

PREPARATION OF CATALYTIC CONVERTER FOR  
TWO STROKE GENERATOR ENGINE

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this work was adequate from scope aspect and quality to award purpose  
Mechanical Engineering Bachelor Degree (Thermal - Fluid)’

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This report is proposed as cater to part of award condition  
Mechanical Engineering Bachelor Degree (Thermal - Fluid)

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MAY 2009

“I admit this report is my own work except each summary and quotation I had explain  
their source”

Signature : .....  
Author : MOHD NOOR ASRIL BIN SAADUN  
Date : .....

To my beloved family, mum and dad,  
thank you for your „doa“, support and encouragement  
that you have given in my life.

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## **ABSTRACT**

Most small utility two stroke engine especially portable generator can emit several hundred times more poisonous carbon monoxide than a modern car's exhaust. This study is to understand and apply the method of catalytic converter component in determining to reduce the emission for small utility two stroke engine such portable generator which almost using at pasar malam. The objective of this study is to investigate the idea of application of catalytic converter at pasar malam portable generator exhaust systems and the possibility of decrease the engine emission without decreasing the engine performances. This work presents a gas analyzer to predict and to evaluate the composition of the emission in two stroke engine for this generator. In this work also the experimental is done without and with installed the commercial catalytic converter, impact of using liquid petroleum gas (LPG) as fuel and also different load imposed to portable generator to make a comparison for their emission effect. This is a quantitative study which involves the use of experimental and analysis to get the information about the data for their effect of composition of emission from the generator exhaust. Data obtained were analyzed and the result of experiment will be compared with original engine where without installed catalytic converter.

## ABSTRAK

Kebanyakan enjin dua lejang yang berkapasiti kecil terutamanya untuk penjana mudah alih boleh mengeluarkan asap karbon monoksida dan asap – asap yang lebih beracun berbanding asap dari ekzos kereta moden. Tujuan kajian ini adalah untuk memahami dan mengaplikasikan kaedah pemangkinan komponen penukar dalaman supaya dapat mengurangkan pencemaran untuk enjin dua lejang yang berkapasiti kecil iaitu penjana mudah alih yang biasa digunakan di pasar malam. Objektif kajian ini adalah untuk menyiasat idea untuk mengaplikasikan pemangkinan penukar dalaman pada ekzos penjana mudah alih pasar malam dan kemungkinan pengurangan pencemaran asap dari enjin tanpa menjejaskan prestasi enjin tersebut. Dalam kajian ini, penganalisis gas digunakan untuk meramalkan dan untuk menilai komposisi pencemaran hasil pembakaran dalam enjin dua lejang untuk enjin penjana ini. Dalam kajian ini juga, eksperimen akan dilakukan dengan memasang bersama pemangkinan penukar sedia ada yang dijual dipasaran dan juga tanpa pemangkin penukar dalaman, kesan penggunaan gas petroleum cecair (LPG) sebagai bahan api dan seterusnya juga beban yang berbeza dikenakan terhadap penjana mudah alih tersebut untuk membuat perbandingan kesan pencemaran asap yang dihasilkan. Kajian ini merupakan satu kajian kuantitatif yang melibatkan eksperimen dan analisis untuk mendapatkan data dan maklumat untuk mengetahui kesan komposisi pencemaran daripada ekzos penjana mudah alih tersebut. Data yang diperolehi akan dianalisis dan hasil eksperimen akan dibanding dengan enjin asli di mana tanpa dipasang pemangkinan penukar dalaman.



## TABLE OF CONTENT

CHAPTER	TITLE	PAGES
	<b>CONFESSION</b>	<b>ii</b>
	<b>DEDICATION</b>	<b>iii</b>
	<b>ACKNOWLEDGMENT</b>	<b>iv</b>
	<b>ASCTRACT</b>	<b>v</b>
	<b>ABSTRAK</b>	<b>vi</b>
	<b>TABLE OF CONTENTS</b>	<b>vii</b>
	<b>LIST OF TABLES</b>	<b>x</b>
	<b>LIST OF FIGURES</b>	<b>xi</b>
	<b>LIST OF GRAPHS</b>	<b>xiii</b>
	<b>LIST OF SYMBOLS</b>	<b>xv</b>
<b>1</b>	<b>INTRODUCTION</b>	<b>1</b>
	1.1 Overview	1
	1.2 Objective	2
	1.3 Scope	3
	1.4 Limitation Of The Study	3
	1.5 Statement Of Problem	4
<b>2</b>	<b>LITERATURE REVIEW</b>	<b>5</b>
	2.1 Overview	5
	2.2 Emission and Regulations	6
	2.3 Types Of Emission:	7
	2.3.1 Carbon Monoxide	8
	2.3.2 Nitrous Oxide	9

