

**THE EFFECT OF IRIS VALVE CONCEPT ON AN INTAKE FLOW OF A  
THROTTLE, THROTTLE BODY UNIT**

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**A report submitted**

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## DECLARATION

I declare that this project entitled “The Effect of Iris Valve Concept on an Intake Flow of a Throttle Body, Throttle Body Unit” is the result of my work except as cited in the references.

Signature : .....

Name : .....

Date : .....

## APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the awards of the degree of Bachelor of Mechanical Engineering (Hons).

Signature : .....

Supervisor's Name : .....

Date : .....

## **DEDICATION**

To my beloved mother and father

## **ABSTRACT**

The focus of this project is to design an iris valve concept for throttle body. This iris valve concept does not commonly used in common cars. Generally, a butterfly valve is mostly used in throttle body. However, there is an obstruction of air flow caused by the butterfly valve concept, which effect the performance and the efficiency of the throttle body itself. Three concepts of iris valve are proposed and the best design is selected by using weighted rated method. The selected design is analyzed by using ANSYS software in order to study the airflow or intake flow in throttle body. The study involves the velocity magnitude, pressure magnitude, Reynold's number, pressure drop and head loss for both butterfly valve and iris valve. The result then is compared to butterfly valve concept throttle body. From the result, it is found that iris valve performance is more efficient compared to butterfly valve.

## **ABSTRAK**

Fokus projek ini adalah mereka konsep injap iris untuk badan pendikit dalam kenderaan. Konsep injap iris ini belum biasa diguna pakai pada keretabiasa. Secara amnya, injap rerama kebanyakannya digunakan pada badan pendikit. Walau bagaimanapun, terdapat halangan aliran udara yang disebabkan oleh konsep injap rerama, yang mempengaruhi prestasi dan kecekapan badan pendikit itu sendiri. Lakaran reka bentuk dipilih dengan menggunakan kaedah 'weighted rated'. Tiga konsep injap iris diusulkan dan satu reka bentuk yang terbaik dipilih menggunakan kaedah penilaian pemberat. Reka bentuk yang dipilih akan dianalisis dengan menggunakan perisian ANSYS untuk mengkaji aliran udara atau aliran masuk dalam badan pendikit. Kajian meliputi magnitud halaju, magnitud tekanan, nombor Reynold's, perbezaan tekanan dan kehilangan tenaga. Hasil keputusan kemudiannya dibandingkan dengan konsep injap rerama badan pendikit. Hasil keputusan, boleh disimpulkan bahawa prestasi injap iris lebih cekap berbanding injap rerama.

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## TABLE OF CONTENT

	<b>PAGE</b>
<b>DECLARATION</b>	
<b>DEDICATION</b>	
<b>ABSTRACT</b>	<b>i</b>
<b>ABSTRAK</b>	<b>ii</b>
<b>ACKNOWLEDGEMENTS</b>	<b>iii</b>
<b>TABLE OF CONTENTS</b>	<b>iv</b>
<b>LIST OF TABLES</b>	<b>vii</b>
<b>LIST OF FIGURES</b>	<b>viii</b>
<b>LIST OF APPENDICES</b>	<b>xii</b>
<b>LIST OF ABBREVIATION</b>	<b>xiii</b>
<b>CHAPTER</b>	
<b>1 INTRODUCTION</b>	
1.1 Background of Study	1
1.2 Problem Statement	2
1.3 Objective of Study	3
1.2 Scope of Study	3
<b>2 LITERATURE REVIEW</b>	
2.1 Automobile	4
2.2 Type of Engines	5
2.3 Throttle Body	7
2.4 Components of Throttle Body	
2.4.1 Throttle Plate	10
2.4.2 Throttle Position Sensor (TPS)	11
2.4.3 DC Motor	12
2.4.4 Flange	14
2.4.5 Gears	15
2.4.6 Springs	16
2.5 Type of Valves	17
2.5.1 Butterfly Valve	18
2.5.2 Iris Valve	19



