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Experimental Investigation of Effect of H Type Tail on Aerodynamic Coefficients of Aircraft Model, With and Without External Fuel Tank

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ABSTRACT

Tail is one of the main components of aircraft to provide stability, control and trim. As yet, different type of tails are designed and produced by manufacturers that each one has specific advantages. Since each tail has its own desired aerodynamic properties; it must stabilize, trim and control the aircraft. In this research, the effect of H type tail on aerodynamic coefficients of an aircraft is investigated experimentally by using a wind tunnel. Results show the variation of aerodynamic coefficients and stability domain with angle of attack of the aircraft model with and without external fuel tank.

KEYWORDS:

H type Tail, Aerodynamic Coefficients, Wind Tunnel

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1- Introduction

Wings are designed to produce the main lift and tails produce lift to control and trim the aircraft. Therefore, if an aircraft is in a situation where its tail produces maximum potential lift, by reaching to stall, dangerous conditions emerge [1].

According to the position of the tail at the rear of the fuselage, wing and engine performance can affect it, especially in the case where the engine is a propeller type. The prop wash of the engine affects the tail performances. H-shaped tail are used for aircrafts which fly at high angle of attack, so that the vertical tail would not be exposed the distributed air flows. High fin at the H-shaped tail enhances the distance of aerodynamic center of tail from the center of longitudinal axis of the aircraft fuselage [2].

A wide variety of research about sustainability and the ability of small aircraft with H-shaped vertical tail, and twin tail are carried out on the Cessna O-2 [3] and by American Defense Science and Technology Agency on F-14 [4] and investigation on couple and uncouple bending torsion modes between two models of twin tail and the tail reaction by Kandil and Sheta [5].

The results of this research show the stable range for the aircraft model by changing the angle of the elevator and ruder. Also with external tank, generated forces and torques show the optimal ranges of parameters.

2- Model

The model used in this test series is one-fifth scale model of a small plane that hits the possibility of installing an external fuel tank under each wing. This model has control surfaces such as aileron, ruder and elevator with the ability to change angles.(Figure 1)

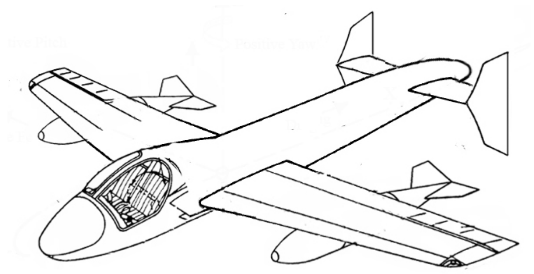

Figure 1. schematic view of aircraft with H-shaped tail and fuel tank.

3- Experimental Program

In order to increase accuracy of the measurement, each case was tested in three velocities at 60, 80 and 90 meters per seconds. It should be noted that the Reynolds number based on chord length wing aircraft models for aerodynamic average flow speeds (60, 80 and 90 m/s) are 530000, 720000 and 800000 and Mach numbers are 0.17 , 0.23 and 0.27, respectively.

In general, there are two errors in measurement, bias and precision. Bias error is related to measuring tools and precision error is related to skill of measurement which is statistical. The errors in lift, drag and pitching moment are 2.3%, 5.7% and 4.1% respectively.

4- Result and Discussion

When two external tanks are installed under the wings, results show the following difference with aircraft without tanks. In this situation the ruder angle is zero. As an example, Figures 4 to 6 show the variation of C_L-α‘ C_D-α and C_m-α. The effects of tanks on aerodynamic coefficient can be categorized as follows; first, C_{Do} increases but Oswald factor decreases. Second, at high attack angle the lift increases clearly and stall is postponed.

