EVALUATION OF A COMPRESSION IGNITION ENGINE PERFORMANCE AND EMISSION USING THEHCO TECH DEVICE (THEHCO TECH)

FOR

SUMBER KURNIA SDN BHD (762471-M)

UTM
UNIVERSITI TEKNOLOGI MALAYSIA

ADC
Automotive Development Centre

A REPORT

(Report No: SUMBER KURNIA SDN BHD (THEHCO TECH)-0006-2014)

BY

AUTOMOTIVE DEVELOPMENT CENTRE (ADC)

FACULTY OF MECHANICAL ENGINEERING

UNIVERSITI TEKNOLOGI MALAYSIA

26th MAY 2014

UTM UNIVERSITI TEKNOLOGI MALAYSIA
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Automotive Development Centre

RUJUKAN KAMI:
RUJUKAN TUAN: UTM.J090803/10.10/16/1 (43/2014) 27/05/2014

Mr. Hisham Bin Mohamad Hashim
Sumber Kurnia Sdn Bhd
No 12 Jalan Bidai U8/21
Bukit Jelutong
40150 Shah Alam, Selangor.

Dear Mr,

DELIVERABLE DOCUMENTS FOR THE ENGINE TESTING EVALUATION ON THEHCO TECH DEVICE.

With regard to the above matter, attached with this letter are the report of the engine performance and emissions evaluation on the Thehco Tech device attached at the tested engine. Also enclosed are certificates and payment received cheque.

2. ADC would like to thank you to Sumber Kurnia Sdn Bhd for having the engine performance and emissions testing at ADC laboratory and highly appreciated for the co-operation given during the testing actity.

Thank you

"INNOVATIVE. ENTREPRENEURIAL. GLOBAL"

Yours sincerely,

MOHD ROZI BIN MOHD PERANG
Research Officer (QA41)
Automotive Development Centre
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Test Certificate

(06-2014)

For:

SUMBER KURNIA SDN BHD

We hereby certify that the results are correct to the best of our knowledge and work undertaken which has been tested by Automotive Development Centre (ADC), Universiti Teknologi Malaysia.

The full details of the tests and the results are given in our reports:

(Report No: SUMBER KURNIA SDN BHD (THEHCO TECH)-0006-2014)

Certificate authorized by:

Prof. Ir. Dr. Azhar bin Abdul Aziz

Director,

Automotive Development Centre (ADC)

Universiti Teknologi Malaysia

AUTOMOTIVE DEVELOPMENT CENTRE * UNIVERSITI TEKNOLOGI MALAYSIA

26 MAY 2014

1.0 INTRODUCTION

The test work was undertaken to determine the performance of an internal combustion engine fitted with Thehco Tech Device (hereafter refer as Thehco Tech) supplied by Sumber Kurnia Sdn. Bhd.

The claims by the client pertaining to the product are the improvement of the following parameters;

1.1 Engine performance i.e. engine torque (τ) and brake power (BP).

1.2 Brake specific fuel consumption (BSFC)

1.3 Brake thermal efficiency (η_{bth})

1.4 Emission gases i.e. oxides of nitrogen (NO_X), hydrocarbon (HC), carbon monoxide (CO), oxygen (O_2), carbon dioxide (CO_2) and soot.

The scope of work undertaken by Automotive Development Centre (ADC) is to evaluate claim (1.1) - (1.4) when the compression-ignition (CI) engine (diesel engine) is run before and after using the Thehco Tech.

2.0 PRODUCT REVIEW

Figure 1 shows the product (Thehco Tech) as supplied by Sumber Kurnia Sdn. Bhd.

