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Overview on drag and drag reduction techniques

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ABSTRACT
Drag and drag reduction is one of the main concerns in aviation industry it is the aerodynamic force which affects the performance of the aircraft . Drag is mainly occurreddue to the difference in velocity between the aircraft and the air and this effect the speed of the aircraft and increase the fuel consumption along with that it creates turbulence so, the reduction of aerodynamic drag will help us to achieve our target as well the paper will give an overview about the drag and its type along with the how they generated and affect the aircraft performance furthermore the main techniques we can use for the reduction and all we need to take care about all the techniques during the conceptual design of the aircraft so we can achieve the fuel consumption and enhanced the aircraft performance .

I. INTRODUCTION

Drag is a regarding force which is caused by the viscosity and the motion of the airflow and the airflow is caused by the wing,rotor , fuselage and protruding object generally drag force opposes the thrust and act rearward parallel to the airflow so for reducing the these factors reduction play a very important role it causes friction , turbulence to be reduce and fluid flow and aircraft efficiency to be increased as well.
Classification of drag-

1.Parasite drag

It is a drag which is generated due to the motion of the aircraft. This drag is comprised of all the forces that work to slow down the aircraft movement this affect all the object whether they can generate lift or not for instance an aircraft with a rough surface will create more parasite drag then the smooth surface .
Parasite drag is further classified in three categories –
1.1. Form drag

This is the type of parasite drag which is generated by the aircraft due to its shape and airflow around it the object with large cross-section will create the large form drag so engine cowling and fuselage is play the major role in creating the form drag.

1.2. Interferencedrags

This is the drag which is generate due to the intersection of the airflow between the airframe example – wing andfuselage so if we consider any two particular part of the plane that intersect at any particular point then where these two point of interest occur these two component will generate high velocity across the respective surface of the aircraft .
1.3. Skin friction drag

This drag which is produced due to the friction between the aircraft and the fluid (air) and the rough spots on the body of the aircraft. Drag is producedin the boundary layer condition due to the friction against the surface of the aircraft and the viscosity of the airflow.
2.Induced drag

Induced Drag isan inevitable consequence of lift and is produced by the passageof an aerofoil (e.g. wing or tailplane) through the air. Air flowing over the top of a wing tends to flow inwards because the decreased pressure over the speed surface is less than the pressure outside the wing tip. Below the wing, the air flows outwards because the pressure below thewing is greater than that outside the wing tip. The direct consequence of this, as far as the wing tips are concerned, is that there is a continual spilling of air upwards around the wing tip a phenomenon called ‘tip effect’ or ‘end effect’. One way to appreciate why a high aspect ratio for a wing is better than a low one is that with a high aspect ratio, the proportion of air which moves in this way is reduced and therefore more of it generates lift.The net direction of airflow past the wing is

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downwards. The lift created by the wing - which is by definition atright anglesto the airflow, is therefore inclined slightly backwards. Induced drag and its wing tip vortices are a direct consequence of the creation of lift by the wing. Since the Coefficient of Lift is large when the Angle of Attack is larger, induceddrag is inversely proportional to the squareof the speed whereasallotherdrag is directly proportional to the square of the speed. Induced drag consists of wave drag

2.1 Wavedrag

Wave drag is the type of induced drag which is caused due to the formation of the shock wave around the aircraft and on the surface of the aircraft. Civil aircraft mostly fly under the Mach number of 0.85 and the shock wave generally general in the supersonic airflow

3.Dragreduction

Aerodynamic drag is separated into induced drag or the drag produce due to life and the parasite drag which also includes the skin friction drag and wave drag. There are many majors that created by the to beaerodynamic drag. Drag reduction is the techniques that cause friction to be reduced and fluid flow to increase so the aerodynamic drag affects the speed of the aircraft and that increase the fuelconsumption and we need to carry more fuel and it increase the weight of the aircraft that generate the viscous drag as well and this affect the aircraft performance. So in the aircraft skin – friction drag and the lift induced drag is the main source of the drag no, doubt that drag reduction is a great challenge but we can cope with it and certainly we can improve that using some of the methods like that So that drag reduction will help us to achieving the fuel consumption and help us to achieving the performance and increase the payload and the range of theaircraft there are various methods available for the drag reduction this these fundamental approaches are very convenient and approachable as well the main classical approaches to increase the aircraft performance , fuel consumption and it can utilize by the considering the structural and the overall design of the aircraft

