I declare that I have been done reading this report
and in my opinion, this report fulfill the condition in all
aspect that must be in project writing as need in partial fulfillment
for Bachelor of Mechanical Engineering (Thermal – Fluid)

Signature	:	……………………………
Supervisor Name	:	En.Safarudin Gazali Herawan
Date	:	……………………………

INVESTIGATION OF SHAFT SPEED CAUSE BY TURBO SYSTEM IN VEHICLES

CHE MOHD ELYAS BIN CHE OMAR

This report had been done
in partial fulfillment for
Bachelor of Mechanical Engineering (Thermal – Fluid)

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

MAY 2010

"I declare that this report had been done originally from me except some of them where I have been explain each one of them with its sources"

Signature : ……………………

Name : Che Mohd Elyas Bin Che Omar

Date : …………………….

Especially to my beloved parents,

My respectfully lecturers,

Also my faithfully friends,

Your prayers always with me every way that I went…

ACKNOWLEDGEMENT

First of all, I would like to thank to our God Allah S.W.T. because with His permission I can finish a "Projek Sarjana Muda" (PSM) to complete the requirement for graduation.

Secondly, I would like to thank to my supervisor, Mr Safarudin Gazali Herawan, Lecturer of Mechanical Engineering Faculty in UTem (Thermal – Fluid), for giving me the opportunity doing my PSM under his supervision. I also would like to thank to him for teaching me more in mechanical engineering subjects especially works for my topic which is effect of turbo system in the automotive exhaust gas system. He also guided me and given advised based on his experience during my progress of this project. I have learned many new things from him.

I would also like to thank to all of lab assistant that involved in this project. I would appreciate all their effort to make this project happen. Thank also for their cooperation with me since the progress of this project for using any of their lab for my experiments.

I would also like to thank to all my friends especially class of 4 BMCT (G2) for being kind and helpful to me until the project done. They have been helping me doing research for this project.

Last but not least, thank to my beloved parents who had give me encouragement until this project done. I hope that this report will be a guide and reference to other students and researchers soon.

ABSTRACT

In vehicles system, there are many types of energy losses such as engine losses, aerodynamic drag and others. In fact, is only 15 percent of the energy from the fuel from tank is used to move car down the road. Such as in exhaust system, the temperature at the exhaust manifold can reach around 900 ºC and this heat will lose to atmosphere. So, the recovery system must be created to solve this problem. One of the systems is “Turbo System” which uses the energy losses from the exhaust system by convert to electric energy. For this project, the installation of turbo system just until turbine shaft which the installation of alternator will continue for the next project. In this system, the energy that flow to the exhaust will rotate the turbine and turbine shaft. The project is to investigate the speed of shaft causes by turbo system in vehicles. The project was also conducted to investigate the pressure and temperature effect on the turbo system.

ABSTRAK

Di dalam sistem kenderaan, terdapat banyak jenis kehilangan tenaga yang berlaku seperti pada enjin, heretan aerodinamik dan sebagainya. Fakta ada menyebut, hanya 15 peratus tenaga daripada bahan api di dalam tangki digunakan untuk menggerakkan kenderaan di jalan raya . Seperti contoh di dalam system ekzos, suhu dalam kebuk ekzos boleh mencapai sehingga 900 ºC and haba ini akan hilang ke atmosfera. Oleh itu, satu sistem pemulihan perlu diwujudkan untuk menyelesaikan masalah ini. Salah satu sistem yang boleh digunakan iaitu "Sistem Turbo" di mana ia menggunakan semula tenaga yang hilang daripada system ekzos dengan menukarkan kepada tenaga elektrik. Bagi projek ini, pemasangan komponen sistem turbo hanyalah sampai kepada aci turbin yang mana pemasangan pengecas elektrik akan disambung pada projek yang seterusnya. Di dalam sistem ini, aliran tenaga yang melalui ekzos akan memutarkan turbin dan aci turbin. Projek ini dijalankan untuk menyiasat kelajuan aci turbin yang disebabkan oleh sistem turbo pada kenderaan. Projek ini juga adalah untuk menyiasat tekanan dan suhu pada sistem turbo yang telah dipasang.