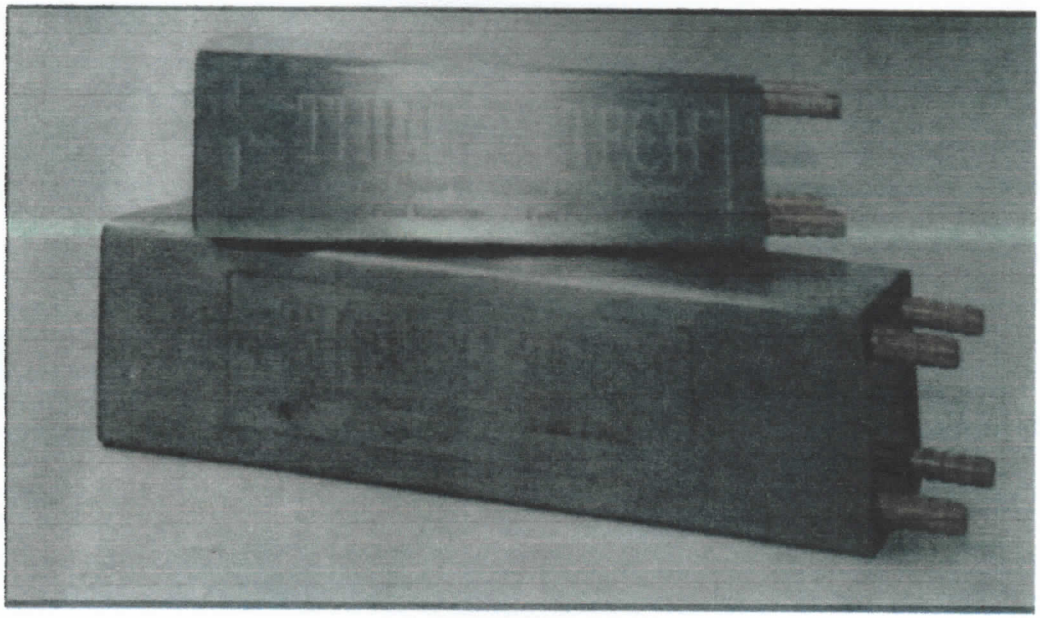


Figure 1: Thehco Tech device

THEHCO stands for Thermo Hydro Cetane and Octane boosting device that is primarily invented and designed for diesel and petrol engines. It has the ability and capacity to improve and upgrade performance of engines running on petrol and diesel. Its design has a positive effect on any internal combustion engine to improve performance efficiency, to reduce exhaust smoke emission and to reduce fuel consumption.

Thehco Tech device uses heat from the engine heat exchanger to activate the fuel to be active and smartly vaporizing the fuel as it enters the combustion chamber, consequently, with just a small amount of engine for sparkling the engine will have an almost total combustion capability. This device is a technology system that can be used on any type of any internal combustion engine for ships and generators.

Figure 2 depicts the arrangement of the Thehco Tech unit attached to the tested engine. Yellow and red arrows indicate the flow of fuel and hot water respectively.

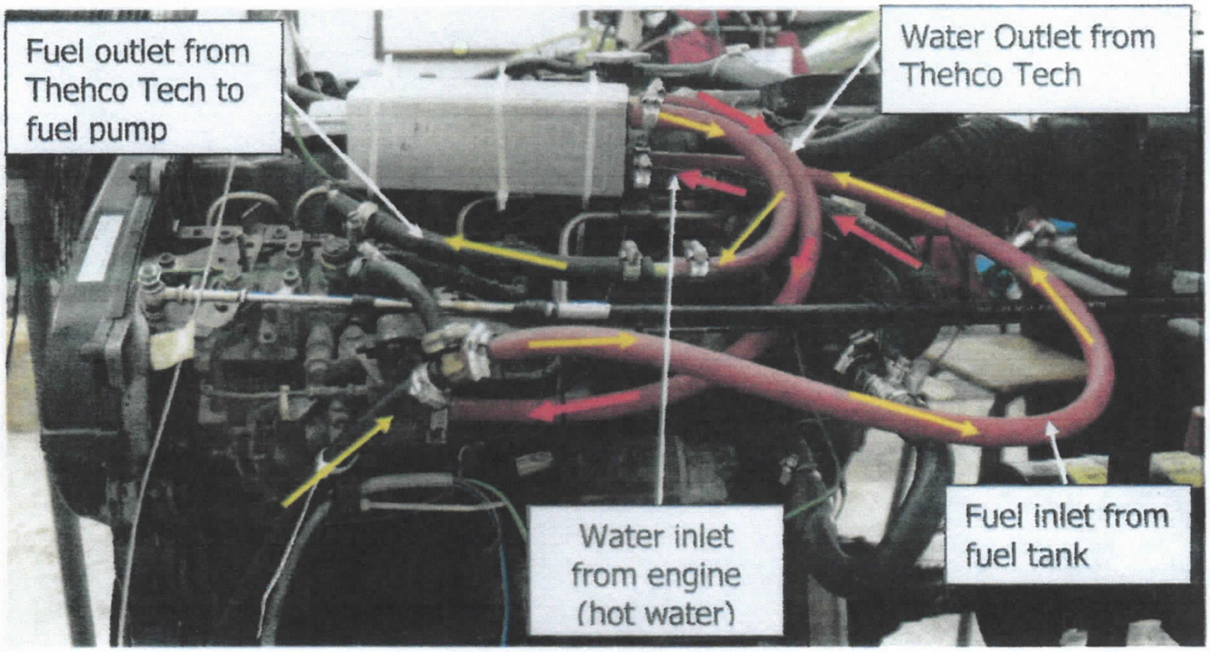


Figure 2: Thehco Tech was attached to the engine

3.0 DURATION

The overall duration of the trial, from engine preparation to completion of the experimental program was carried out from 05th-06th May, 2014.

