CFD Analysis On Retraction Of Wings In Fighter Aircraft

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Abstract**—***The development of retractable wing technologies for flight regime adaptation has received great interest from Researchers and engineers in the past years. This project deals with developing an aircraft with a retractable wing in a high-performance fighter aircraft that can operate efficiently in multiple flight conditions by changing its external shape. Retractable wing can encompass many aspects of the aircraft design, including the location, shape, area and angle of the wings, tail or fuselage. This new concepts and technology has developed and enhance the overall flight performance of aircraft, to reduce the effect of Drag and Shockwaves, thereby increasing the lift coefficient and reduce the fuel consumption of the fighter aircraft. The development of retractable wing will also increase the maneuverability during flight at supersonic speed.*

Keywords—lift; drag; wing mechanism.

1. INTRODUCTION

The delta-wing is a wing plan form shape in the form of a large swept-back triangle. Its design was first used by Alexander Lippich, a German engineer. The delta wing configuration became a very popular design for high-speed use, and was used nearly exclusively by Convair in the United States and Dassault in France.

In early use, delta-winged aircraft were often found with no other horizontal control surfaces, but most modern versions use a forward canard to control the airflow over the wing during lower altitude flight. Here the other engineers became very interested in his interceptor designs, and started work on a larger version.

The design generated intense interest around the world at that time and very soon, nearly every aircraft design was designed around a delta wing configuration. Examples of delta wing aircraft include the British Airways Concorde, the F-15, F-16, F-22, Convair B-58 Hustler, the Avro Arrow, and the MiG-21.

2. SUPERSONIC AERODYNAMICS

A. Lift

The ultimate object of the aerofoil or aircraft wing is to obtain the lift necessary to keep the airplane in the air. In order to obtain this lift it must be propelled through the air at a define velocity and it

must be set at a definite Angle of Attack to the flow of air past it.

The general formulae to express the Lift Coefficient is given by,

Lift = CL* 1/2 ρV2*Sc

Where, CL- Lift Coefficient, ρ – Air density, kg/m3, V- Air Speed, m/s,S- force,

c – Chord length, m.

B. Drag

Aerodynamic drag generally consists of friction drag and pressure drag. Friction drag is determined almost entirely by the state of the boundary layer (laminar, transition or turbulent), and does not vary greatly between subsonic and supersonic flight. On the other hand, pressure drag increases markedly at supersonic speed due to shock waves generated by the airframe and propulsion system.

The general formulae to express the Drag Coefficient is given by,

Drag = CD* 1/2 ρV2*Sc

Where, CD- Drag Coefficient, ρ – Air density, kg/m3, V- Air Speed, m/s,S- force,

c – Chord length, m.

3. LIFT PRODUCTION MECHANISM

The restrain to a sharp leading edge, allows for the application of numerical methods based on the Euler equations, as the vortices generation along the leading edge is mainly generated by the abrupt change in velocity vector at the leading edge. The contribution to the total vortices by the impingement of the viscous layers from the upper and lower side at the leading edge is negligible.

The high pressure gradients on the surface between the leading edge vortex and the leading edge itself, may furthermore lead to secondary separation of the shear layer underneath the primary vortex. This shear layer rolls up to form the so-called secondary vortex, where the leading edge vortex is subsequently denominated primary vortex.

The rotation of the secondary vortex is opposite to that of the primary vortex. These two vortices to the total vortex lift on a slender, sharp leading edge delta wing can vary depending on the status of the boundary layer at separation. A laminar state leads to a weaker primary and a stronger secondary vortex, compared to the turbulent state.

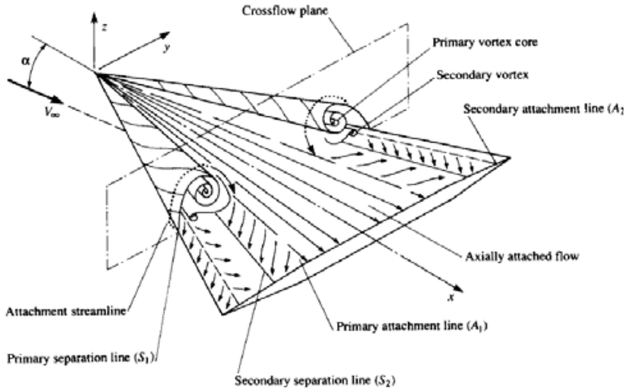


Figure 1: Flow over a Delta Wing at Incidence

4. METHODLOGIES

A.Pneumatics Wing Mechanism

Pneumatics involves the use of pressurized gas to create mechanical motion. The pneumatic concept for the wing and the pneumatic concept for the tail. A pneumatic system meets the system requirements, requires minimal maintenance and is reliable. However, a pneumatic system is expensive, difficult to integrate, exceedingly heavy and complex to operate.