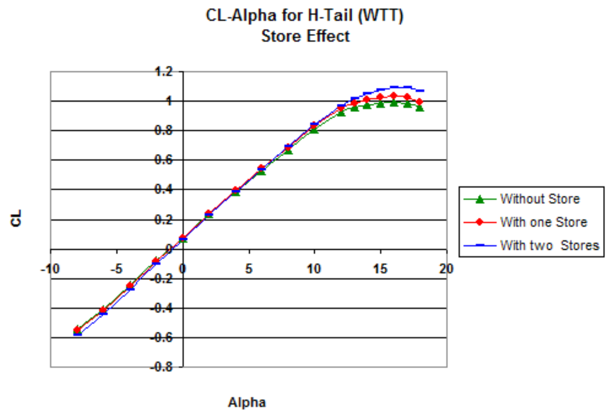

Figure 2. $C_l - \alpha$ with and without external tank

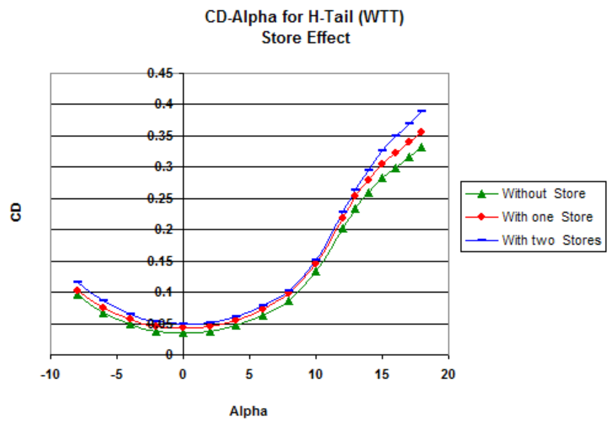

Figure 3. $C_D - \alpha$ with and without external tank

Another test case is the aircraft with two ruder

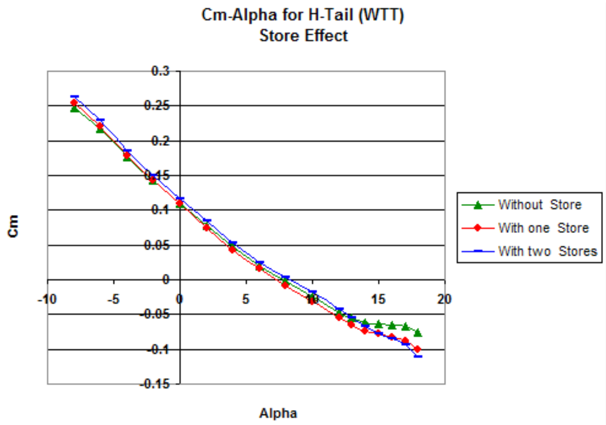

Figure 4. $C_m - \alpha$ **with and without external tank**

angles, +10 and -10 degrees. Figures 7 to 9 show the variation of C_D-α ، C_m-α and C_l-α. The deviation of ruder angle from zero degree gives rise to side force. Therefore, the side force coefficient changes in comparison to the reference angle.

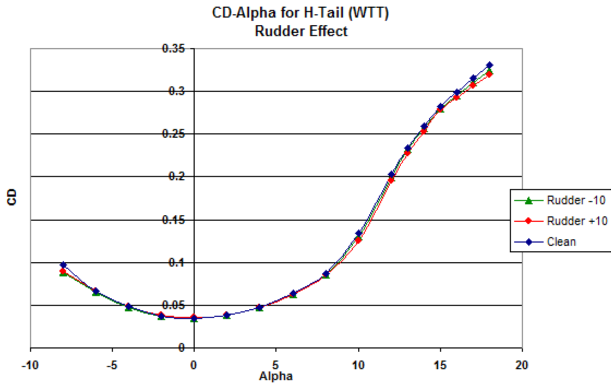

Figure 5. $C_D - \alpha$ **with variable ruder angle**

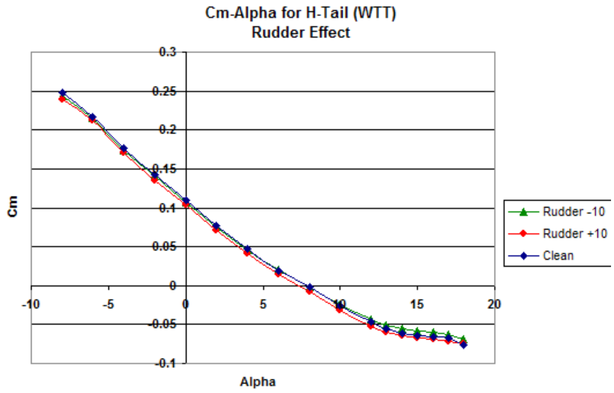

Figure 6. $C_m - \alpha$ **with variable ruder angle**

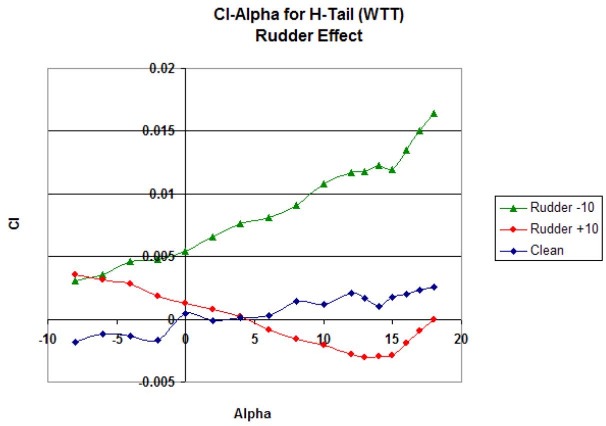

Figure 7. $C_l - \alpha$ **with variable ruder angle**

5- Conclusions

Installation of external tank increases the lift coefficient and postpones the stall. Deviation of ruder angle gives rise on side force. Therefore, creates pitching moment which is dominant.

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