4.0 TEST EQUIPMENTS

The engine and test equipments used for this experimental work are:

4.1 Compression ignition engine, diesel engine (Mitsubishi 4D68, 2.0 liter)

The compression ignition engine is used for comparative engine performance assessment as shown in Figure 3. The engine is not equipped with a catalytic converter in which the output gases are the actual by-products of the combustion emitted via the exhaust of the engine. Table 1 exhibits the specifications of the tested engine.

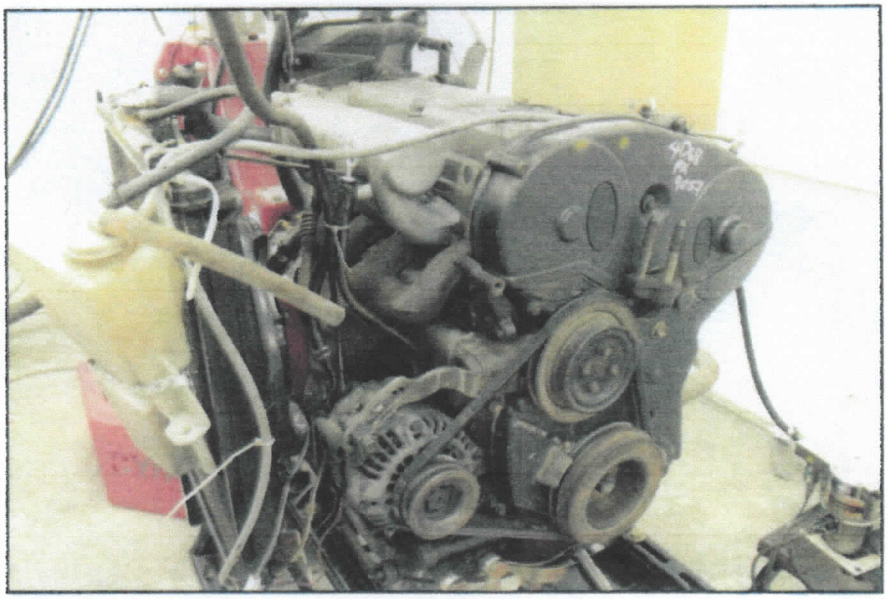


Figure 3: Mitsubishi 4D68, 2.0 liter diesel engine

Table 1: Engine specifications

Engine name:	Mitsubishi 4D68 (diesel engine)
Engine capacity:	1.998 liter
Compression ratio:	22.4:1
Number of cylinder	4 in-line

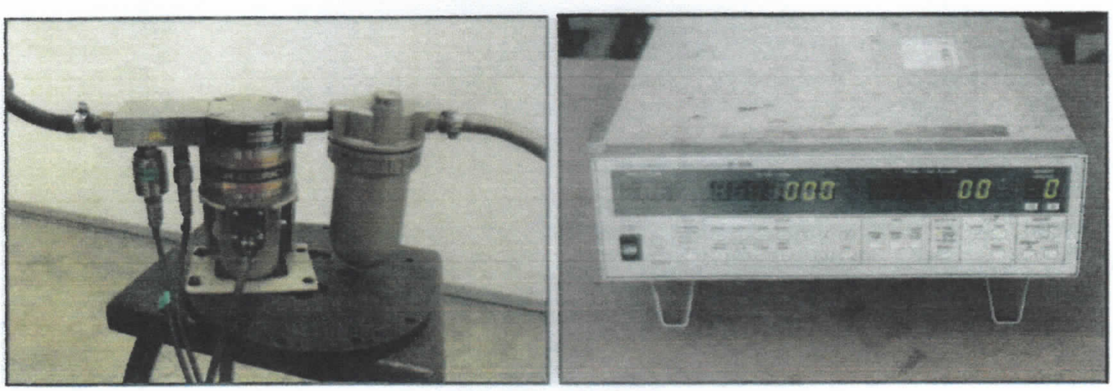
4.2 Eddy current dynamometer (Dynomite)

The dynamometer is coupled directly to the engine in order to simulate load on the engine for measuring the engine torque (Figure 4).