2.5.3	Ball Valve	20
2.5.4	Slider Valve	23
<b>3</b>	<b>METHODOLOGY</b>	
3.1	Project Gantt Chart	26
3.2	Project Flowchart	30
3.3	Project Milestone	32
3.4	Project Timeline	34
3.5	Conceptual Designs	
3.5.1	Conceptual Design I	35
3.5.2	Conceptual Design II	38
3.5.3	Conceptual Design III	40
3.6	Final Design	41
3.7	Selection Method	42
3.8	Designing Process	
3.8.1	Solidworks Drawing	44
3.8.2	ANSYS Simulation (Fluent Fluid Flow)	50
3.8.2.1	Iris Model	50
3.8.2.2	Butterfly Valve	56
<b>4</b>	<b>RESULT AND DISCUSSION</b>	
4.1	Introduction	62
4.2	Velocity	64
4.2.1	Butterfly Valve	64
4.2.2	Iris Valve	74
4.3	Reynold's Number	81
4.4	Pressure	84
4.4.1	Butterfly Valve	84
4.4.2	Iris Valve	94
4.5	Pressure Drop	104
4.6	Head Loss	106

<b>5</b>	<b>CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH</b>	<b>109</b>
	<b>REFERENCES</b>	<b>111</b>
	<b>APPENDICES</b>	<b>119</b>

## LIST OF TABLES

<b>TABLE</b>	<b>TITTLE</b>	<b>PAGE</b>
3.1	Gantt chart for first semester (PSM I)	28
3.2	Gantt chart for second semester (PSM II)	29
3.3	Project Milestone for first semester (PSM I)	33
3.4	Project Milestone for second semester (PSM II)	34
3.5	Components and functionality for design I	37
3.6	Components and functionality for design II	39
3.7	Components and functionality for design III	41
3.8	Weight Rated Method	42
4.1	Equivalent dimensions	63
4.2	Velocity magnitude for butterfly valve and iris valve	81
4.3	Reynold's number for butterfly valve	82
4.4	Reynold's number for iris valve	83
4.5	Pressure magnitude for butterfly valve and iris valve	104
4.6	Pressure drop for butterfly valve and iris valve	106
4.7	Head loss for butterfly valve and iris valve	108

## LIST OF FIGURES

<b>FIGURE</b>	<b>TITTLE</b>	<b>PAGE</b>
2.1	The Spark Ignition (SI) Engine and Compression Ignition (CI) Engine	6
2.2	The throttle body	8
2.3	The throttle plate	10
2.4	The Throttle Position Sensor (TPS)	11
2.5	Direct Current (DC) motor	13
2.6	Flange	15
2.7	Gear in throttle body	16
2.8	Spring	17
2.9	Butterfly valve	18
2.10	Iris valve	20
2.11	Ball valve	21
2.12	Slider valve	24
3.1	Project flowchart for first semester (PSM I)	30
3.2	Project flowchart for second semester (PSM II)	32
3.3	Project timeline for first semester (PSM I)	34
3.4	Project timeline for second semester (PSM II)	35
3.5	Conceptual design I	35

3.6	Conceptual design II	38
3.7	Conceptual design III	40
3.8	Solidworks drawing for blade	44
3.9	Solidworks drawing for rotating plate	45
3.10	Solidworks drawing for pin	46
3.11	Solidworks drawing for base body	47
3.12	Solidworks drawing for handle	48
3.13	Solidworks assembly	49
3.14	Tree outline of geometry design modeler	50
3.15	Geometry design modeler for iris valve with idle condition	50
3.16	Tree outline for mesh	51
3.17	Mesh for iris valve with idle condition	52
3.18	Tree outline for setup	53
3.19	Setup for iris valve with idle condition	53
3.20	Tree outline for solution	54
3.21	Tree outline for results	55
3.22	Tree outline of geometry design modeler	56
3.23	Geometry design modeler for butterfly valve with idle condition	56
3.24	Tree outline for mesh	57
3.25	Mesh for butterfly valve with idle condition	57
3.26	Tree outline for setup	58
3.27	Setup for butterfly valve with idle condition	59
3.28	Tree outline for solution	60
3.29	Tree outline for result	60