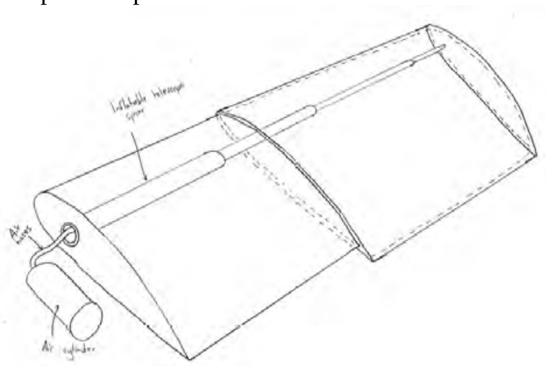


Figure 2: Pneumatics Mechanism

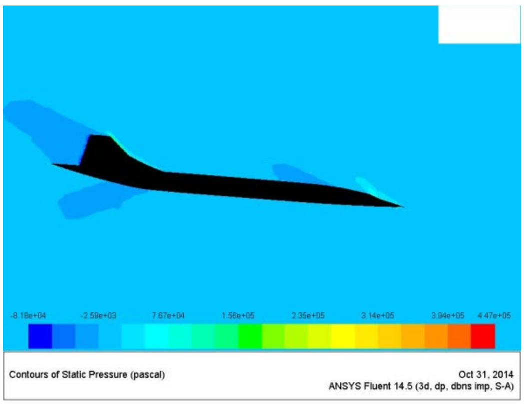
B.Boundary Conditions

1.Inlet is assumed to be mass flow inlet inlet at 400.085 at 1400K.

2.The outlet is assumed to be pressure outlet at 0 pascal.

5. CFD RESULTS

A. Static Pressure



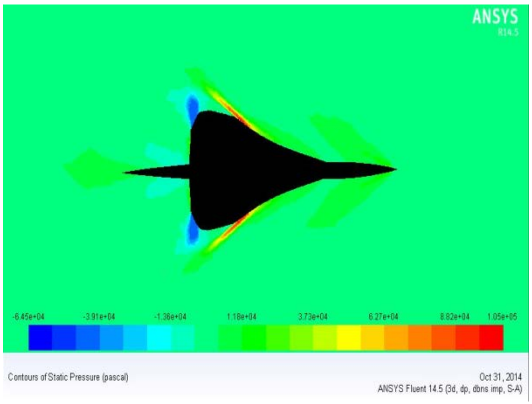


Figure 3: Side View and Top View of Static Pressure

B. Dynamic Pressure

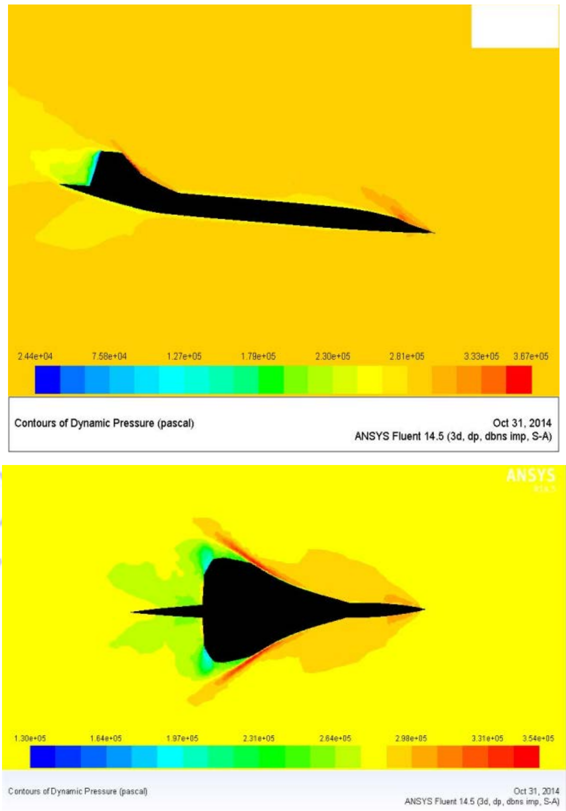
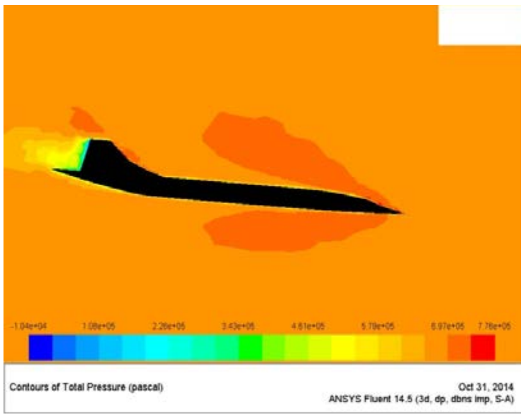


