Evolution of Techniques for Reduction of Drag & Stall at The Aircraft.

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***Abstract*- Drag is a mechanical force which reduces the aircraft speed, it is generated by the interaction and touching of the solid body with fluid or airmass. This drag is mainly responsible for high fuel consumption and sometimes stalls the compressor of the engine. In this paper we are studying the evolution of the methods for reducing drag and stall in aircrafts as well as the new upgraded and futuristic technologies to diminish drag and increase efficiency of the engine resulting in reduction of fuel consumption as well as stalling in the engine.**

Though drag is mainly generated by physical contact there is no physical touch between two objects. It acts in a manner that gravitational force and electromagnetic forces act. When drag is generated, the solid body is in touch with fluid or liquid airmass. One aspect must be cleared, if there is no fluid, there is no drag. Drag is due to the differential velocities of solid and liquid objects.

In this paper, we will also study the velocity difference between solid body and liquid body, through which we can comprehend on how to reduce drag in aircraft.

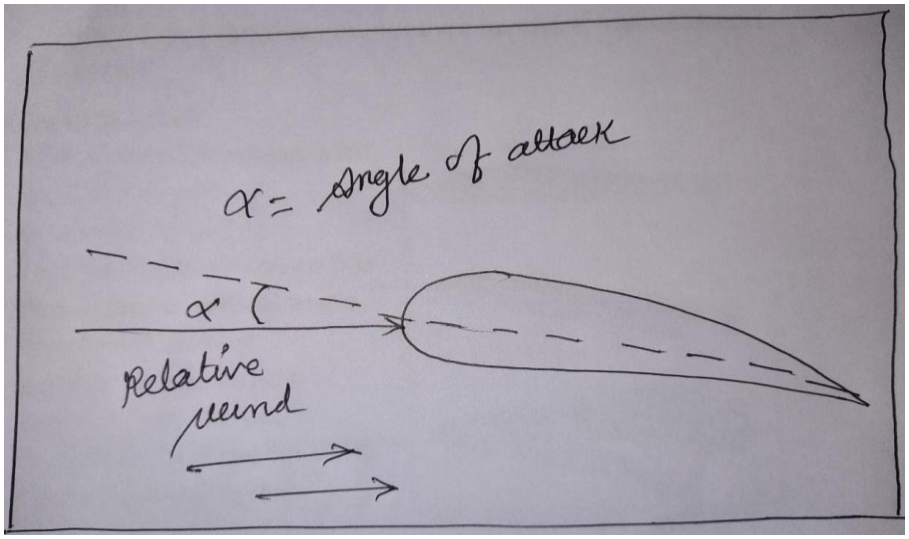
Key words: Stall, Compressor, Drag, Aircraft etc.

INTRODUCTION:

Drag is a mechanical force which reduces the speed of an aircraft. Drag is a force which is also called fluid resistance. It is the force acting in an opposite manner to the relative and dynamic motion of any object moving with the respect to a surrounding fluid.

The existence Of Drag: Between two surfaces or layers (solid – airmass) or between a fluid and solid surface.

Drag is directly proportional to velocity. It means if the velocity increases, then there is high drag and if the velocity of the moving object decreases, then there is low drag. When the airplane moves or lifts upwards, air-molecules are stationary and compositive force which oppose the motion and lift of the aircraft. If motion is high then there is higher drag which is also responsible for stall in the compressor of the engine. Hence the angle of attack is responsible to break down the composite force which is in the form of drag.



If the angle of attack is improper and velocity of the aircraft is not high enough, it will lead to the stalling of aircraft's engine compressor.

Types of Drag:

There are various types of drag, classified based on their cause of composite force of drag.

A) Form Drag or Pressure drag is due of the size and shape of the object. It means that huge aircrafts have higher drag and smaller aircrafts have low drag. However, drag is also directly proportional to the angel of attack and also velocity of the object.
B) Skin Friction or Viscous Drag is because of the friction between fluid body and surface of the solid body.

Skin is the solid body and friction is generated due to surrounding airmass.

If the body is flat then there is higher friction, due to increased surface area, if the body is oval shaped, there is lower friction. Hence the design of the aircrafts and submarines are oval and not be flat due to the direct relationship between friction and surface area of contact.

For aircraft the, Parasite Drag exists, which is the additive drag of both pressure drag and friction drag.

Parasite Drag = Pressure Drag + Friction Drag.

Lift is inversely proportional to drag. If lift increases, drag is low and when life=t decreases, drag is higher. This differs from other resistive forces which are dry Friction force which is independent to the velocity. Drag force always reduces the fluid velocity relative to the solid object in the fluid's path.