4.1	Contour of velocity magnitude for 15 <sup>0</sup> degree butterfly valve	64
4.2	Streamline of velocity magnitude for 15 <sup>0</sup> degree butterfly valve	65
4.3	Contour of velocity magnitude for 30 <sup>0</sup> degree butterfly valve	66
4.4	Streamline of velocity magnitude for 30 <sup>0</sup> degree butterfly valve	67
4.5	Contour of velocity magnitude for 45 <sup>0</sup> degree butterfly valve	68
4.6	Streamline of velocity magnitude for 45 <sup>0</sup> degree butterfly valve	69
4.7	Contour of velocity magnitude for 60 <sup>0</sup> degree butterfly valve	70
4.8	Streamline of velocity magnitude for 60 <sup>0</sup> degree butterfly valve	70
4.9	Contour of velocity magnitude for 75 <sup>0</sup> degree butterfly valve	71
4.10	Streamline of velocity magnitude for 75 <sup>0</sup> degree butterfly valve	72
4.11	Contour of velocity magnitude for 90 <sup>0</sup> degree butterfly valve	73
4.12	Streamline of velocity magnitude for 90 <sup>0</sup> degree butterfly valve	73
4.13	Streamline of velocity magnitude for 5 mm iris valve	74
4.14	Streamline of velocity magnitude for 15 mm iris valve	75
4.15	Streamline of velocity magnitude for 25 mm iris valve	76
4.16	Streamline of velocity magnitude for 35 mm iris valve	77
4.17	Streamline of velocity magnitude for 45 mm iris valve	78
4.18	Streamline of velocity magnitude for 55 mm iris valve	79
4.19	Contour of pressure magnitude for 15 <sup>0</sup> degree butterfly valve	85
4.20	Streamline of pressure magnitude for 15 <sup>0</sup> degree butterfly valve	85
4.21	Contour of pressure magnitude for 30 <sup>0</sup> degree butterfly valve	87
4.22	Streamline of pressure magnitude for 30 <sup>0</sup> degree butterfly valve	87
4.23	Contour of pressure magnitude for 45 <sup>0</sup> degree butterfly valve	88
4.24	Streamline of pressure magnitude for 45 <sup>0</sup> degree butterfly valve	89

4.25	Contour of pressure magnitude for 60 <sup>0</sup> degree butterfly valve	90
4.26	Streamline of pressure magnitude for 60 <sup>0</sup> degree butterfly valve	90
4.27	Contour of pressure magnitude for 75 <sup>0</sup> degree butterfly valve	91
4.28	Streamline of pressure magnitude for 75 <sup>0</sup> degree butterfly valve	92
4.29	Contour of pressure magnitude for 90 <sup>0</sup> degree butterfly valve	93
4.30	Streamline of pressure magnitude for 90 <sup>0</sup> degree butterfly valve	93
4.31	Contour of pressure magnitude for 5 mm iris valve	94
4.32	Streamline of pressure magnitude for 5 mm iris valve	95
4.33	Contour of pressure magnitude for 15 mm iris valve	96
4.34	Streamline of pressure magnitude for 15 mm iris valve	96
4.35	Contour of pressure magnitude for 25 mm iris valve	97
4.36	Streamline of pressure magnitude for 25 mm iris valve	98
4.37	Contour of pressure magnitude for 35 mm iris valve	99
4.38	Streamline of pressure magnitude for 35 mm iris valve	99
4.39	Contour of pressure magnitude for 45 mm iris valve	100
4.40	Streamline of pressure magnitude for 45 mm iris valve	101
4.41	Contour of pressure magnitude for 55 mm iris valve	102
4.42	Streamline of pressure magnitude for 55 mm iris valve	102

