Journal of Physics Special Topics

P3_4 Keeping Your Head In The Clouds

J. Bettles, I. Clarke, M. Perry and N. Pilkington.

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH.

October 02, 2011

Abstract

An investigation into whether the ship "Cloudbase" from the Captain Scarlet TV series could actually maintain stationary altitude. The weight of the Cloudbase structure was calculated to be 3.24 x 10^{10}N assuming it is mostly comprised of carbon fibre, it would need a power of 1.61 x 10^{13}W to run the engines alone equivalent to roughly 644 thousand nuclear power plants. This idea was determined unfeasible.

Introduction

In the 1960s a TV show named *Captain Scarlet* featured a ship named 'Cloudbase' which acted as an aircraft carrier and base for the hero. This report looks at whether it would be possible using current technologies to create a full scale version of Cloudbase and keep it at a stationary altitude.

Weight Of Cloudbase

The first step is to calculate the weight of the Cloudbase structure to enable an estimate of how much force would be needed to keep Cloudbase stationary in cruising altitude. This was done using dimensions of a current sea fairing aircraft carrier also assuming that the Cloudbase structure would be made of carbon fibre with a density of 1740kgm^{-3} [1]. This value was assumed as Cloudbase would need to be low in mass whilst remaining strong and durable. As the structure would, however, have to contain people, planes and a power source for the engines it would in reality be a lot heavier so the best case scenario has been calculated.

Figure 1 – A photo of Cloudbase used in the TV series [2].

The dimensions of Cloudbase will be modelled after a Nimitz-class nuclear aircraft carrier [3], Figure (1) shows Cloudbase and how it could behave as an aircraft carrier, as both are to be used as a portable runway and plane storage vessel. The length, height and width respectively of a Nimitz-class nuclear aircraft carrier are roughly 333m by 73m by 78m producing a total volume of 1.90 x 10^{6}m^{3}. Using the density above, a mass of 3.30 x 10^{9}Kg was calculated, assuming Cloudbase to be a rectangular block of uniform density.

The weight of the ship was calculated using equation (1) below, along with the assumption that Cloudbase would sit at an altitude of 12,000m [4], the cruising height of most commercial jets,

$$F = GM_e m_c / r^2, \quad (1)$$

where G is the gravitational constant of 6.67 x 10^{-11} $m^3kg^{-1}s^{-2}$, M_e is the mass of the Earth (5.97 x 10^{24}Kg), m_c is the mass of Cloudbase previously calculated (3.30 x 10^9Kg) and r is the radius of the Earth plus the altitude of Cloudbase (6.39 x 10^6m). Equation (1) was used as Cloudbase is at a high altitude, which will make a small difference in the acceleration due to gravity compared to the value at the surface of Earth. From equation (1) the weight of Cloudbase was calculated to be 3.24 x 10^{10}N. (I get 3.22 x 10^{10} N when using the more accurate values for Me and r)

Engine Power

Next the power consumed in maintaining altitude will be calculated, this was completed by setting the weight equal to the thrust of the engines. This is allowed assuming there are no external forces such as atmospheric currents.

Comparisons were made to the Euro-fighter Typhoon engines running at dry thrust, this would mean no fuel would need to be burnt inefficiently and other means of power could be used instead of internal combustion. The Euro-fighter Typhoon engine puts out roughly 60kN of thrust for roughly every 2.98 x 10^7W of energy put in [5]. This would mean that around 540 thousand engines would be needed resulting in a power of 1.61 x 10^{13}W needed to run them, assuming the input energy is directly converted to thrust. This in reality couldn't happen as a lot of heat and noise would be produced.

The energy required is equivalent to the energy output of roughly 644 thousand nuclear power plants emitting 25MW each [6], this many facilities wouldn't fit on Cloudbase, as well as adding too much weight for it to stay airborne. This results in the concept of holding Cloudbase at constant altitude to be unsuccessful.

Conclusion

The concept of Cloudbase being able to stay at constant altitude for a prolonged period of time is unfeasible as too much weight would have to be added by a power source and as well as fitting the power source into the structure. Approximately 644 thousand nuclear power plants fuelling 540 thousand engines would need to be used to hold Cloudbase at a constant altitude which seems to be an incredibly unachievable quantity.

References

[1] - Carbon Fibre information page -http://www.carbon-fiber-hood.net/cf-information – Accessed on 02/11/11.

[2] – Space Model Photography - http://www.keithmcneill.pwp.blueyonder.co.uk/3c.html – Accessed on 02/11/11.

[3] – Aircraft Carrier Flight Line Page - http://www.transpixs.com/pages/pcvns.htm – Accessed on 02/11/11.

[4] – Altitude of a commercial jet - http://hypertextbook.com/facts/2003/DanielCheng.shtml – Accessed on 02/11/11.

[5] – Web page on jet propulsion - http://www.bloodhoundssc.com/car/jet_propulsion.cfm – Accessed on 02/11/11.

[6] – Hyperion Nuclear Power Module - http://www.hyperionpowergeneration.com/ – Accessed on 02/11/11.