UNIVERSITI TEKNIKAL MALAYSIA MELAKA

EFFECT OF COEFFICIENT DRAG TOWARDS SHARK FIN ANTENNA AND VORTEX GENERATOR WITH NEW CONCEPT DESIGN

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Automotive) with Honours.

by

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2019

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: EFFECT OF COEFFICIENT DRAG TOWARDS SHARK FIN ANTENNA AND VORTEX GENERATOR WITH NEW CONCEPT DESIGN

SESI PENGAJIAN: 2019/2020

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive) with Honours. The member of the supervisory is as follow:

Signature: …….

Supervisor : MOHD HAFIZI BIN ABDUL RAHMAN

ABSTRAK

Matlamat projek ini adalah untuk menyiasat kesan ' Drag Coefficient' bagi 'shark fin antenna' dan 'vortex generator' terhadap kenderaan. Masalah yang dihadapi sewaktu menjalankan projek ini adalah kekangan waktu untuk menghasilkan reka bentuk model 'shark' fin and 'VG'. Analisis bagi projek ini telah disimulasikan secara visual menggunakan perisian Altair ACU Console dan kemudiannya dilihat dalam ACU Field bagi mendapatkan kontur tekanan dan kontur magnitud halaju untuk melihat perubahan pada kenderaan. Hasil simulasi untuk 'Computational Fluid Dynamic' (CFD) disusun menjadi jadual dan diplotkan kepada graf untuk melihat dengan lebih jelas prestasi dan juga menganalisis secara sistematik. Bagi menghasilkan reka bentuk shark fin dan vortex generator pula, perisian CATIA V5R21 digunakan untuk meghasilkan lakaran 3D sebelum dianalisis.

ABSTRACT

The aim of this project is to examine the effects of the' Drag Coefficient' of the' shark fin antenna' and the' vortex generator' on vehicles. The problem I encountered while working on this project was the time constraints to produce the shark fin and' VG' designs. Analyzes for this project were visualized using Altair ACU Console software and then viewed in ACU Field to obtain pressure contours and velocity contours to see vehicle changes. The simulation results for' Computational Fluid Dynamic' (CFD) were collected into tables and plotted on graphs to show more clearly the output and the systematic analysis. CATIA V5R21 software was used to produce 3D sketches before analysis to produce shark fin and vortex generator designs.

DEDICATION

I dedicate this project to God Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and understanding. He has been the source of my strength throughout this program and on His wings only have I soared. I also dedicate this work to my beloved parents that always support me from the beginning until I in last semester. Might not forget my colleague, Syahfendi, who helped me to complete this project regardless of the time and the most person that I inspire Allahyarham Encik Ahmad Taufiq bin Zainal Abidin Thank you, and may Allah bless you all.

ACKNOWLEDGEMENTS

First and foremost, I would like to take this opportunity to express my gratitude to my supervisor, MR Mohd Hafizi Bin Abdul Rahman from the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTEM) for allowing me to carry out this project under his supervision. Without his guidance and help, this project wouldn't have been a reality. I would also like to thank to my fellow friends for always motivating and providing support whenever needed which certainly helped in completing this project. Lastly, thanks to everyone who had been the crucial parts of realization of this project. Not forgetting, my humble apology as it is my beyond my reach personally mentioned those who involved directly or indirectly ono to one.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Increasingly expensive fuel costs and greenhouse gas guarantees to regulate temperature changes around the world make design engineers always look for ways to save oil consumption through vehicle design where drag-force reductions can save a little bit of fuel and increase vehicle efficiencies. The use of more fuel is related with aerodynamic dragging which is higher the coefficient of drag, higher the used of fuel but the efficiency of the car is lower. Therefore, this thesis will explain the effect of drag coefficient towards vehicle by using vortex generator and how it relates with saving fuel consumption and more efficient. The pressure drag and surface friction drag are two main component that can be known for aerodynamic drag where more than half percent of pressure drag highly depends on vehicle body surface because of producing boundary layer separation at rear window surface and formation of wake region behind the vehicle make a higher resistance. Separation location will be determined by the wide of wake region and it affect, it also determines the value of aerodynamic drag that was produced. Based on research that has be done, when the vehicle moves at highway speeds, it contributed about 40% to 50% of the total vehicle fuel consumption because of aerodynamic drag where this value is higher to waste the fuel.