## LIST OF APPENDICES

<b>APPENDIX</b>	<b>TITTLE</b>	<b>PAGE</b>
A	Conceptual Design I (Sketch)	119
B	Conceptual Design I (Solidworks)	120
C	Conceptual Design II (Sketch)	121
D	Conceptual Design II (Solidworks)	122
E	Conceptual Design III (Sketch)	123
F	Conceptual Design III (Solidworks)	124
G	Exploded View	125



## LIST OF ABBREVIATIONS

TPS	-	Throttle Position Sensor
ICE	-	Internal Combustion Engine
SI	-	Spark Ignition
CI	-	Compression Ignition
DC	-	Direct Current
AC	-	Alternative Current
$v$	-	Velocity / Flow speed
$P$	-	Pressure
$\Delta P$	-	Pressure drop
$Re$	-	Reynolds number
$\rho$	-	Density of the fluid ( $\text{kg/m}^3$ )
$D$	-	Characteristic of linear dimension / Diameter (m)
$\mu$	-	Dynamic viscosity of the fluid ( $\text{kg/ms}$ )
$P_1$	-	Inlet pressure (Pa)
$P_2$	-	Outlet pressure (Pa)
$g$	-	The local acceleration due to gravity ( $\text{m/s}^2$ )

# CHAPTER 1

## INTRODUCTION

### 1.1 Background of Study

The throttle body is part of the air intake system which controls the amount of air that flows into an engine's combustion chamber. In a throttle body, there is a moving plate which is known as butterfly valve. A throttle body fuel injection system comprises a fuel injector which sprays fuel into an induction bore of circular cross section for mixture with induction air passing through the bore. Mechanical throttle body is suitable for off-road and on-road application as it is mostly used for medium and high-end motorcycles, scooters, ATV and snowmobiles.

Whenever the accelerator or acceleration pedal inside the vehicle is being pushed down, the butterfly valve is open and air flows into the engine. This process controls the speed of the engine as well as the speed of the vehicle. This process then manipulated the amount of airflow into the combustion chamber which causes the vehicle to accelerate.

The throttle body is located between the air filter and the intake manifold which is also containing a pivoting flat valve (butterfly valve) that is used to control the amount of air intake flow into the engine. It is usually attached to or near the mass airflow sensor. The throttle is defined to be the mechanism by which fluid flow is managed by constriction or obstruction.

In general, there are two types of throttle body which are mechanical throttle body and electronic throttle body. Normally, the accelerator pedal motion is mechanically connected to the throttle linkages which rotate the throttle plate. While in cars with electronic throttle control which is also known as drive-by-wire and ride-by-wire in motorcycles, the throttle linkages are being controlled by an electric actuator. In electronic throttle body, the accelerator pedal is connected to a sensor instead of connected to the throttle body itself. The sensor is used to output the signal to the Electronic Control Unit (ECU) for the ECU to determine the throttle opening. The ECU then controls the operation of the valve.

The electronic throttle body is just like a typical throttle body. There are an electronic servomotor or stepper motor and a Throttle Position Sensor (TPS) instead of cables in the throttle body. The electronic throttle body consists of three main components which are a module at the accelerator pedal, a throttle valve that is controlled by a servo or electric motor and a powertrain or engine control module.

## **1.2 Problem Statement**

In an idle throttle body, the internal flow is normally stuck or blocked as there is an obstruction in butterfly valve as a vertical pole has been put at the center of the valve. If there is obstruction blocked the air flow, there are many recirculation occurred in the flow. The airflow transfer into the combustion chamber will be less efficient. This condition effect the engine speed. In short, the speed of engine will be reduced if there is any obstruction occurred in air flow in throttle body. In order to overcome this problem, Iris valve concept is introduced. Iris valve concept does not have any obstruction for the airflow. Throughout this study, the butterfly valve concept and Iris valve concept have been compared for idle throttle, partial throttle, and full throttle, in term of air flow pattern including the velocity magnitude, pressure magnitude, Reynold's number, pressure drop and head loss. Iris valve

concept can be compared to butterfly valve in terms of behavior and which one provides better performance.

