# STUDY ON HEAT EXCHANGER FOR STEAM GENERATOR FROM WASTE HEAT

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

# STUDY ON HEAT EXCHANGER FOR STEAM GENERATOR FROM WASTE HEAT

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**A report submitted in fulfilment of the requirement for the degree of Bachelor of Mechanical Engineering (Thermal & Fluid)**

**Faculty of Mechanical Engineering**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2017**

**DECLARATION**

I declare that this project report entitled “Study on Heat Exchanger for Steam Generator from waste heat” is the result of my own work except as cited in the references.

Signature :.....

Name of Supervisor :.....

Date :.....

**PENGAKUAN**

Saya akui laporan ini yang bertajuk "Kajian penukar haba untuk penjana stim dari haba sisa" adalah hasil kerja saya sendiri kecuali yang dipetik daripada sumber rujukan.

Tandatangan :.....

Nama :.....

Tarikh :.....

**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 award of the degree of Bachelor of Mechanical Engineering (Thermal & Fluid).

Signature :.....

Supervisor's Name :.....

Date :.....

**PENGESAHAN PENYELIA**

Saya akui bahawa telah membaca laporan ini dan pada pandangan saya laporan ini adalah memadai dari segi skop dan kualiti untuk tujuan penganugerahan Ijazah Sarjana Muda Kejuruteraan Mekanikal (Thermal & Bendalir)

Tandatangan :.....

Nama Penyelia :.....

Tarikh :.....

**DEDICATION**

To my beloved mother and father.

**DEDIKASI**

Khas buat

Ayah dan Ibu tersayang.

## ABSTRACT

In this modern era, motor vehicles are rapidly increase which cause global warming by expelling carbon dioxide gas, carbon monoxide gas and etc. In order to overcome this phenomenon, new motor vehicle technology should be introduced. So that, the purpose of the research is to determine the optimal performance of heat exchanger as steam generator for waste heat recovery. Eventually, current motor vehicle's engine energy flow from fuel to internal combustion engine and produce thermal energy. The thermal energy will be transfer to exhaust system. Without realize, a lot of wasted energy has been lost when engine start running and the efficiency of the engine has been decrease. Thus, a mechanical invention system which is heat exchanger are used to convert waste heat energy to heat recovery energy. The heat exchanger plays a significant role by absorb the heat produce by the engine exhaust system and convert the liquid into steam. So that, the recovery energy is the high temperature that expelled from exhaust system. As a result, the energy source help to produce electrical power and keep the engine running warm. Through this study, a steam generator mechanism has been developed in interest to utilize the wasted energy from exhaust system of engine.

## ABSTRAK

Di zaman moden ini, peningkatan kenderaan bermotor menyebabkan pemanasan global dengan membuang gas karbon dioksida, gas karbon monoksida dan lain-lain. Dalam usaha untuk mengatasi fenomena ini, teknologi baru dalam kenderaan bermotor harus diperkenalkan. Tujuan kajian ini adalah untuk menentukan prestasi penukar haba sebagai penjana stim pemulihan haba sisa. Biasanya, aliran tenaga enjin dalam kenderaan bermotor mula daripada bahan api ke enjin pembakaran dalaman dan menghasilkan tenaga haba. Tenaga haba yang dihasilkan itu akan dipindahkan ke sistem ekzos. Tanpa disedari, banyak tenaga sia-sia telah hilang apabila enjin mula berfunsi dan kecekapan enjin juga akan menurun. Oleh itu, sistem ciptaan mekanikal iaitu penukar haba digunakan untuk menukarkan tenaga haba sisa kepada tenaga haba pemulihan. Penukar haba memainkan peranan penting dengan menyerap haba yang dikeluar daripada sistem ekzos enjin dan menukar cecair menjadi stim. Di samping itu,suhu tinggi yang dikeluarkan oleh sistem ekzos adalah tenaga pemulihan. Akhirnya, kuasa elektrik telah dihasilkan daripada bantuan sumber tenaga kuasa dan menjalankan enjin dengan baik. Melalui kajian ini, satu mekanisme penjana stim telah dihasilkan untuk menukar haba sisa yang keluar daripada sistem ekzos enjin ke haba pemulihan.