Hence, to redesign overall of body shape vehicle took a long time to produced and higher cost for reduce the aerodynamic drag. So, by focused on location that affecting the drag, engineer design can create device for vehicle where can reducing the aerodynamic drag and offers inexpensive solution to improve fuel efficiency besides providing the aesthetic value for the vehicle. The flow separation control is an important knowledge for fundamental fluid dynamic that should be study where it is use in various application of engineering especially in aerodynamic.There is various method or ways has been research to control the flow separation to know if it can be preventing or can be reduce the effects.

To achieve that, vortex generator can create boundary layer that can reduce the drag at rear vehicle and make it efficient when moving on the road especially at the highway. If the same principles applied into the sedan car, theoretically the drag coefficient (*Cd*) can be reduced by the help of vortex generator.

Figure 1. 1: Roof Vortex Generator

1.2 Background

An aerodynamics is defined as, to study the flow of air around and through the vehicles especially in motion. Aerodynamics developments play an important role in vehicles like cars whereby applying the principle of aerodynamics, it is possible to reduce the coefficient of drag (*Cd*) of vehicles and thus contribute to its fuel efficiency. Most of the research on the benefits of VGs has been conducted in the field of aviation. Some research has also proven that VGs can produce measurable improvements in drag reduction on vehicles.

Additionally, it has potential to reduce the coefficient of drag CD on a vehicle and save fuel, which is the benefits when using VGs on a passenger vehicle. For example, they can help reduce soiling of the rear window. Also, unlike other drag reduction devices currently in the

market such as spoilers, wings and front splitters, VGs have a less prominent appearance on vehicles, while still providing drag reduction benefits. In addition, they are relatively easy to install and remove without leaving any permanent marks on the mounting surface, which can potentially affect the resale value of a vehicle. Finally, they tend to be more cost effective than the alternatives mentioned above.