### **1.3 Objectives of Study**

- To design a throttle body unit using Iris valve concept using Solidworks software.
- To study the air flow pattern through the valve for idle throttle, partial throttle and full throttle using ANSYS software.
- To compare the result with conventional throttle body.

### **1.4 Scope of Study**

1. The design of Iris valve and throttle body are drawn using SolidWorks software.
2. The model used as a benchmark for this study is Flow Dimension Proton Persona 1.6 Throttle Body.
3. The design of throttle body is analyzed using Ansys software.
4. The design does not involve in design packaging for real application.
5. No material is considered on designing process.
6. No cost is considered for study purposes.
7. No temperature is considered during the study.
8. No manufacturing process is considered for the study.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Automobile

An automobile means a privately-owned self-propelled road vehicle, which is usually consists of seat one to eight people, four wheels and an internal combustion engine. The English word 'car' origin from Latin's word, which means wheeled vehicle. 'Automobile' is generally a classical compound word, which is 'auto' is derived from Ancient Greek, means 'self'. While 'mobile' is derived from Latin's word, which means 'movable'. According to Jackson Nyamwange, in the order word, an automobile or car is a wheeled vehicle which carries its own motor. This automobile is used to carry and transport passengers and goods (Jackson, 2014). This kind of automobile or car usually used as transportation. The car is most primarily run on the road and commonly used to transport people instead of transporting goods.

According to some Internet resources, an automobile or car is most widely used came in 20<sup>th</sup> century. It is applied to replace animal-drawn carriages and existing carts. There are many additional features and controls, such as air ventilation systems, rear-reversing cameras, in-car entertainment, and navigation systems, have been added to vehicles in order to improvise and meet the customer comfort. The driving control systems, control system for parking, and lights have been added to the vehicle in order to improve the reliability of the vehicle instead of making the vehicle easier to operate (Anonymous, n.d).

Automobile normally powered by steam or electricity. Most of the car propelled by internal combustion engine in 2010s. This car is fuelled by the combustion of fossil fuels or petrol. Meanwhile, the electric cars became commercially available in the 2000s. Generally, the electric car concept is powered by electricity. Existences of vehicles bring many benefits to the people, including on-demand transportation and mobility (Anonymous, n.d). This type of vehicles also provides independence and convenience for the customer or user. On top of that, the commercials of the vehicle bring advantage to the economy by providing societal benefits in order to obtain occupations and gain currencies, especially from the automobile industries. Other than that, people can comfortably travel from one place to another place including far-reaching place within short period.

## **2.2 Type of Engines**

Internal combustion engine contains the combustion of fuel and oxidizer such as air. This type of combustion usually takes place within a confined space which is known as a combustion chamber (Anonymous, 2008). Gases with high temperature and pressure are produced as the expansion of exothermic reaction occurred. Internal combustion engine is basically defined as useful work as gases with high temperature perform expansion process in order to move the solid parts of the engine.

Stearns engine is a type of an external combustion engine. It is basically used to heat a separate working fluid into work by moving a turbine or piston. Fuel, which contains chemical energy is converted into mechanical energy by operating the combustion process in engine itself. Figure 1 below shows the typical Spark Ignition (SI) engine and Compression Ignition (CI) engine, which are most widely applied in automotive industries.