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LIST OF SYMBOLS

T	=	Temperature, Celsius ºC / Fahrenheit, F
n	=	number of revolution per cycle
V_d	=	displacement volume (m^3)
W_b	=	brake work of one revolution
N	=	Engine speed (rev/s)
T	=	Torque (N.m)
w	=	Power (watt)

CHAPTER I

INTRODUCTION

1.1 Project background

Turbocharger are the recovery system for this wasted energy by using the waste energy that flow through the exhaust system and been used again in engine performance. The turbocharger is bolted to the exhaust manifold of the engine and uses the exhaust flow from the engine to spin a turbine. The turbine is connected by a shaft to the compressor, which the compressor will compress the air going into the pistons. For this project, a recovery system has been discovering called "Turbo System". This system also uses the same concept with turbocharger which uses the flow of wasted energy from exhaust system to rotate the turbine shaft in this system. The function of turbine shaft is to rotate the alternator to produce electric current. But, the installation of turbo system in this project just until turbine shaft which is not cover until an alternator. This system has been installed to the 4A-GE engine that used to investigation about turbine shaft speed which to investigate how much the turbine shaft can rotate in this system. This project also to investigate the pressure and temperature in this system which the pressure and temperature is related with shaft speed performance.

1.2 Project significant

The significant of this project is developing a system recovery for the wasted energy in vehicles. This wasted energy has a potential to increase the efficiency of the engine and also get the better performance of the engine. From this recovery system, the electric energy can be produced for the future function such in hybrid car or used for electrical components in the car. The electric energy can be stored in one device such as battery and can be use for multi-function in vehicles that used electric as their energy source. So, it become suffer lose if this wasted energy did not been used for improvement and this project is very significant to the new era of automobile in our country with the increasing of petroleum price.

1.3 Objective

1. To investigate pressure, temperature, and shaft speed from turbo system in vehicle due to recovery of the wasted energy at exhaust manifold.
2. To study sensor contribution of throttle body and load cell.

1.4 Scope

In this research, the experimental for project must be developed and the results of the experiments analyzed. Below are the scopes for this project:

1. Installation of turbo system components.
2. Conduct experiments to determine shaft speed, pressure and temperature.
3. Analysis of data from the experiment.

1.5 Problem Statement

Generally, energy losses occur from engine to the exhaust system in vehicles which the waste energy that flow through the exhaust system is not used as recovery waste energy such as to generate energy and others. Turbocharger and supercharger are the recovery system for this wasted energy by using the waste energy that flow through the exhaust system and been used again in engine performance. Therefore, one system from turbocharger concept called 'Turbo System' was developed by using the rotational of the turbine in producing current by using an alternator. Main target of this system is to rotate the alternator to produce more current and the current can be store for the other function in the vehicle. The current stored can be as a future function such as hybrid vehicle or something else. However, the investigation for this system must be carried out with data and analysis to see the turbine performance especially turbine shaft speed. The investigation is required to determine how much shaft speed that can be produced from the turbine in turbo system, the pressure used to rotate the turbine blade and also the temperature value in this system.

CHAPTER II

LITERATURE REVIEW

2.1 Turbocharger and Supercharger mechanism

Turbocharger and Supercharger mechanism are the same system, which is to increase the air volume into the combustion chamber.