<b>CHAPTER</b>	<b>TITLE</b>	<b>PAGES</b>
2.4	Catalytic Converter:	11
2.4.1	Overview	12
2.4.2	How a catalytic converter works	13
2.4.3	Reaction in converter	14
2.4.4	Types Of Catalytic Converter	15
2.4.4.1	Two Way Catalytic Converter	15
2.4.4.2	Three Way Catalytic Converter	16
2.4.5	Catalytic Converter Substrates	17
2.4.6	Catalytic Physical Structure	19
2.4.7	Catalytic Converter Failure	20
2.4.8	Catalytic After Treatment	21
<b>3</b>	<b>METHODOLOGY</b>	<b>24</b>
3.1	Introduction	24
3.2	Collecting the information	24
3.3	Flowchart of the process	25
3.4	Portable Generator	26
3.5	Gas Analyzer Stargas 898 Plus	29
3.6	Experiment Procedure	30
3.7	Lambda Factor	36
3.8	Exhaust Gas Values	37
<b>4</b>	<b>REDULT AND DATA ANALYSIS</b>	<b>38</b>
4.1	Introduction	38
4.2	Figure about each part of experiment	38
4.3	Experiment Result	42
4.4	Calculation For Lambda Factor	46
4.5	Analysis of Emission Each Component Gas	50

<b>CHAPTER</b>	<b>TITLE</b>	<b>PAGES</b>
	4.6 Analysis of effect using different Fuel, Catalytic Converter and Load	56
<b>5</b>	<b>DISCUSSION</b>	65
	5.1 Introduction	65
	5.2 Safety and precaution during the experiment	66
	5.3 Diagnosis using gas analyzer	67
	5.4 General rules for emission analysis	67
	5.5 Analyzing exhaust emission reading	68
	5.6 Causes of excessive exhaust emissions	69
	5.7 Fabrication process problem	70
	5.8 Interference Gas	72
<b>6</b>	<b>CONCLUSION AND RECOMMENDATION</b>	73
	<b>REFERENCES</b>	75
	<b>BIBLIOGRAPHY</b>	76
	<b>APPENDIXE</b>	77

**LIST OF TABLES**

<b>NO.</b>	<b>TITLE</b>	<b>PAGE</b>
2.1	Typical Properties Of Catalyst Substrates	22
3.1	The Feature Of The Generator	27
3.2	Specifications Of The Portable Generator	28
4.1	Emission Analysis For Catalytic Converter And Petrol	42
4.2	Emission Analysis For Catalytic Converter And LPG	43
4.3	Emission Analysis Using Petrol As Fuel With Load	44
4.4	Emission Analysis Using LPG As Fuel With Load	45

**LIST OF FIGURES**

<b>NO.</b>	<b>TITLE</b>	<b>PAGE</b>
2.1	Spark-Ignited Gasoline Engine Emissions	6
2.2	Trend Of Pollutants Versus The Air Fuel Ratio	8
2.3	Position Of The Catalyst (Horizontal)	11
2.4	Position Of The Catalyst (Vertical)	11
2.5	Schematic Of Catalytic Converter Works	13
2.6	Position Of The Catalytic At Exhaust Flow	14
2.7	Schematic Of Cutaway Of Typical Catalyst Design	17
2.8	Bead Bed Reactor Design	19
2.9	Monolithic Reactor Design	19
2.10	Application Of A Catalyst To A Motorcycle Engine	23
3.1	Experimental Flow Chart	25
3.2	Yamaha Portable Generator	26
3.3	Stargas 898 Plus Main Unit	24
3.4	Stargas 898 Plus Multi Function Trolley	24
3.5	Stargas Menu Page	30

