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P6_8 B-29 Boomer Bomber

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Abstract

In this paper, the feasibility of floating a B-29 bomber crashed at the bottom of Lake Mead with flotation bags (as is done in the game Fallout New Vegas) is discussed, where it is found possible as the buoyant forces overcome the weight. However the mass of nitrogen required to inflate the bags fully is found to be far too high to be realistically carried by one man to the location and sunk to such a depth.

Background

At the bottom of Lake Mead, Nevada, USA, there is a B-29 Bomber plane that crashed in 1948 [1]. In the game Fallout New Vegas, developed by Obsidian Entertainment, set in the year 2281, the plane is miraculously still intact and still submerged in the lake. One of the quests in the game requires you to attach two large flotation devices called deployable ballasts under its wings and bring it to the surface so it may be repaired and reused [2]. In this paper the feasibility of its flotation will be discussed.

Ballast Specification

The flotation devices used are Deployable Ballasts, that were used by NASA to keep test rockets afloat for ease of recovery once they had completed their mission and landed in a body of water [3].

As depicted in Figure 1, there is one ballast placed under each wing, which in their inflated state appear roughly the same diameter as the fuselage of the aircraft and one quarter of its length. This sets the diameter of the ballast at 2.896m and length at 7.544m [4].

Figure 1: An in-game screenshot of the B-29 Bomber floating on the surface of Lake Mead, with the two yellow deployable ballasts between the engines under each wing. [2]

We assume the ballasts to be cylinders and use the equation,

$$V_b = 2\pi r^2 l, \tag{1}$$

to find the volume of the ballasts combined, V_b,where r and l are the radius and length, respectively, of one of the ballasts. The combined volume is found as 99.38m^3.

Ballast Inflation

If it is assumed that the bags are to be fully inflated at the depth of the plane, they would have to have an internal pressure, P, equal to the water pressure, P_w. The water pressure can be found using

$$P_w = \rho g h, \tag{2}$$

where ρ is density of water, g is acceleration due to gravity, and h is the depth. If we set $\rho = 1000\text{kgm}^{-3}$, $g = 9.806\text{ms}^{-2}$, and $h = 42.67\text{m}$ (which is the depth of the bomber according to an article written in 2008 [1]), the water pressure is found to be 418.6kPa. The ideal gas equation rearranged to find the number of moles of gas, n,

$$n = \frac{PV}{RT}, \tag{3}$$

where P is pressure, V is volume, R is the ideal gas constant, and T is temperature. If we substitute $P = P_w$, $V = V_b$, $R = 8.314\text{Jmol}^{-1}\text{K}^{-1}$ and assume a temperature of 283.2K (average temperature of Lake Mead minus a few degrees due to decreased temperature at depth [5]), then the number of moles of gas required to inflate the bag is 17610mol. Typically molecular nitrogen is used in things like airbags as it can be easily produced through chemical reactions, thus we will convert this into a mass of nitrogen using the equation,

$$m_{N_2} = nM, \tag{4}$$

where M is molar mass of nitrogen (28.01gmol^{-1}), and m_{N_2} is the mass of nitrogen which is found as 494.4kg.

Buoyancy Calculation

With the equation,

$$F_g = (m_{N_2} + m_p)g, \tag{5}$$

the downward force due to gravity F_g can be found from combining the mass of nitrogen m_{N_2} and mass of the plane m_p (34tonnes)[6]. This force is found as 338.4kN. The corresponding buoyant force from the inflated bag can also be calculated as the weight of water displaced by it using

$$F_b = -\rho g V, \tag{6}$$

where F_b is the buoyant force and the rest as before. The buoyant force is -971.2kN.

Conclusion

If the buoyant force (Eq. (6)) and weight (Eq. (5)) are combined, the net force would be 632.8kN upwards, thus the plane would indeed be brought to the surface by the bags. To counter this however, 494.4kg of nitrogen is an incredibly large amount of gas, and would not be possible for a single person to carry (as is done in Fallout New Vegas), therefore is incredibly unrealistic. As the buoyant force is so high, there is clearly room to decrease the volume of the bags and thus the mass of gas required, this reduction could be the focus of a future paper.

References

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