2.1.1 Supercharger Mechanism

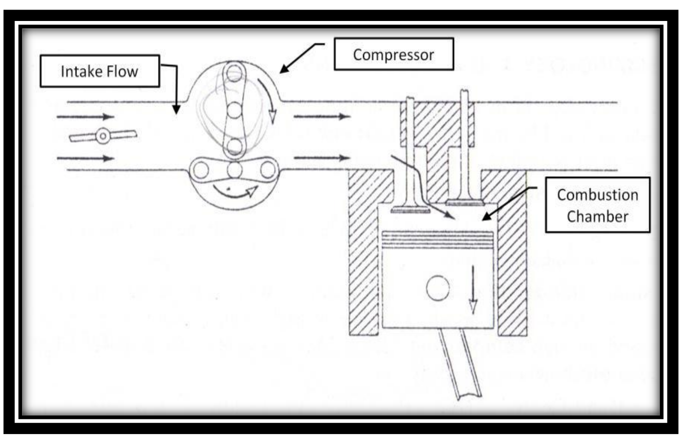

Figure 2.1: Supercharger used to increase inlet air pressure to engine.
(Source: www.engineering fundamentals of the internal combustion engine)

Superchargers are mechanically driven directly from the engine crankshaft and the speed of engine will running the compressor with the same speed. It can be powered mechanically by a belt, gear, shaft, or chain connected to the engine's crankshaft. The power to drive the compressor is a parasitic load on the engine output, and this is the major disadvantages compared to the turbocharger system. This is because, if the power output of the engine low, it cannot run the compressor with the optimum speed.

A major advantages of the supercharger us very quick response to throttle changes. Being mechanically linked to the crankshaft, any engine speed change is immediately transferred to the compressor. Nowadays, people have modified this system to be more efficient by running the compressor by using the turbine known as turbocharger system. So, the compressor did not add any load to engine.

2.1.2 Turbocharger Mechanism

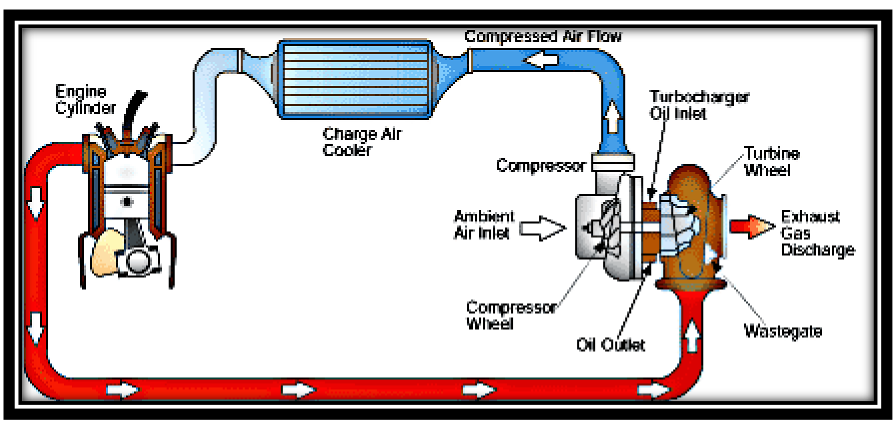

Figure 2.2: Compressor used to increase air pressure to engine.

(Source: **www.google.com**)

The turbocharger is bolted to the exhaust manifold of the engine. The exhaust from the cylinders spins the turbine, which works like a gas turbine engine. The turbine is connected by a shaft to the compressor, which is located between the air filter and the intake manifold. The compressor pressurizes the air going into the pistons. The exhaust from the cylinders passes through the turbine blades, causing the turbine to spin. The more exhaust that goes through the blades, the faster they spin.

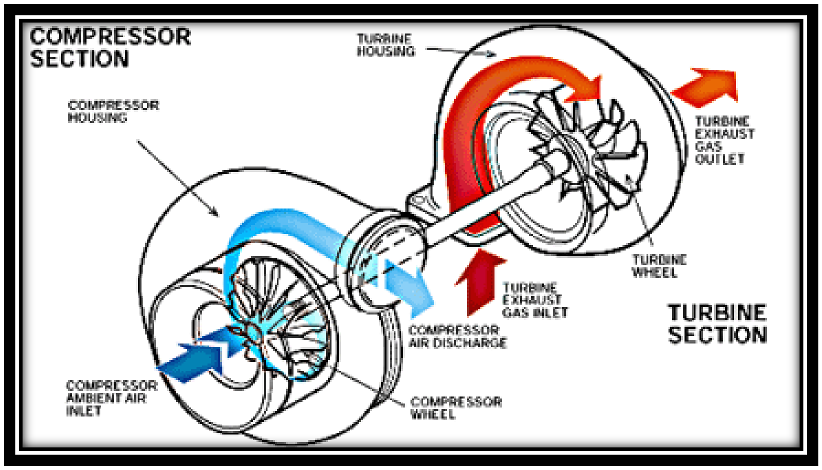

Figure 2.3: Compressor and turbine section

(Source: www.google.com)