<b>NO.</b>	<b>TITLE</b>	<b>PAGE</b>
3.6	Stargas Gas Analysis Page	31
3.7	Stargas Standard Test Page	32
3.9	Curves Graph Page	34
3.10	Histogram Graph Page	34
3.11	Print Page Setting	35
4.1	Initial Condition Of Hole Exhaust Of Generator	39
4.2	Hole Exhaust Of Generator Using Converter Diameter Size	39
4.3	Connector For 2 Stroke Catalytic Converter	39
4.4	Connector For 4 Stroke Catalytic Converter	39
4.5	2 Stroke Catalytic Converter	40
4.6	4 Stroke Catalytic Converter	40
4.7	Generator Connect With 4 Stroke Catalytic Converter	40
4.8	Generator Connect With 2 Stroke Catalytic Converter	40
4.9	Generator Operate With Using LPG As Fuel	41
4.10	Generator Burden With Load	41
5.1	Using Screw With Bolt And Nut For Tighten	70
5.2	The Initial Condition Of Exhaust Generator	71
5.3	The Connector	71
5.4	Applying Rubber Masking Tape	71
5.5	Initial Condition Gas Analyzer Nozzle	72
5.6	New Filter And Copper Pipe Used As Nozzle	72

**LIST OF GRAPH**

<b>NO.</b>	<b>TITLE</b>	<b>PAGE</b>
4.1	Emission Without Catalytic Converter For Petrol	50
4.2	Emission Without Catalytic Converter For LPG	51
4.3	Emission With 2 Stroke Catalytic Converter For Petrol Operation	52
4.4	Emission With 2 Stroke Catalytic Converter For LPG Operation	52
4.5	Emission With 4 Stroke Catalytic Converter For Petrol Operation	54
4.6	Emission With 4 Stroke Catalytic Converter For LPG Operation	54
4.7	Comparison Of CO Emission For Petrol Operation	56
4.8	Comparison Of CO Emission For LPG Operation	58
4.9	Comparison Of CO <sub>2</sub> Emission For Petrol Operation	59

<b>NO.</b>	<b>TITLE</b>	<b>PAGE</b>
4.10	Comparison Of CO <sub>2</sub> Emission For LPG Operation	59
4.11	Comparison Of O <sub>2</sub> Emission For Petrol Operation	61
4.12	Comparison Of O <sub>2</sub> Emission For LPG Operation	61
4.13	Comparison Of HC Emission For Petrol Operation	63
4.14	Comparison Of HC Emission For LPG Operation	63



**LIST OF SYMBOLS**

CO	-	Carbon Monoxide
CO <sub>2</sub>	-	Carbon Dioxide
NO <sub>x</sub>	-	Nitrogen Oxides
NO <sub>2</sub>	-	Nitrogen Dioxides
SO <sub>x</sub>	-	Sulfur Oxides
O <sub>2</sub>	-	Oxygen
PM	-	Particulate Matter
HC	-	Hydrocarbons
UHC	-	Unburned Hydrocarbons
Ppmv	-	Part Per Million Volume
H <sub>2</sub>	-	Hydrogen
EPA	-	Environmental Protection Agency
HP	-	Horse Power
% Vol	-	Percent Volume

## CHAPTER I

### INTRODUCTION

#### 1.1 Overview

Catalysis has provided one of the most realistic methods of decreasing the levels of exhaust gas species. However its efficiency of oxidation depends on amount of CO, HC and air and also temperature of exhaust gas. Catalytic converters especially with the fuel enriched exhaust gas of small capacity two-stroke engine undergo rapid damage of perforation and clog by unburned oil. They can cause also threat of misfire. With its subsequent fuel enriching of exhaust gas causes a thermal shock to the substrate. In general the efficiency of the catalyst is dependent upon two parameters, namely the physical formulation and the nature of the flowing gas containing different chemical substance. Recently widely applied fuel injection reduces to a large extent this phenomenon.

Engine performance changes as a result of negative effect of gas wave motion in exhaust system with monolith of converter, which should be fixed in exhaust pipe, where higher temperature takes place to initiate chemical reactions especially during engine start. Value of decreasing of engine torque and increasing of fuel consumption are the main parameters determining possibility of applying of catalytic converter in exhaust system. Most often catalytic converters in exhaust systems of two-stroke engines are placed before silencer.

Big size of the converter and lower temperature of gas flowing out from silencer takes effect on longer time of heating and oxidation of exhaust compounds. Placing catalytic converter near exhaust port assures higher temperature of wash-coat in catalyst containing precious metal as a result of short distance from exhaust port, but can also influence stronger on pressure variation before exhaust port.

## **1.2 Objectives Of The Study**

This study scientifically reviews the current state of knowledge about air pollution caused by two stroke generator engine combustion. The main objective of this investigation is to question the perception about the idea of application of catalytic converter at portable generator exhaust systems and the possibility of decreasing the engine emission without decreasing the engine performances.

