Aerodynamic Effect on a Vehicle Profile

Tewodros GebreMichael Bezabh

Lecturer, School of Mechanical and Industrial, Dire Dawa Institute of Technology, Dire Dawa, Ethiopia

ABSTRACT

Aerodynamics is the way air moves around things. The rules of aerodynamics explain how an object is able to move. Anything that moves through air reacts to aerodynamics effect. A well streamlined air will result in the vehicle profile take less drag force resulted in less amount of fuel consumption in day to day activities. There is effect of material selection for fuel in terms of cost, strength, and weight and vehicle speed. During impact of the stream air and the vehicle profile there is an impact in energy of less or high, depending up on material resistance.

Keyword: - *Aerodynamics, streamlined air, vehicle profile, material*

INTRODUCTION

Aerodynamics is the study of how gases interact with moving bodies. Because the gas that we encounter most is air, aerodynamics is primarily concerned with the forces of drag and lift, which are caused by air passing over and around solid bodies. Engineers apply the principles of aerodynamics to the designs of many different things, including buildings and bridges; however, the basic concern is on aircraft and automobiles.

1.1 **Aerodynamic drag**

The basic aerodynamic force that applies to nearly everything that moves through the air is drag. Drag is the force that opposes an aircraft's motion through the air, according to NASA. Drag is generated in the direction the air is moving when it encounters a solid object. In most cases, such as in automobiles and aircraft, drag is undesirable because it takes power to overcome it. There are, however, some cases when drag is beneficial, such as with parachutes. As engines became more powerful and cars became faster, automobile engineers realized that wind resistance significantly hindered their speed. Drag cannot be the only consideration. While lift is desirable for an airplane, it can be dangerous for an automobile. In order to maintain better control for steering and braking, cars are designed so the wind exerts a downward force as their speed increases. However, increasing this downward force increases drag, which in turn increases fuel consumption and limits speed, so these two forces must be carefully balanced.

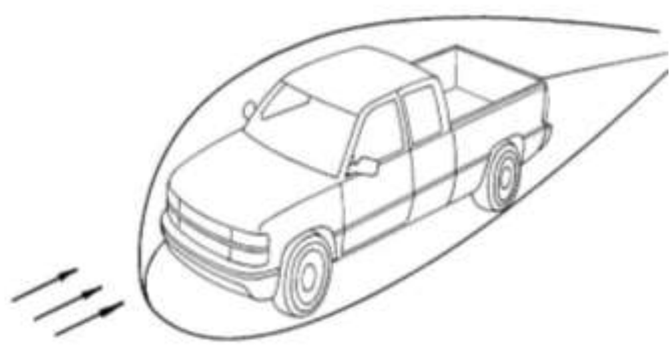

Figure1: Air stream along the vehicle profile

1.2 cross-sections

We know that there are several different areas depending up on cross-section used in the drag equation. The drag is caused by friction between the air and the vehicle profile; a logical choice would be the total surface area of the contacting surface with air stream. If we think of drag as being a resistance to the flow, a more logical choice would be the frontal area of the contacting body which is perpendicular to the flow direction. Since the drag coefficient is determined experimentally, by measuring the drag and measuring the area and performing the necessary math to produce the coefficient, so the use of **area** which can be easily measured is computed in coefficient has a different

2. LITERATURE REVIEW

The flow of air in the vehicle profile crates a KE overall the vehicle body

$$KE= ½ (w/\rho) V^2 = ½ mv^2 = ½ (\rho \times vol) v^2$$

Air has viscosity, due to the internal friction between adjacent layers of air, there is relative air movement, resulting in sliding between adjacent layers of air, and as a result energy is dissipated. When air flows over the vehicle, a thin boundary layer is formed between the main airstreams and the surface. The body then takes place within this boundary layer via the process of shearing of adjacent layers of air. When air flows over any surface, air particles in intimate contact with the surface loosely attach themselves so that relative air velocity at the surface becomes zero. The relative speed of the air layers adjacent to the air surface film will be very slow; however, the next adjacent layer will slide over already moving layers so that its relative speed will be somewhat higher. Hence the relative air velocity further out from the surface rises progressively between air layers until it attains the unrestricted main air stream speed.

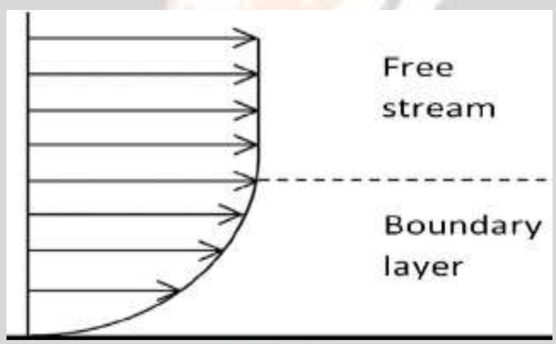

Figure 2: Boundary layer

Pressure drag can be reduced by streamlining any solid form exposed to the air flow, through different cross section , as a result the air to flow smoothly around the front half and part of the rear before flow separation occurs there by reducing the resistance by about half that of the flat plate. The resistance of a section can be further reduced. Even bigger reductions in resistance can be achieved by proportioning the section with a fineness ration of the profile. This gives a flow resistance of roughly over the section of the vehicle profile.

