Reduction in Fuel Consumption By Reducing Drag Force

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Abstract- *Due to escalation in oil and gas prices continuously the world over the engineers were trying to developed the various method to save the energy and to protect the Global environment, fuel consumption reduction is a primary concern of the modern car manufacturers. Drag reduction is essential for reducing the fuel consumption. Designing a vehicle with a minimized Drag resistance provides economical and performance advantages. Decreased resistance to forward motion allows higher speed for the same power output, or lower power output for the same speed. The shape is an important factor for drag reduction. To design an efficient shape of the car that will offer a low resistance to the forward motion, the most important functional requirement today is the low fuel consumption. The resistance, termed as the drag force (or the drag coefficient in non dimensional terms), is a strong function of the shape of the car. This suggests it is important how the fluid particles move about the car and how fast they move along their path.*

Keywords- Fuel consumption, drag force , tractive force.

I. INTRODUCTION

Due to the global climate change of today the automotive industry invests significantly in reducing the fuel consumption of their products. The companies are, at first hand, pushed by the governments and legislations to reduce the emissions of their vehicles. There are many approaches to reduce the emissions and all of them are of importance for the automotive industry. One way is toswitch to a more environmental friendly fuel or base the power train on other technologies such as electric or hybrid. A lot of work is put into making existing technology more efficient, for example reduction of internal friction, optimize combustion e.g. direct injection, spark timing etc., as well as downsizing and turbo charging of internal combustion engines. However one of the most effective approaches is to reduce thedriving resistance of the vehicle. For a vehicle the following expression can be determine as the required force to propel the vehicle.

Freq = Fd + Fr + Fa + Fg .

Where,

Fd = 1/2 * V2 is the aerodynamic drag force
Fr = force due to rolling resistance
Fa = force required to accelerate the vehicle
Fg = Wsin is the climbing resistance due to gravity.

Hence the mass, the rolling resistance and the aerodynamics are the parameters left for the automotive industry to improve.
Still in general for a typical passenger vehicle the rolling resistance and aero- dynamic resistance are equal in around 100km/h and at highway velocities the aerodynamic drag is the main source of driving resistance whereas the rolling resistance stays more or less constant.

II. OBJECTIVE

The objective of this project is to reduce the fuel consumption by reducing drag force Fuel consumption is one of them a in factors which increase the operating cost of transportation which is directly proportional fuel price. Reduction in stress on vehicle body by reducing drag.

III. METHODOLOGY

The drag force mainly depend upon the projected area by reducing projected area and flow separation fuel consumption is reduced.

IV. ANALYTICAL WORK

Calculation of drag force

Drag force is mainly depends upon frontal projected area and co-efficient of drag. FD=0.5*CD*A*V2 Where,

FD=Drag force,
CD =Co-efficient of drag.
A=Projected area
V=Velocity

The drag force is also term in tractive force which used to calculate fuel consumption

Wheel resistance

FR=fr*mf*g*cosαst
FR=0.12*250*9.81*cos(0)
FR=269.775N

Air resistance(Drag force)

FD=0.5*ρL*CD*A*v^2
FD=0.5*1.199*0.5*0.87096*(16.66)^2
FD=71.83N

Gradient Resistance

Fst=mf*g*sin(Ѳ)
Fst=250*9.81*sin(10)
Fst=425.8721N

Acceleration resistance

Fa=m*a*λ
Fa=250*5.4*1
Fa=1350N
Tractive force Ftotal=269.77+71.83+425.8721+1350= 2118 N

Fuel consumption

FC=bsfc/n_d($F_{tractive)}$)+bsfc*E_{acc}+Gi(t_i+t_b)
E_{acc}=Energy required to run accessories
Gi= Idle fuel consumption per unit time
t_i.t_b=Idle spent time during idling and breaking.