Another objective in this study is to make a comparison about the emission from two stroke engine especially for portable generator powered with gasoline. To make this comparison, the portable generator set must be installed with suitable catalytic converter and measure the effect of different emission using a gas analyzer. The suitable catalytic converter is from two stroke engine since the small generator used two stroke engines.

This study also evaluates how to make the experimental process of the catalyst and assessment of designed at exhaust system. The experimental procedure of this catalytic converter system is necessary to characterize the catalyst and to optimize the emission of two stroke engine for portable generator. Then the objective of this study also is to obtain an emission value and comparison of the emission effect using of LPG and apply with different load at two stroke generator engine.

### **1.3 Scope**

The scope of this study is to make ability or application of the catalytic converter for small utility two stroke engine especially for portable generator. The exhaust from a two-stroke generator engine will be characterized using one type of gasoline, conventional lead-free gasoline. In addition, exhaust emissions of carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), oxygen (O<sub>2</sub>) and hydrocarbons (HC) will be measured. The two-stroke engine tested with use of catalysts at the exhaust to improve the emission after installation catalyst and assessment of designed exhaust system. This study discusses about the performance, combustion and emission characteristics of a two-stroke spark ignition engine in which the catalytic converter will be installed at exhaust system. Catalysts such as copper, chromium and nickel in the form of coating and a catalytic prechamber with platinum tipped multi-electrode spark plug were tried out to ensure rapid and efficient combustion. Considerable reduction of CO and HC emissions were obtained with some of the catalysts. Generally, the conventional gasoline gives higher effects a difference between lubricants was also seen, especially in combination with gasoline.

### **1.4 Limitation Of The Study**

This study will be done at University Technical Malaysia Melaka ( UTeM ) laboratory. This study only concentrate at the exhaust system to reduce the emission of the portable generator where it almost using at pasar malam. The catalytic converter using in this study are from automobile market and not specifically designed for small utility two stroke engine such of a portable generator.

## **1.5 Statement Of Problems**

In studying a catalytic converter of a two stroke engine for pasar malam portable generator, there are several things need to understand to solve the problem. The generator is working in two stroke engine and powered by gasoline fuel. The emission from this type of generator can emit several hundred times more poisonous carbon monoxide than a modern car's exhaust. To help quantify the dangers of improperly used portable generators and evaluate possible technical solutions to the problem, catalytic converter can be used to reduce the emission and then make the pasar malam generator safe to use without causes hazard poisoning for the user. The important aspect of the work is to determine the efficiency of the catalytic converter for the generator without decreasing the engine performances. To make a comparison between with and without effect of catalytic converter, gas analyzer is used to predict and to evaluate the gas composition from emission in two stroke engine for this portable generator.

## **CHAPTER II**

### **LITERATURE REVIEW**

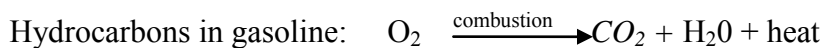
#### **2.1 Overview**

Chapter 2 discusses about studies on the problem of emissions from two-stroke engine type. The major gasoline engines pollutants are carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>), sulfur oxides (SO<sub>x</sub>), particulate matter (PM), various hydrocarbons (HC) and also produces carbon dioxide, a greenhouse gas. The two-stroke engines produce significant amounts of unburned hydrocarbons, atomized lubricating oil, and CO due to their design, but little NO<sub>x</sub>. Carbon monoxide is generally a product of incomplete combustion and is frequently found in rich mixtures.

There are many effects to human health and environment if exposed with this toxic gas. Carbon monoxide binds with hemoglobin in the blood, reducing the blood's capacity to carry oxygen. This can result in heart strain and pulmonary problems. NO<sub>x</sub> combines with moisture to produce acid rain, and increases the risk of respiratory disease and causes pulmonary and respiratory problems. NO<sub>x</sub> and volatile organic compounds are also precursors for photochemically-produced ozone (smog), which is an irritant that affects the eyes, upper respiratory tract and causes asthma and headaches. Hydrocarbons in the atmosphere react photochemically to produce smog and this is a major problem. Also, certain hydrocarbons are directly toxic to the human body.

## 2.2 Emissions And Regulations

The development of the spark-ignited combustion engine permitted the controlled combustion of gasoline that provides the power to operate the automobile. Gasoline, which contains a mixture of paraffin and aromatic hydrocarbons, is combusted with controlled amounts of air producing complete combustion products of  $\text{CO}_2$  and  $\text{H}_2\text{O}$  and also some incomplete combustion products of  $\text{CO}$  and unburned hydrocarbons (UHCs).



