trimaran with the specified characteristics and operating conditions. It highlights the importance of considering both the thrust generated by propulsion systems and the power requirements across a range of speeds when designing and operating such

Paddlewheel Power Requirements

The type of craft to be propelled is a trimaran, with a wetted surface pontoons that measure 60 feet in length, 2 feet in width, and 4 feet in height. This is a freshwater craft. The vessel weight is 15,000 pounds. Now calculate the immersion depth of the pontoons and the amount of horsepower needed to drive the boat 8 knots with 2 separate paddlewheels which have a blade measure of 6 ft wide, by 4 feet in height, and there are 8 total blades. Then compare that to two screw propeller outboards with a diameter of the screw of 16 inches. Calculate the horsepower needed for each method of propulsion.

To approach this task, we will first calculate the immersion depth of the pontoons for the trimaran, which will give us an understanding of how much of the pontoons are submerged and therefore the displacement of the vessel. Next, we will calculate the horsepower needed to drive the boat at 8 knots using both the paddlewheel and screw propeller propulsion methods.

Calculating Immersion Depth of the Pontoons

The trimaran's pontoon dimensions are given, and we know the total weight of the vessel. Using the principle of buoyancy (Archimedes' principle), the weight of the water displaced by the pontoons will equal the weight of the vessel.

Given:

- Vessel weight = 15,000 pounds
- Pontoon dimensions: Length = 60 feet, Width = 2 feet, Height = 4 feet
- Density of freshwater = 62.4 pounds per cubic foot

We'll start by calculating the immersion depth of the pontoons.

Horsepower Needed for Paddlewheel Propulsion

After determining the immersion depth, we'll calculate the horsepower needed to drive the boat at 8 knots using paddlewheels. For this, we'll consider the efficiency of paddlewheel propulsion and the resistance encountered by the vessel at this speed.

Given:

- Speed = 8 knots (convert to feet per second)
- Paddlewheel blade dimensions: Width = 6 feet, Height = 4 feet, Total blades = 8
- Efficiency factors and resistances will be estimated.

Horsepower Needed for Screw Propeller Propulsion

For the screw propeller propulsion, we'll calculate the horsepower needed based on the characteristics of the propellers and the same speed. We consider the diameter of the screw (propeller) and the typical efficiency of such propulsion systems.

Given:

- Diameter of the screw = 16 inches (convert to feet)
- Speed = 8 knots

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Paddlewheel Propulsion vs. Screw Propeller

Discuss the benefits of a paddlewheel propulsion vs screw propeller, including efficiencies and charting the power available for a 4 ft wide by 3 foot height paddlewheel blade comparing total blades of 4, 5, 6, 7, 8, 9, 10, and 11 total blades.

Paddlewheel propulsion and screw propeller systems are two methods used to propel vessels through water. Each system has its unique advantages and efficiencies, which can significantly affect the performance and applicability of different types of watercraft. In this article, we will explore the benefits of paddlewheel propulsion compared to screw propeller systems, focusing on their efficiencies. Additionally, we will present charts that illustrate the power available from a paddlewheel with a blade size of 4 feet in width by 3 feet in height, comparing the impact of varying the total number of blades from 4 to 11.

Paddlewheel Propulsion vs. Screw Propeller: An Overview

Paddlewheel Propulsion:

Paddlewheel propulsion, one of the oldest forms of propelling boats, uses large wheels with paddles attached around their circumference. These wheels rotate, pushing against the water to propel the vessel forward. This method is particularly effective in shallow waters and where maneuverability at low speeds is crucial.

Screw Propeller:

The screw propeller, or simply propeller, is a much more common propulsion system in modern watercraft. It consists of rotating blades that operate similarly to a screw, moving water in the opposite direction to propel the boat forward. Propellers are known for their efficiency at higher speeds and deeper waters.

Efficiencies and Benefits

Paddlewheel Propulsion:

- **Shallow Water Navigation:** Paddlewheels are more efficient in shallow waters because they are less likely to get damaged from the seabed or debris.
- **Maneuverability:** At lower speeds, paddlewheels provide better maneuverability, making them ideal for riverboats and ferries.
- **Historical and Aesthetic Value:** Paddlewheelers have a unique charm and are often used in tourist attractions for their nostalgic value.

Screw Propeller:

- **High-Speed Efficiency:** Screw propellers offer better performance and efficiency at higher speeds, making them suitable for modern shipping, naval vessels, and recreational boats.
- **Versatility:** They can be used in various water conditions, including open sea and deep waters, without the risk of damage from underwater obstacles.
- **Design Flexibility:** Propellers can be designed with different numbers of blades and shapes to optimize performance for specific conditions.

Power Available from a Paddlewheel: A Comparative Analysis

To understand the impact of the number of blades on the performance of a paddlewheel, let's analyze the power available from a paddlewheel with a blade size of 4 ft wide by 3 ft height. The total number of blades will vary from 4 to 11. The power generated by a paddlewheel can be influenced by several factors, including the water's resistance

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Trimaran Paddlewheel

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