The density of air is the mass per unit volume

Mass =m kg

Volume =v m3

Density= ρ kg/m

Hence

ρ = m/v kg/m^{-3}

m= ρ v (kg/m$^3 \times$ m^3) kg

Therefore the momentum lost by

Air per second =VA m^2

From Newton's second law relate at which the movement of air is changed will give the force exerted on the plate.

Force on plate=ρA v^2

However, the experimental air thrust against a vehicle profile is roughly 0.6 of the calculated =ρA v^2 Force. This considerable 40% error is basically due to the assumption that the air striking the plate is brought to rest and falls away, where in fact most of the air escapes round the edges of the plate and the flow then becomes turbulent. In fact the theoretical air flow force does not agree with the actual experimental force (F) impinging on the plate, but it has been found to be proportional to =ρA v^2

$$F \alpha Av^2$$

Therefore air resistance $F=tAv^2$ where t is the coefficient of proportionality.
The constant t is known as the coefficient of drag, it has no unity and its value will depend upon the shape of the body exposed to the airstreams.

Vehicle Type	Drag Coefficient (t)
Saloon car	0.22-0.4
Sports car	0.28-0.4
Light van	0.35-05
Buses and coaches	0.4-0.8
Articulated trucks	0.55-08
Ridged truck and draw bar trailer	0.70-9

Table 1: drag coefficient for different vehicle

The general tendency for aerodynamic lift and drag coefficients to decreases with increased edge radius or chamfer: experiments carried out showed for a particular car shape how the drag coefficient was reduced from 0.43 to 0.40 with an edge radius/chamfer increasing from zero to 40mm and there be a slightly greater reduction with chamfering than. Rounding the edges; however, beyond 40mm radius there was no further advantage in increasing the edge radius or chamfer.

Wind tunnel in ventilation with different shaped tail models have shown that the minimal drag coefficients were produced with extended tails but the shape would be impractical for design reasons. Conversely if the rear ends tail is greatly exaggerated air mass distributions around a car bodies for various nose profiles.

Any car with a rear end (base) slope surface angle ranging from 90to 50 is generally described as a square back style. Between this angular surfaces inclinations range for a square back car there is very little change in the air flow pattern result on variation in the after body drag. With a parallel sided square back rear end configuration, the whole rear surface area(base area) becomes an almost constant low negative pressure wake region Tapering the rear quarter side and roof of the body and rounding the rear end tends to lower the base pressure. In addition to the base drag, the after body drag will also include the negative drag due to the surrounding inclined the negative drag due to the surrounding inclined surfaces.

Theoretical Analysis

A moving vehicle on a road is resisted by aerodynamic forces, known as air resistance, and road resistance, which is generally teemed as rolling resistance. In addition to these types of resistance, the vehicle has to overcome grade resistance when it moves on a gradient, because the weight of the vehicle is to be liquored through a vehicle is proportional to the total resistance to its motion and the speed.

Power enquired to propel the Vehicle is

P_v = RV /1000 ((1000/ (60X60)) = RV /3600 in kW.

Where R= Ra +Rr, when the vehicle moves along a level ground (road).

R= Ra +Rr +Rg, when the vehicle moves up a gradient.

The engine power required will take into account the losses in transmission, Hence

P_{req} = Pv /t = RV/3600ht, in kW.

Where p_v = power required by the vehicle

p_{req} = the engine power required taking into account the losses in transmission.

V= speed of the vehicle in Km/hr.

t = transmission or drive line efficiency

R= total resistance in Newton

Ra = air resistance in Newton

Rr= rolling resistance in Newton

R_g= grade resistance in N

The resistance offered by air to the movement of a vehicle has influence on the performances well as stability of the vehicle; it is basically depends upon the size and shapes of the vehicle profile and speed $R_a = K_a Av^2$

Where

A= project area

V= speed of the vehicle

K_a = coefficient of air resistance N-hr^2/m^2-km^2

= 0.023 for best streamlined cars

= 0.031 for average cars

CONCLUSION

The automotive industries area crucial sector for transportation, but depending on the speed of an automobile there is a drawback. The basic drawback many based on the cross section or the profile of the vehicles, It is a highly complicated to overcome such case involving in numerous efficient and dependable mechanical properties of the component material. Best aerodynamically profile gives a comfort and protection to passengers as well as fuel economy. As the perpendicular ness of the front faces of the automobile increases the drag force also increases due to the general laws of Newton, which is stress is directly proportional the applied load an inversely to the cross section.

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