3..1 Induced drag reduction

Interference drag is the drag which is generated due to the mixing of the airflow between the component of the aircraft so to reduce interference drag winglet is the best option. Winglet is the tip of the wing of an aircraft it opposes the drag produce due to the wingtip vortices it make the winglet even more efficient .

As there are various type of the winglet available in aviation industry but out of which blended winglet is best and it enhanced the overall performance of the aircraft as well.

Blended type winglet

Blended winglet are attach to the tip of the wing and gives the smooth curves surface that intends to reduce the drag at the winglet junction of the aircraft and increase the aircraft performance as well .

The main agenda for using this type of wingtip is to reduce induce drag induced drag is the part of the aircraft drag due to the effect generating lift wing produce air motion which is known as circulation as they generate the lift this is characterized flow of the air between the Wingtip and upward flow of air upward of the wingtip as the result of that wing flies in the downwards and the lift slightly tilted towards backward .so the backward component of lift known as the induce drag. As blended winglet have the upward swept extension to the aircraft wing it gives the aspect of a large radius as well as the smooth chord variation in the alteration section of the aircraft . But reduction in the drag required a change in the flow field of the air to reduce the kinetic energy and this method can be used by increasing the span of the wing or by attaching the non planar element that have the similar effect although winglet installed by the retrofit required the significant changes to the wing structure of the aircraft.

Wing span

Wingspan is the total distance from tip of one wing to the other wing of the aircraft as we know wing is one of the most critical part of the aircraft as it generates the lift it plays a significant role in the aircraft. From the potential flow theory so any changes in the changes in the circulation with the span will lean to the trailing vortices . As the result these vortices will downslope flow over and create the wingtip vortices so if wingspan of the aircraft is short the change of circulation will be larger and if the wing span if the aircraft is long the change in circulation will be slow and less vortex will induced in other words more wingspan will have no vortices at all due to no tip out there . If the aspect ratio is higher then the induced drag will produce so due to the effect of the Reynolds number if two aircraft if same wing area are flying at equal speed with same angle of attack as well then the drag coefficient will be higher for the wing that have the smaller chord ad compared to the other aircraft . For the reduction of drag we can extend or differ the wing area of the aircraft by

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changing the span or the chord length of the wing although this is very small variation if it is compared with the variation of the induced drag with changing of wingspan. The induced drag is due to the pressure difference at the chord so it can help us out to decrease so we need to keep that short as the chord is larger the more drag will be induced.

From the mathematical calculation Cd is inversely proportional to the (chord)^0.129 so the cofficent of drag depend on the aspect ratio .so by this we can figure it out the 30% increase in chord length will decrease the drag coefficient by approx. 1%

3.2 parasite drag reduction

Parasite drag is the drag which acts on the aircraft when the aircraft is moving through the air this drag is consist of the form drag and the skin friction drag it's affects all the parts of the aircraft here skin friction drag is the type of the parasite drag and this drag is very difficult and reduction of this drag required various smooth filing on the body of the aircraft which is impossible to make any smooth surfacing object as there is no such object which is perfectly smooth the rough surface on the body of the aircraft will deflect the streamlined flow of the air so on the body of the aircraft it will create resistance to the smooth airflow and the resistance can be reduce by delaying that particular point at which the laminar flow create turbulence and affect the aircraft overall performance .