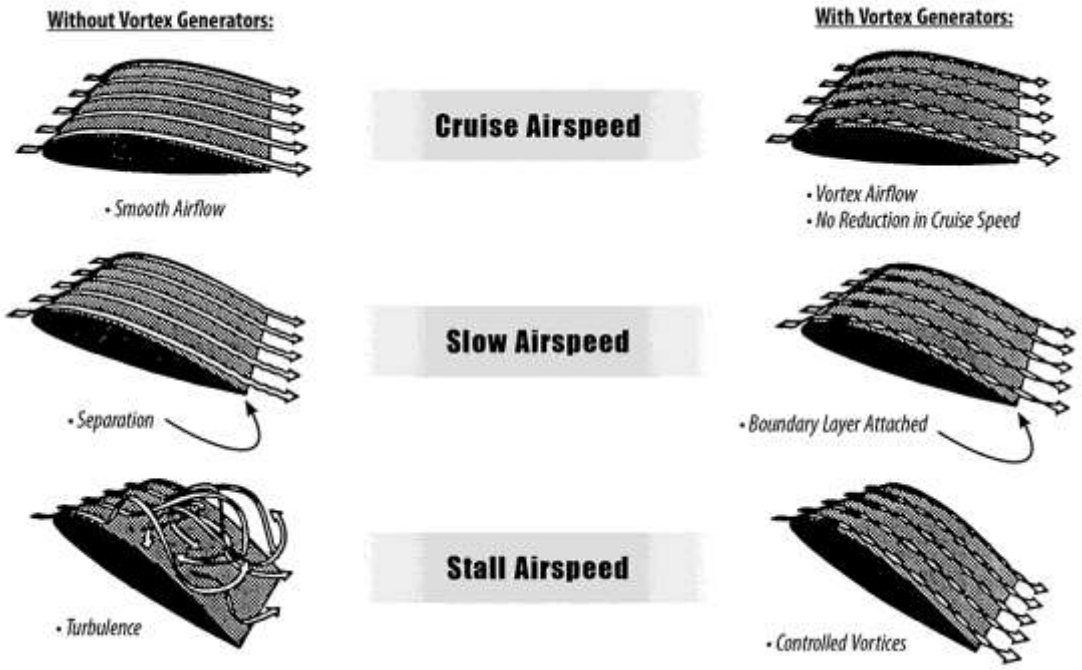

Figure 1. 2: Air Flow with VGs and Without VGs

1.3 Problem Statement

The issue that is happening today in the automotive industry, when drivers drive vehicles at a speed more than 100 km / hour, it cause the air around the vehicle to be high due to the resulting resistance and produce high force which makes the vehicle slow down and consumed more fuel. The process to improve the aerodynamics design of a vehicle required a long research and high cost to redesign the aerodynamics features and it may take many years to develop the desirable aerodynamic design.

This research will be investigating and focus at rear surface of vehicle which turbulence boundary layer will happen at the speed 100km/h and above. This situation will be forming the lift, which can reduce the lift and overall drag. Therefore, buy using vortex generator is the best way to solve this problem. However, it is important to study the of type vortex generator and size of vehicle using.

1.4 Project Objective

i. To investigate the effect of Shark Fin and Vortex Generator towards drag coefficient of vehicle.

ii. To develop the new concept of shark Fin that can apply with Vortex generator.

1.5 Scope

The scope of this design project starts from designing the model of shark fin with vortex generator until the analysis. The overall scope of this project listed below:

i. Design the model of Shark Fin with vortex generator on paper as first sketcher before redesign in computer by using Software CATIA V5.
ii. After the final design is complete, it will be run the analysis of the model by CFD where to get the result either there is any effect on coefficient drag compare with base design that do not use vortex generator and shark fin.
iii. Then, use the SLS 3D printing machine to fabricate the model as final product.
iv. The design should be designed in terms of size and height to ensure its effects on the drag coefficient when mounted on the vehicle.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The purpose in this chapter is to provide the details and information about the effect of Coefficient Drag towards vortex generator and shark fin new design concept that used in automotive industries, the materials use for designing the shark fin, the types of shark fin that common use and the comparison of the design. In this section also show the fabrication process used to produced shark fin design. Before design the vortex generator, it should be understanding about aerodynamic to know how the air flow around the car also the base of lift and drag force on a car.

Lift Coefficient (*Cl*) was defined as acting perpendicular force of the vehicle motion or force that create at rear vehicle because of drag. Normally it was applied on aircraft to create positive lift to help it fly but not for vehicles. Vehicles need negative lift as it required to give downward force for vehicle and this force helps to increased vehicle grip on the road which leads to faster cornering speed. The main factor to vehicle drag is the pressure resistance at the front of vehicle, friction on body surface and the relatively negative pressure left behind the vehicle. (Hu, Liao, Ye, Zhao, & Yan, 2011)

Drag Coefficient and the lift coefficient were expressed as:

$$C_L = \frac{2F_L}{\rho V^2 A}$$

$$C_D = \frac{2F_D}{\rho V^2 A}$$

$C_L = Lift\ coefficient$

$C_D = Coefficient\ of\ Drag$

$F_L = Lift\ force$, N

$F_D = Drag\ Force, N$

$\rho = Air\ Density, Kg/m^3$

A = Frontal Area, m^2

$V^2 = Velocity, m/s$

2.1 History of Shark Fin Antenna

Fin type antennas are shaped like shark fins and go by the trade name of LPA (Low Profile Antenna). When it was first time introduced to the market, the fin type antennas did not have radio functions, and instead served such purposes as mobile communication and GPS. In 2010, fin type antennas with radio functions were introduced, and have been adopted in many vehicles ever since. In contrast to conventional black rod type antennas, they were developed with an emphasis on design as to synchronize with the car body.

These antennas are not prone to theft as they are fully attached to the car body, unlike rod type antennas which could be dismantled. Also, since they are short, drivers did not to worry about bumping their antennas in garages with low ceilings. Currently, composite types of these antennas that support various media in addition to radio are constantly being introduced to the market on the back of the evolving technology.(Baxter, 2016)