Short Communication



# Floatplane vs wig: a very fast approach

**Abstract**

In this short paper a fast comparison between a seaplane and a WIG craft is presented, based on the approximate calculation of the required power at level flight and cruising speed. Two similar capacity generic crafts are used, one seaplane flying at 10000 ft at 300 km/h IAS and the other one flying at 7 m from the sea surface also at 300 km/h. It was found as expected, especially if an improvement is added, that the one flying in ground effect requires less power than the seaplane.

**Keywords:** floatplane, WIG craft, humanitarian purposes, marine hull

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## Introduction

Sea always was an out most important field for commercial, military and humanitarian purposes. Ships are able to transfer a huge amount of payload along great distances, but at slow speeds as compared to aircrafts of any kind. On the other hand, aircrafts are able to carry a much less amount of payload also at great distances but much faster as compared to ships.

Since a lot of main cities are located nearby a body of water (New York for instance), the use of seaplanes was a solution. The main issue of the seaplanes, either with floats or with a marine hull, is a weight and drag penalty as compared to their land based counterparts. The weight penalty is related to the structural strength required to sustain impact loads during takeoff and landing phases, even during operations at protected areas, such as bays of gulfs. The floats and the marine hull, due to their geometry are the source of an aerodynamic drag penalty, which in turn makes the required power or thrust, i.e. the fuel consumption to increase. For all the above reasons, the use of seaplane is actually restricted in lake operations or in short flights between islands (as at the Ionian Sea in Greece for instance).

On the other hand, all existing WIG crafts also have a marine hull, so the problem of weight and drag penalty still exists. Even with this penalty, the commercial exploitation of a WIG craft is cheaper than an existing seaplane of similar performance. This is because a WIG craft has to climb to some meters from the sea surface instead of climb at a cruising altitude, even for a VFR flight. If the weight and drag penalty could be removed, the WIG craft efficiency would be drastically improved.

In this paper, two generic craft are considered: one seaplane with floats and one WIG craft of identical geometry, payload capacity and performance. Both crafts have the same geometry but the WIG craft is equipped with hydrofoils instead of floats. This is an idea already applied to the French G.A. amphibian LISA AKOYA[1] (Figure 1), which actually flies. The advantage of this idea is that the hydrofoils have much less weight and hydrodynamic drag than floats, which accelerates the transition from the displacement mode to the hydroplaning mode during takeoff run. In flight the drag penalty of the hydrofoils is much less than the one corresponding to the floats. The above characteristics alleviate the penalties associated with marine hull or floats. It must be pointed out that in this paper no optimization was made in the case of the WIG craft geometry i.e. no low aspect ratio reversed delta wing or RAM effect enhancement under the wings is considered.

**Figure 1** The hydrofoils of the Lisa Akoya amphibian are clearly shown.

## Results

The common characteristics of both generic crafts considered in this paper are shown in Table 1. In Table 2 are showed the specific characteristics of the floatplane. The float length is taken equal to 80 % of the fuselage length.[2] The WIG craft MTOM is taken to be 15 % less than the one of the floatplane and equal to 5100 kg.

**Table 1** Common characteristics of both crafts

| Fuselage section | Circular |
|---|---|
| Fuselage Length (m) | 17 |
| Fuselage Diameter (m) | 3,4 |
| Wing Span (m) | 16 |
| Wing Surface ($m^2$) | 39 |
| Cruising Speed (IAS, km/h) | 300 |

**Table 2** Specific characteristics of the float plane

| | |
|---|---|
| Mtom (kg) | 6000 |
| Number Of Floats | 2 |
| Float Length (m) | 13,6 |
| Float Frontal Area ($m^2$) | 2,25 |

In Table 3 the total drag coefficient breakdown of both crafts is shown. Lift coefficient for in ground effect flight is calculated according to a semi empirical equation, equation 1:

$$C_{L\,GROUND} = C_L \frac{\left(\frac{8h}{b}\right)^2}{1+\left(\frac{8h}{b}\right)^2} \quad (1)$$

Where: $C_{L\,GROUND}$ and $C_L$ are respectively the lift coefficients in ground effect and at an altitude h and b is the semi span of the craft.

Total drag coefficient breakdown for both crafts

| | FLOATPLANE | WIG |
|---|---|---|
| $C_D$ Parasite | 0,02919 | 0,01841 |
| $C_D$ Induced | 0,0108 | 0,0106 |
| $C_D$ Total | 0,05206 | 0,03736 |
| Total Drag (N) | 8636 | 6264 |
| Req. Power (HP) | 1262 | 670 |

Since a flight at cruising speed is considered here, low angles of attack are assumed. According to,[3] for low angles of attack $C_{D\ PAR} = 1{,}25C_{D\ FRICTION}$. The drag coefficient due to the tail unit, according to,[3] equals to 24 % of the drag coefficient of the fuselage - wing combination. The aerodynamic interference drag coefficient accounts for 5 % of the total drag. The total drag coefficient for the floatplane equals to (equation 2):

$$C_{D\ TOTAL} = \left(\left( C_{D\ FUS+WING} + C_{D\ FLOATS}\right)1{,}24\right)1{,}05 \qquad (2)$$

For the WIG craft the corresponding equation (equation 3) is

$$C_{D\ TOTAL} = \left(1{,}24C_{D\ FUS+WING}\right)\ 1,\ 05 \qquad (3)$$

The flight speed is taken equal to the cruising speed. The floatplane is flying at 10000 ft (3000 m) where the air density equals to 0,909 kg/m$^3$ and the kinematic viscosity coefficient equals to 1,863. 10$^{-5}$ m$^2$/s. The corresponding values for the WIG craft flying at 7 m above the sea surface are 1,225 kg/m$^3$ and 1,46.10$^{-5}$ m$^2$/s respectively. The Oswald coefficient is taken equal to 0,6 in both cases.

## Conclusion

A fast required power evaluation was made between two crafts, one floatplane and one WIG craft. The WIG craft is equipped with hydrofoils instead of marine hull or floats, which permits to keep a smooth geometry. It has been shown that the WIG craft is much less fuel consuming than the floatplane.

## Acknowledgments

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## Conflicts of interest

Authors declare that there is no conflict of interest.

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