Laminar flow

Laminar flow is the smooth flow of the air over the fuselage, wings and the body of the aircraft as laminar flow is very important factor during the flight and this is often found in the front of the streamlined body as the disturbance occurred on the smooth slow over the wing section it creates the turbulent and because of the turbulence it affects the performance and due to that drag created. Here the uninterrupted flow of the boundary layer in the aircraft knows as the laminar airfoils.

Laminar flow theory gives out the evolution of the symmetrical airfoils section and that had to be in same curvature on both sides the surface. On the normal airfoils the boundary layer would have interrupted at the very fast speed and as a resultant turbulent flow over the reminder of the airfoils. Induced drag released as drag goes up to the point of the maximum speed at that time and some part of the aircraft would be affected as it creates the drag and this process of formation of the boundary layer form one next to each other. Laminar flow is totally opposite to turbulent flow as laminar flow make them more aerodynamic and efficient so as a result it increases the performance of the aircraft. Laminar flow control by the boundary situation and here distributed sections acts in different ways to achieve the desirable target and conquer the laminar turbulent transaction. So firstly it will decrease the boundary layer thickness after that it will create the velocity profile within the layer and it will increase the boundary layer and help to coop up with the drag as well.

Gap seals

The gaps between the control system and the wings in the Aircraft are the spots of drag creation during flight the flow of the air moves from high pressure area to the low pressure area .the path of the flow is through the control surface gaps between the wing of the aircraft and the fuselage here air through the gaps on the wings creates the turbulence because of that it reduces the efficiency and increase the drag ideally there should be no gaps between the control surface of the aircraft at all by sealing the gaps between the control system of the aircraft and wings can perfect the airfoils structure and reduce the turbulence and disturbance some manufacturer install the gap seal on the aircraft to counter this problem even some manufacturer provide the installation kits for some as well these kits are very easy to install and include the flap- to – fuselage gap seals and the aileron to wing gap seals also and including drag reduction its also increase the cruise speed of the aircraft and Lowe down the stall speed for the during the take- off and the landing.

Aircraft fairing

Aircraft fairing is a type of structure it help us to produce a smooth outline and also help in the reduction of drag .in the Aircraft wherever two surface meet as the result interference drag forms in the behind of trailing edge so this drag generated in many points like struts ,wing and fuselage connection point. fairing help us in the reduction of interference drag as well as it improves the appreance to many types of fairings available for the structure of the aircraft.

Fairing structure are the cover for the gaps between the wings, landing gear legs and other parts of the fuselage as well. So if we can't remove that particular parts as they are very essential part during flight so we can streamline it as well by fitting it with the fairings on the structure of the aircraft so if we can streamline the landing gear legs and tail gear installation then we can see the

increase in the speed of the aircraft and it will also decrease the interference drag .

II. RESULT &DISCUSSION

Aerodynamic force that applies to the aircraft when it's moves in the air is Known as the drag even there are different types of drag acting on it which create due to non laminar flow on the aircraft and the the gaps between the wings and the control system and also occurred due to the difference in velocity between the aircraft and the air this effect the speed of the aircraft and increase the fuel consumption along with that it creates turbulence . Sothe decrease all this problem there are many methods available to reduce it we can use different methods to decrease the reduction but we cant reduce the hundred percent drag from the moving objects in the air but we can minimize it . By using reduction methods suppose there is and change in drag coefficient by 0.01 approximately them it will improve the fuel efficiency by 0.1 mpg so by taking all the parameters into consideration we can reduce the drag and get the better performance of the aircraft and can achieve the high speed .

III. CONCLUSION

From the past few year drag and the drag reduction have been the oriented towards the investigation as well as the main research topics to find out the various modern solutions for the reduction of drag different concept and theories have been presented till now it shows the how drag affects the performance of the aircraft and how alternate methods available to overcome from this main issue so in the paper there is an overview about the drag and the drag reduction techniques how we can use the different types of methods example – laminar flow technology by using this technique we can get the uninterrupted flow of air even innovative wing tip device also help in decreasing drag so by using the he drag reduction we can improve the aircraft performance .

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