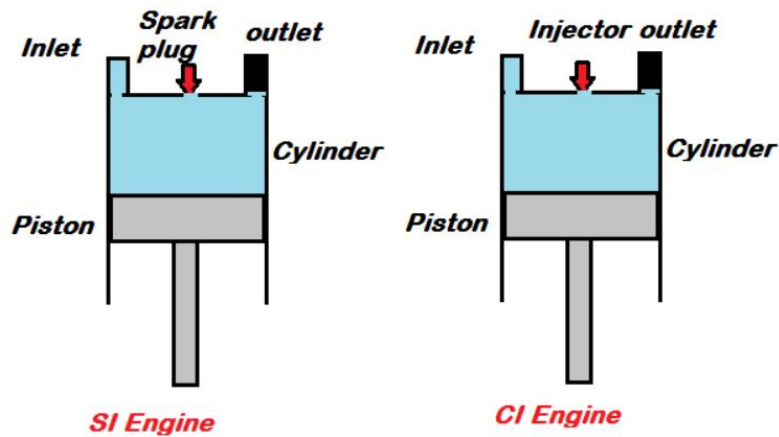


Figure 1: The Spark Ignition (SI) Engine and Compression Ignition (CI) Engine

According to some Internet resources, the internal combustion engine is known as atmospheric engines. Basically, there are two types of engines used in automobile industries, which are Spark Ignition Internal Combustion Engine (SI) and Compression Ignition Internal Combustion Engine (CI). Spark Ignition Internal Combustion Engine (SI) and Compression Ignition Internal Combustion Engine (CI) are known as Petrol cycle and Diesel cycle, respectively. Another common example of Spark Ignition (SI) engine are Otto engines and gasoline engines. For Spark Ignition (SI) Engine, the liquid fuel is atomised, vaporized and the mixed with air in correct proportion. The process takes place and the mixtures are taken to the engine cylinder through the intake manifolds. The Spark Ignition (SI) is basically the ignition of fuel-air mixture caused by an electric spark while Compression Ignition (CI) is the ignition of only the liquid fuel into the cylinder under high pressure (Anonymous, n.d).

Like gasoline, a Diesel type internal combustion engine functioned by burning or combusting the mixture of fuel and air within the cylinders. Both gasoline and Diesel engines are reciprocating engines that convert chemical energy in fuel to mechanical energy. The conversion of chemical energy occurred as the pistons are driven to move laterally in two directions. The pistons, which are connected to the crankshaft of the engine, act to convert the linear motion into rotary motion for propelling the wheels of the vehicle. As the fuel and

the oxygen from the air reacts chemically, a series of small explosions or combustion released energy (Anonymous, n.d).

However, Diesel type differs from gasoline type for combustion process. For Diesel type engine, fuel ignites on its own while for gasoline, the combustion starts with sparks from the spark plugs. With the same horsepower, Diesel type engine is heavier than gasoline type engine. Diesel type engines normally consist of stronger materials in order to withstand and support the greater dynamic forces produced by higher combustion pressure.

There are two types of engine principle which are Two-Stroke type and Four-Stroke type. Two-Stroke type basically consisted of two strokes completing only one revolution of the crankshaft. The two strokes type involved are the compression and power-expansion strokes. Four-Stroke type cycle engine basically consisted of four strokes which are intake or suction, compression, power-expansion, and exhaust strokes. For Two-Stroke type, end of combustion strokes and the beginning of the compression strokes occur simultaneously. This process is called as a first stroke while the second strokes involved the intake and exhaust strokes, which is also occur simultaneously (Sorusbay, 1995).

### **2.3 Throttle Body**

In general, the throttle is defined as a mechanism that manages the flow of fluid, air, or any substances through the obstruction into the intake manifold of an engine. The throttle valve in an intake system functioned to monitor the flow of fluid, air, or any substances into the engine. According to Mustapha Bordjane and David Chalet in 2015, the throttle valve acts to allow the flow of the air from one end of the manifold. Meanwhile, the air then is drawn out from the other end through the cylinder. The air passes through a filter and then regulating by a throttle valve. The throttle body of an internal combustion engine generally