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A1 5 Aeolus' Gift

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Abstract

During Odysseus' ten year journey, returning from the Trojan War, he is gifted a magical bag of wind to help him reach his home of Ithaca. Modelling the bag of wind as a propellant for a rocket system, this paper shows that the magical bag of wind would have a sustained thrust of approximately 6.8 N. Furthermore, the mass of this fuel would have been over $111,000$ kg, thus having a similar fuel-to-capsule mass ratio as a Saturn V rocket.

Introduction

The Odyssey is one of the most popular epic poems in literature, and depicts the story of the mythical king Odysseus on his ten year journey back to Ithaca after the Trojan War [1]. In Book 10 of the Odyssey the crew happen upon the island of the wind god Aeolus, who gifts them a bag of wind to propel them home. Whilst initially leaving the gift unused, disaster strikes when the bag is opened by a treacherous crew member mere minutes before the crew arrive back on Ithaca, and they are blown all the way back to the Aeolian Islands. This paper serves to put fact to fiction, and examine the physical parameters of this bag of wind if it existed in reality.

Calculations

The Bag of Wind is being modelled with the Tsiolkovsky Rocket equation [2] (also known as the Ideal Rocket equation). Since the crew does not close the bag again, it is assumed that the boat is propelled until the fuel depletes, making m_f exclusively the dry mass of the ship.

$$\Delta v = v_e ln\left(\frac{m_o}{m_f}\right) \tag{1}$$

Where Δv is the change in velocity produced by the exhaust velocity (the speed at which the fuel leaves the rocket system), v_e, scaled by the ratio between the original (m_o) and final masses (m_f). With the appropriate application, Equation 1 can be very useful when approximating Aeolus' gift's physical properties. Firstly, we assume the ship to be a Penteconter, and so have a mass of $11,500$ kg [3]. Secondly, we assume the boat travelled with a constant velocity when it was blown away from Ithaca back to the Aeolian Islands. Both of these locations are being assumed to be their real-life counterparts, and as such are approximately $1,100$ km away by sea (D) [4]. From Book 10 [1], which describes the bag of wind being opened at dawn, and the winds ending at dusk, we assume it takes 12 hours for the fuel to deplete (t).

$$v = \frac{D}{t} \approx 25.5 \text{ ms}^{-1} \tag{2}$$

As the boat starts from resting, this also means $\Delta v = 25.5$ m/s. From this, we can calculate the force of the thrust (F) such a propellant would produce. Please note that as an initial conceptualisation of a magical object, effects of air resistance are being ignored in favour of a more detailed examination in future works. The thrust calculation is as follows:

$$F = m_f \frac{v_f - v_o}{t} \approx 6.8 \text{ N} \tag{3}$$

Where $v_f - v_o$ is Δv. In order to utilise Equation 1, we will use the below equation relating the thrust to the exhaust velocity (v_e), so that this unknown variable can be substituted out of the Rocket Equation.

$$F = \frac{dm}{dt} v_e \tag{4}$$

Where dm is the change in mass; in our case the ratio of the entirety of the propellant (m_p), to dt, the total time of the journey (12 hours). Rearranging to make the unknown variable, v_e, the subject, and substituting into Equation 1, we can calculate how much air will be needed as propellant to accomplish this feat. By substituting m_o (original mass) to be $m_f + m_p$ (final mass and propellant mass respectively), we can rearrange and simplify the Ideal Rocket Equation to calculate the mass of the propellant.

$$m_p = \frac{F\ t\ ln(m_f)}{\Delta v} \approx 111,000 \text{ kg} \tag{5}$$

Discussion

To summarise, when modelling a magical bag of wind as propellant, covering the distance described in the Odyssey it requires a constant thrust of 6.8 N, and a total fuel mass of nearly $111,000$ kg. While the thrust may appear low, it is actually in keeping with other propulsion systems. The lower bound of propulsion systems is electric propulsion, which typically have thrusts in the mN range [5]. Additionally, the total fuel mass though certainly an extremely high value, is not entirely unreasonable when compared to rocket systems of today. One of the most famous rockets, the Saturn V, had a capsule mass (or dry mass) of 7.01% of the total system, with the rest being propellant [6].

Similarly, when modelling the Penteconter as the capsule and the bag of wind as propellant, the ship is about 10.4% of the total system. Therefore, though an entirely fantastical scenario, it is amazingly consistent with realistic capsule and propellant systems. The most unrealistic part of the scenario is the ship's ability to carry an oxhide pouch of as much as $111,000$ m^3 in volume. The alternate, and more likely, hypothesis is that the air inside is heavily pressurised. The exact dynamics of this are, again, a possible area of future research.

Conclusion

To conclude, an initial realisation of a magical gift bestowed by a mythical wind god reveals some seemingly incredible parameters, derived from the feats observed in Book 10 of the Odyssey and Tsiolkovsky's Rocket Equation. However, whilst having the mass of the propelling wind be over 950% of the mass of the ship, this actually creates a very believable ratio in keeping with modern rocket systems like the Saturn V.

References

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