Figure 4 : Side View and Top View of Dynamic Pressure

C. Total Pressure



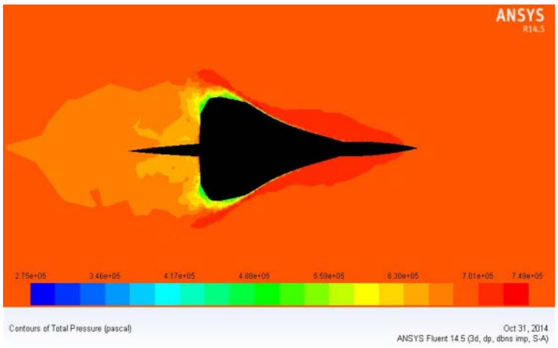


Figure 5: Side View and Top View of Total Pressure.

D. Velocity Countours

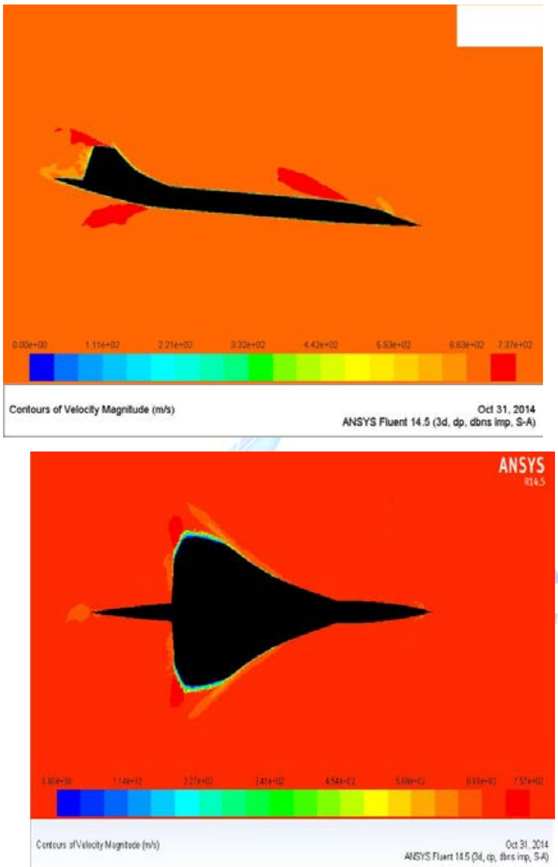


Figure 6: Side View and Top View of Velocity Countour

Based on the CFD analysis that is performed in the FLUENT software and the resultant Static, Dynamic and Total Pressure of the Concorde SST fighter aircraft has been analyzed. Then, the Velocity contours of the Concorde SST fighter aircraft also analyzed. Based on this analysis the resultant Lift and Drag coefficient are calculated for the Concorde SST fighter aircraft and the values of Lift and Drag coefficient are,

- Lift Coefficient: 0.026
- Drag Coefficient: 0.0297

6. CONCLUSION

Thus a novel approach is tried to analyze to get the insight of the flight motion at a Mach number of 2.The lift and drag coefficient values are listed below. In the future work an effort is to be taken to reduce the wing span through either mechanical or hydraulic means. This retracted wing can produce least drag in turn saves more fuel when the flight is in constant altitude.

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