V. LITERATURE SURVEY

Effect of various deflectors on drag reduction for trucks Harun Chowdhurya,*, Bavin Loganathana, IsratMustarya, HazimMoriab, FirozAlama

In this particular paper the main work done by the authors on drag deflector. In the past 20 years the truck's those are manufactured in south Asian countries like Bangladesh, India, and Pakistan. They does not consider the that much effect of drag on vehicle and they just make the vehicle based on their aesthetic due to which the frontal area of vehicle so enlarge and, it invites to flow separation due to which large pressure difference occurs and drag induced on the body. Due to induced drag fuel consumption is reduces and it also affect the environment.

In this project work the various dummy model were constructed and by doing wind tunnel simulation the comparison is to be done on the different dummy model and it's to be founded that the vehicle which are manufactured in this countries having high flow separation and large amount of drag induced on body by providing efficient deflector the flow separation is avoided and fuel economy is also get more better. By replacing these deflectors with an aerodynamic one will not only save fuel consumption but also reduce significant amount of greenhouse gas emission.

Aerodynamic study of Human Powered Vehicles FirozAlama*, Pedro Silvaa, Gary Zimmerb

With the current issues associated with fossil fuels and carbon emissions the need for alternate energy methods is greater than ever. The National Pollutant Inventory (2009-2010) suggests that transport is responsible for 13.5% of Australia's total greenhouse gas emissions.

In this paper by using the HPV (Human Powered Vehicles) the various aerodynamic analyses are done on it, in HPV the frontal area is reduced but due to certain opening like manhole for insertion and opening surrounding to wheel, drag force induced due to mirror and various effects of seating position on drag is to be done on wind tunnel simulation, by doing the simulation the facts comes out that at high level with inclination and medium level with inclination are best for reducing drag force by applying canopy on driver head there is much reduction in drag and also by applying visor in front of driver this also affects the drag but the effects of visor is much at medium speed(70-80 km/ph) and low at lower and high speed. Additionally, the reclining position further backward may provide better physical advantages for endurance as indicated by observation at a race event. As expected, component add-ons and their positions generally increase drag more at low speeds than at high speeds. The magnitude of aerodynamic drag significantly varies with the test vehicles' physical profiles.

Numerical Study on Aerodynamic Drag Reduction of Racing Cars S.M. Rakibul Hassan*, Toukir Islam, Mohammad Ali, Md. Quamrul Islam

Aerodynamic drag is one of the main obstacles to accelerate a solid body when it moves in the air. When a racing car or road vehicle burns fuel to accelerate, drag force pulls it from back to reduce the speed and hence the fuel efficiency is adversely affected. About 50 to 60% of total fuel energy is lost only to overcome this adverse aerodynamic force.

In this paper the aerodynamic analysis is done based on analytical calculation and effect of various speed on drag, as the velocity of moving vehicle increases the stagnation pressure is also increases due to which the pressure at rear of vehicle is much lower as compared to front of vehicle due to which negative suction pressure occur at rear side of vehicle and it pulls the vehicle to back due to which drag induced on body and by providing inclination the back side angle the flow separation is reduces ,another method to avoid the flow separation is by using deflector .

Hence, from above research they concluded thatflow separation is responsible for the major portion of aerodynamic drag of racing cars, it means maintaining streamline shape, reducing surface roughness, fewer joints of the body or avoiding sharp fillets, controlling lift force reduces the drag.

“The Drag busters”
R. Hendrickson, Grumman, with Dino Roman and Dario Rajkovic,

They has given the importance of drag. Drag is the heart of aerodynamic design. The subject is fascinatingly complex. All aerodynamicists secretly hope for negative drag. New design that employ advanced computational aerodynamics methods are needed to achieve vehicles with less drag than current vehicles.

“Aerodynamic shape optimization in automotive Industry” FredriqueMuyl, Laurent Dumas and Vincent Herbert

They has given the important aspects of the aerodynamic shape optimization tool for complex industrial flow. For each evaluation required by the optimizer, The Navier-Strokes equations are solved with a commercial CFD code on an unstructured mesh surrounding the shape to optimise.

VI. CONCLUSION

After studying significant number of paper’s it is found that the main source of producing drag are basically projected area, flow separation, pressure drop along the body.
Hence, to reduce the drag flow separation avoided by making streamline flow along the body and by using various deflectors and avoiding corner and edges.

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