On the other end of the shaft that the turbine is attached to, the compressor pumps air into the cylinders. The compressor is a type of centrifugal pump; it draws air in at the center of its blades and flings it outward as it spins. In order to handle speeds of up to 150,000 rpm, the turbine shaft has to be supported very carefully. Most bearings would explode at speeds like this, so most turbochargers use a fluid bearing. This type of bearing supports the shaft on a thin layer of oil that is constantly pumped around the shaft. This serves two purposes: It cools the shaft and some of the other turbocharger parts, and it allows the shaft to spin without much friction. There are many tradeoffs involved in designing a turbocharger for an engine.

However, a turbocharger differs in that the compressor is powered by a turbine driven by the engine's own exhaust gases. From Figure 2.4, we can see the different performance of the engine with and without turbocharger for 1982 Datsun 280ZX engine according power and torque graph versus revolution per minutes. From the graph, it shows that the performance of the turbocharger engine is better than the natural aspirated (without turbocharger).

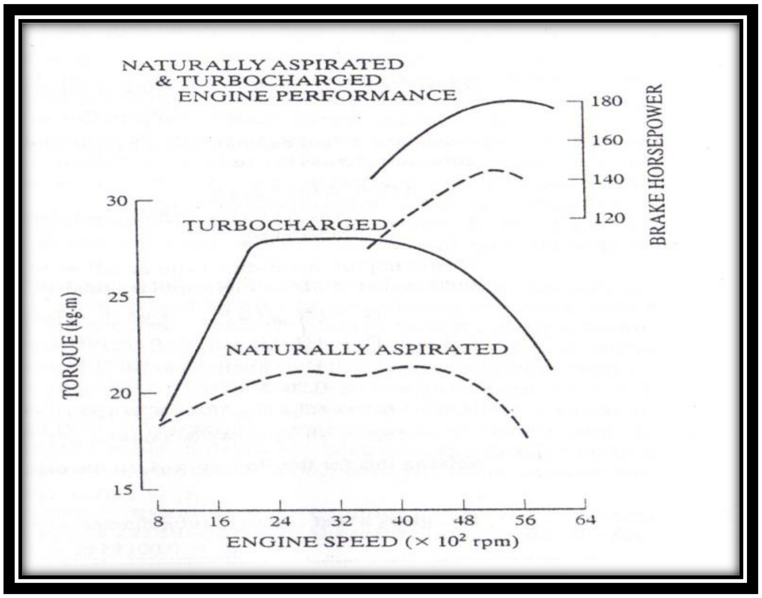

Figure 2.4: Power and torque curves of 1982 Datsun 280ZX

(Source: Pulkrabek, 2004)

2.1.3 Turbocharger bearing system

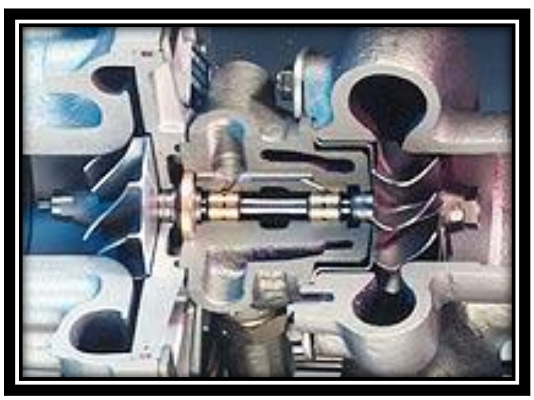

Figure 2.5: Turbocharger bearing system (cut-away model)

(Source: www.turbodriven.com)

The turbocharger shaft and turbine wheel assembly rotates at speeds up to 300,000 rpm. Turbocharger life should correspond to that of the engine, which could be

1,000,000 km for a commercial vehicle. Only sleeve bearings specially designed for turbochargers can meet these high requirements at a reasonable cost.