During the combustion process very high temperatures are reached due to diffusion burning of the gasoline droplets, resulting in thermal fixation of the nitrogen in the air to form  $\text{NO}_x$ . The quantity of pollutants varies with many of the operating conditions of the engine but is influenced predominantly by the air: fuel ratio in the combustion cylinder. Figure below shows the engine emissions from a spark-ignited gasoline engine as a function of the air: fuel ratio.

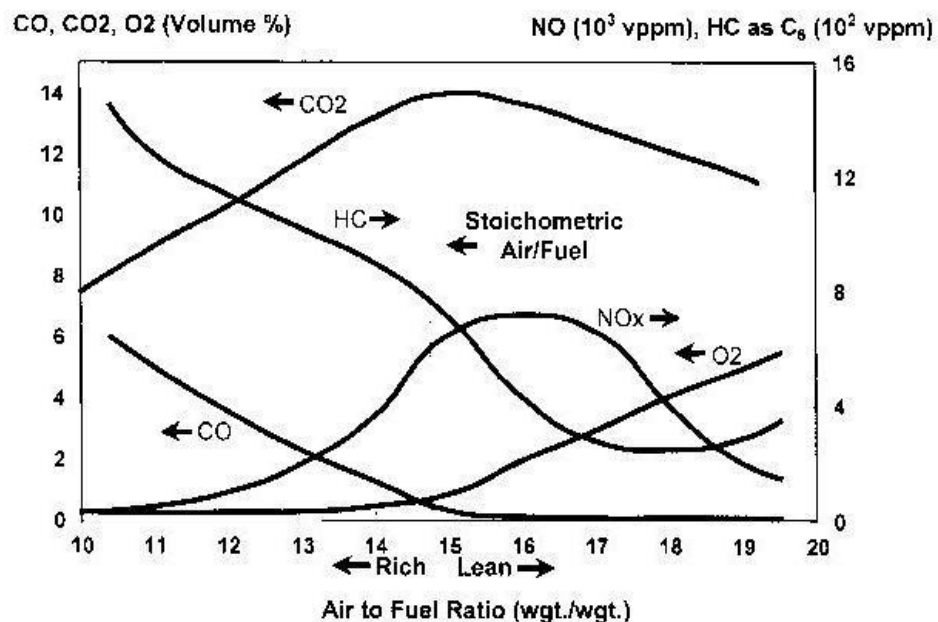


Figure 2.1: Spark-ignited gasoline engine emissions as a function of air: fuel ratio  
(Source: Kummer, (1980) )

When the engine is operated rich of stoichiometric, the CO and HC emissions are highest while the NO<sub>x</sub> emissions are depressed. This is because complete burning of the gasoline is prevented by the deficiency in O<sub>2</sub>. The level of NO<sub>x</sub> is reduced because the adiabatic flame temperature is reduced. On the lean side of stoichiometric, the CO and HC are reduced since nearly complete combustion dominates. Again, the NO<sub>x</sub> is reduced since the operating temperature is decreased. Just lean of stoichiometric operation, the NO<sub>x</sub> is a maximum, since the adiabatic flame temperature is the highest. At stoichiometric, the adiabatic flame temperature is lowered because of the heat of vaporization of the liquid fuel gasoline. The actual operating region of combustion for the spark-ignited engine is defined by the lean and rich flame stability, beyond which the combustion is too unstable. Within the region of the spark-ignited engine operation, a significant amount of CO, HC, and NO<sub>x</sub> is emitted to the atmosphere. The consequences of these emissions have been well documented but briefly. CO is a direct poison to humans, while HC and NO<sub>x</sub> undergo photochemical reactions in the sunlight leading to the generation of smog and ozone.

### **2.3 Types Of Emissions**

Gasoline engines contribute to air pollution by emitting high levels of particulate matter, lead if leaded gasoline is used, carbon monoxide, nitrogen oxides, and volatile organic compounds. Emissions are higher in two-stroke engines because of the design of the engine because the gas is exchanged through ports located in the cylinder, usually opposite each other. A fresh fuel and air mixture compressed in the crankcase enters through the intake opening, while exhaust gases exit through the exhaust port. While both the intake and exhaust ports are open some of the fresh fuel and air mixture escapes through the exhaust port.

As a result of these scavenging losses, which can amount to 15–40 percent of the unburned fresh charge, the exhaust contains a high level of unburned fuel and lubricant. Nitrogen oxide emissions tend to be lower because a significant portion of the combustion products remains in the cylinder.