A) The lift induced drag appears with the wings and winglet (lifting body) in aviation and the lift induced drag also appears with semi-planning (pulling hulls) for the watercraft.
B) The Wave Drag (Aerodynamic) is caused in the presence of the shock waves which first appears at the subsonic aircraft speeds, when the local velocities become a supersonic. Here the wave drag is only because of the shocking waves due to the wave which passed from supersonic waves. This is especially true in fighter aircrafts. This same phenomenon also happens in case of submarine.
C) Wave Resistance (Ship Hydrodynamics) happens when the solid object is moving on the fluid (fluid dynamics), both have varying velocity which makes the surface waves.
D) The Boat Tail Drag on the aircraft is caused by the angle with which the rest of the fuselage or engine nacelle which would narrow down the engine exhaust diameter.

The Ram Drag.

It is produced when free stream of air is brought inside the aircraft. The jet engine brings air on board and mixes it up with fuel, which is burnt and forms the exhaust in order to product thrust. This inlet airflow or airmass taken by engine through the compressor would produce thrust called as Ram Drag. Ram Drag thrust is called Negative Thrust because it is subtracted from the gross thrust due to inflow of the mass flow of inlet air.

The Angle of Attack & Drag.

The angle of attack is directly proportional to drag and lift. It means if the angle of attack is raised then the lift and drag will be raised. It also depends upon the shape as well as mass of the aircraft. The angle of attack is described as the difference between the wing which is pointing and where the wings are going on.

The angle of attack increases with increasing the drag and lift both. When the angle of attack is high and airflow across the upper surface of the aerofoil becomes detached it would be resulting in a loss of the lift which is called stall.

If the velocity is high then there is higher drag and if the velocity is controlled, then the lift is high and drag is low. If the angle of attack is high and velocity is also high then there is higher possibility of stall. In order to prevent from stall in the compressor and engine one has to fly the aircraft at constant speed and low angle of attack also maintaining the body-air ratio (solid-fluid ratio).

Techniques which are used to reduce drag.

1) Flush – Mounted Rivets.

The microscopic changes to the smooth surface bring a change and increases the drag on the aircraft.

Rivets used by engineers to reduce the drag as soon as possible.

2) Gap Seal – Gap between flight control and wing are the perfect spots for drag creation. Airflow moves from areas of high pressure to the low pressure through these small gaps, a pressure gradient is created, resulting in turbulent airflow and increasing drag.

3) Fairings – when two surfaces meet, interference drag forms behind the trailing edge of these surfaces. This happens on struts, gear and the wing/fuselage connection point.

4) Wheel Pants – the smooth and rounded surfaces allow airflow to move around the struts with less drag created than bare wheels sticking out in the winds.

5) Winglets – which are the wings that generate lift, generate lift perpendicular to the relative winds.

6) Feathering propellers – Feathered Position which allows constant speed. The feathered component, which would be the propeller aligns itself with the wind which would ensure that the least amount of surface area is exposed.

These all would significantly reduce drag, allowing air to flow past the propeller with minimal interference.

The relation between stall & drag.

Stall is mainly for the loss of height and loss of control of the aircraft. When the angle of attack is high or increased the lose of the control or CL would also be raised. When the airflow increase above this critical angle of attack or stall angle then it is very difficult to move the airflow to the inlet of the compressor and ultimately the aircraft's engine gets choked. The main reason behind the Stall is angle of attack and velocity of the aircraft, if the velocity of the aircraft is high when the aircraft is lifting then the compressor gets stalled because of stopping of airflow to the inlet of the Compressor, ultimately resulting in choking of the aircraft engine.

The relation between drag and stall is simple as both are dependent upon the angle of attack and velocity of the drag, if the velocity is not constant then the aircraft gets turbulent due to drag.

CONCLUSION:

Drag must be reduced for saving fuel of the aircraft from higher consumption. If drag is high then the engine must be forced high and higher force of engine would consume more fuel. The consumption of fuel also depends on the velocity of the aircraft at the time of lifting. The compressor will get stalled once the airflow has been stopped, leading to consumption of high fuel. When the aircraft is lifting, the pilot must consider that velocity be constant. Not too high or increasing within the lifting and to maintain the angle of attack while lifting the aircraft.

The reduction of drag is required most for smooth take off of the aircraft. When the solid and liquid fluid with a different velocity interacts with each other, only then drag has been produced. Drag is also responsible for the crash of the aircraft and stalling of the compressor occurs leading to engine failure.

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