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| | |
|---|---|
| 3D | Three dimensional |
| ICE | Internal Combustion Engine |
| TEMA | Tubular Exchanger Manufacturers Association Community |
| Cu | Copper |
| ℃ | Degree Celcius |
| PSM | Projek Sarjana Muda |
| mPa | Mega-Pascal |
| CAD | Computer Aided Diagram |
| Σ | Summation |
| Hz | Frequency |
| W | Watt |
| V | Volt |
| min | Minutes |
| $\epsilon$ | Effectiveness |
| ηp | Pump Efficiency |
| $\dot{m}$ | Mass flow rate |
| Cp | Constant specific heat capacity |
| ΔTh | Temperature difference of hot stream |

# CHAPTER 1

# INTRODUCTION

## 1.1 BACKGROUND

The issue of global warming has pushed the effort of researchers not only to find alternative renewable energy, but also to improve performance of machines in order to save energy. This includes the utilization of waste energy into 'useful energy'. Once heat losses are minimised, investing in waste heat recovery can yield significant energy savings. The higher the temperature, the higher the quality and the more cost effective the heat recovery will be. (BCS, Incorporated 2008). Moreover, just 15 percent of the energy from the fuel we put in conventional vehicle is utilized to move your car down the road depending on the drive cycle or it used to run useful accessories, for example air conditioning heater and etc. (Jadhoa Js, T.D , 2013). The rest of the energy is lost to engine and used to power accessories. There are many technology developed to improve fuel efficiency one of it is by using back the waste heat produced. There are three main components used to create this recovery system such as heat exchanger, steam turbine and generator.

Heat exchanger is a device that is used for transfer thermal energy between two or more fluid, between a solid surface and a fluid, or between solid particulates and a fluid, at

differing temperatures. Normally, heat exchanger related to two different temperature of streams which are hot stream and cold stream. (M.Seifert, and J.Ringler, 2013).

The heat transfer surface is a surface of the exchanger core that is in direct contact with fluids and through which heat is transferred by conduction. To increase heat transfer are, appendages known as fins may be intimately connected to the primary surface to provide extended, secondary or indirect surface. Thus, the addition of fins reduce the thermal resistance. The heat transfer coefficient can also be higher for fins. (R.K.Shah and D.P Sekulic, 2009).

## 1.2 PROBLEM STATEMENT

The rapidly increase of motor vehicles globally increase the usage of petroleum and also increase of carbon dioxide in the atmosphere which can cause global warming. As to overcome this phenomenon, new motor vehicles technology should be introduced without increasing harmful emissions. Internal combustion engine in most typical gasoline fuelled vehicles, which mostly used in passenger car, it was approximated that 21% of the fuel energy is wasted through the exhaust. (R.E.Chammas and D.Clodic, 2005). The remaining heat is expelled to the environment through exhaust gases and engine cooling system. It means estimate 60 to 70% energy losses as a waste heat through exhaust. Therefore an interest to utilize the wasted energy by developing a heat recovery mechanism of exhaust gas from internal combustion engine with the aim that it will increase the efficiency of the engine. The energy from the exhaust gas can be make use to supply an extra power source for vehicles and theoretically proven that it also can be an overall reduction in greenhouse gas emission.

## 1.3 OBJECTIVES

The objectives of this project are as follows:

Objective 1

-The first objective for this project is to design a new heat exchanger mechanism to optimize the waste heat that implemented in the vehicle.

Objective 2

-The second objective is to determine the performance of the heat exchanger of waste heat recovery system.

## 1.4 SCOPE OF PROJECT

In this research, the result will be conduct experimentally and also will be analysed and interpret. Below are the scope of the project:

a) Based on objective 1, my scope of project is:

-To study the material properties of heat exchanger using CES Edu pack software.

- To design a new heat exchanger by using Solid Work software

b) Based on objective 2, my scope of project is:

-To determine the performance analysis for the heat exchanger (new and current) in term of ability to absorb heat.

- To determine the rate of heat transfer and effectiveness of the heat exchanger.

## 1.5 GENERAL METHODOLOGY

Simulation and experimental progress were carried out to achieve the objectives and the scopes in this project. The purpose of this simulation is to give better understanding on the ability of heat exchanger to absorb the heat.

First, find the material data that need to design the heat exchanger by using CES Edu pack. Choose the best material by understanding the material properties and compare the materials. CES Edupack is a solitary set of teaching resources that support Materials Education across Engineering Design and Sustainable Development. The CES Edupack software also provides engaging ways to explore and understand the world of material. The three main characteristics of this software are it is very familiar with material space, it can visualize the properties using charting tools, and also can match the materials to application for better understanding.

Next, design a new heat exchanger by using SolidWork software. SolidWork is a solid modelling computer-aided design (CAD) and computer aided engineering (CAE) that covers all aspects of your product development process with a seamless, integrated workflow, sustainable design. Engineers can span multiple disciplines with ease, shortening the design cycle and delivering innovative products. It is a dedicated software for modelling and has the following characteristics:

a) **3D CAD** – Draw in 3d view and quickly transform into new ideas.

b) **Visualization** – Design the model faster by turning imagination into reality.

Next, conduct an experiment to collect data regarding the performance of the heat exchanger as steam generator. The experimental work will be conducted in several condition with variety of inputs such as engine speed, vehicle speed, and number of passengers. Moreover the analysis also will be carry on to improve the performance of the steam generator. Based on the results, do comparison between new and current heat exchanger to determine the best heat exchanger with the ability of good absorb of heat. At last, a report writing for this project will be written at the end of this project.