Radial bearing system

With a sleeve bearing, the shaft turns without friction on an oil film in the sleeve bearing bushing. For the turbocharger, the oil supply comes from the engine oil circuit. The bearing system is designed such that brass floating bushings, rotating at about half shaft speed, are situated between the stationary centre housing and the rotating shaft. This allows these high speed bearings to be adapted such that there is no metal contact between shaft and bearings at any of the operating points. Besides the lubricating function, the oil film in the bearing clearances also has a damping function, which contributes to the stability of the shaft and turbine wheel assembly. The hydrodynamic load-carrying capacity and the bearing damping characteristics are optimised by the clearances. The lubricating oil thickness for the inner clearances is therefore selected with respect to the bearing strength, whereas the outer clearances are designed with regard to the bearing damping. The bearing clearances are only a few hundredths of a millimetre.

The one-piece bearing system is a special form of a sleeve bearing system. The shaft turns within a stationary bushing, which is oil scavenged from the outside. The outer bearing clearance can be designed specifically for the bearing damping, as no rotation takes place.

i. Axial-thrust bearing system

Neither the fully floating bushing bearings nor the single-piece fixed floating bushing bearing system support forces in axial direction. As the gas forces acting on the compressor and turbine wheels in axial direction are of differing strengths, the shaft and turbine wheel assembly is displaced in an axial direction. The axial bearing, a sliding surface bearing with tapered lands, absorbs these forces. Two small discs fixed on the shaft serve as contact surfaces. The axial bearing is fixed in the centre housing. An oil-deflecting plate prevents the oil from entering the shaft sealing area.

ii Oil drain

The lubricating oil flows into the turbocharger at a pressure of approximately 4 bar. As the oil drains off at low pressure, the oil drain pipe diameter must be much larger than the oil inlet pipe. The oil flow through the bearing should, whenever possible, be vertical from top to bottom. The oil drain pipe should be returned into the crankcase above the engine oil level. Any obstruction in the oil drain pipe will result in back pressure in the bearing system. The oil then passes through the sealing rings into the compressor and the turbine.

iii Sealing

The centre housing must be sealed against the hot turbine exhaust gas and against oil loss from the centre housing. A piston ring is installed in a groove on the rotor shaft on both the turbine and compressor side. These rings do not rotate, but are firmly clamped in the centre housing. This contactless type of sealing, a form of labyrinth seal, makes oil leakage more difficult due to multiple flow reversals, and ensures that only small quantities of exhaust gas escape into the crankcase.

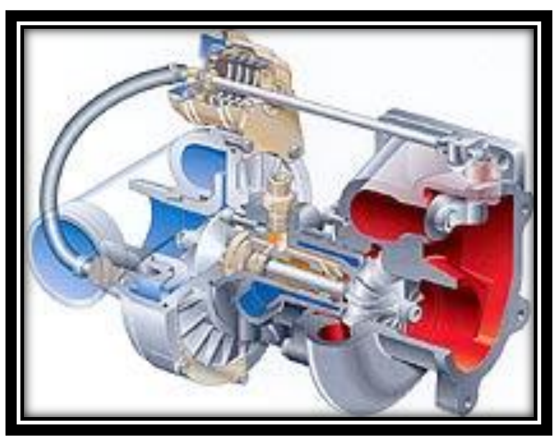

Figure 2.6: Water-cooled bearing housing

(Source: www.turbodriven.com)

Petrol engines, where the exhaust gas temperatures are 200 to 300 °C higher than in diesel engines, are generally equipped with water-cooled centre housings. During operation of the engine, the centre housing is integrated into the cooling circuit of the