Figure 4: Dynomite eddy current dynamometer

4.3 Fuel flow meter (Ono Sokki)

The flow meter is installed in the fuel line to measure the net fuel flow rate consumed by the engine. Figure 5 (a) and (b) show the fuel consumption components.



(a) Fuel flow detector (b) Fuel flowmeter

Figure 5: Fuel measuring components

4.4 Dyno-Max software

The function of this software is to log-in all the parameters automatically (Figure 6). The parameters of concern are engine speed, torque, brake power, etc.

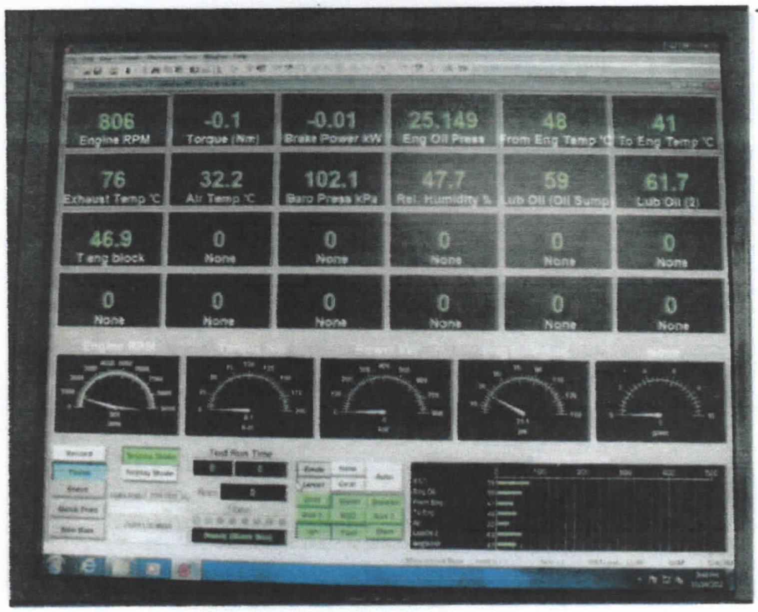


Figure 6: Dyno-Max software display

4.5 Diesel Smoke Tester (Bosch)

The equipment (Figure 7) is used as the soot test during the experimental work.

Figure 7: Bosch diesel smoke meter

5.0 TEAM MEMBERS

The members of the evaluating team comprised of the following:

1) Prof Ir Dr. Azhar bin Abdul Aziz	- Director (VK06)
2) Dr. Zulkarnain bin Abdul Latiff	- Research Consultant (DS52)
3) Mr. Mohd Rozi bin Mohd Perang	- Research Officer (QA41)
4) Mr. Hishammudin bin Mohd Jamil	- Senior Assistant Engineer (J29)
5) Mr. Mohd Nazri bin Misseri	- Assistant Engineer (J29)

The test was conducted at ADC laboratory located at block P21, Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, Skudai, Johor.

6.0 TEST PROCEDURES

The testing was done at variable speed equivalent to 30% of full rack setting) which was based on the BS 5514 procedures for engine performance test.

The standard engine performance characteristics will be used as a base data. Then the engine was installed with Thehco Tech and the same test condition was set and run. Later these data will be observed and compared to the base performance characteristics to see any changes (if any). The details of the testing procedures are:

6.1 The standard engine was run under idling speed until it was stable and all the required parameters were noted (e.g. fuel consumption)

6.2 Then, the engine speed was set at 4000 rpm (30% of full rack setting). Here, all the required parameters (e.g. engine speed, torque and brake power) were logged in automatically by the Dyno-Max software. The fuel consumption and emissions data will be recorded manually.

6.3 For the next set of data, the engine speed was decreased by 500 rpm through applying load (increase load) to the engine via the dynamometer. The test was repeated until the engine speed reaches 1500 rpm. Again, all the required parameters were logged and recorded.

6.4 Once this was done, the applied load was released until it reaches minimum torque and at the same time the engine speed was decreased until it reaches idling speed.

6.5 Once completed, the engine was turn off and followed by other testbed subsystem.

6.6 Steps (6.1) to (6.5) were then repeated for the engine equipped with Thehco Tech.

7.0 RESULTS AND DISCUSSIONS

7.1 Engine Performance Test

7.1.1 Torque (τ)

Figure 8 shows the graph of torque against engine speed before and after the used of Thehco Tech device. The torque produced by the engine equipped with Thehco Tech is higher than the standard engine condition. The significant increment appeared at all engine speed conditions with an average of 7.03%. The maximum increased is 8.57% at 2000 rpm. At maximum engine speeds the differences are minimal.

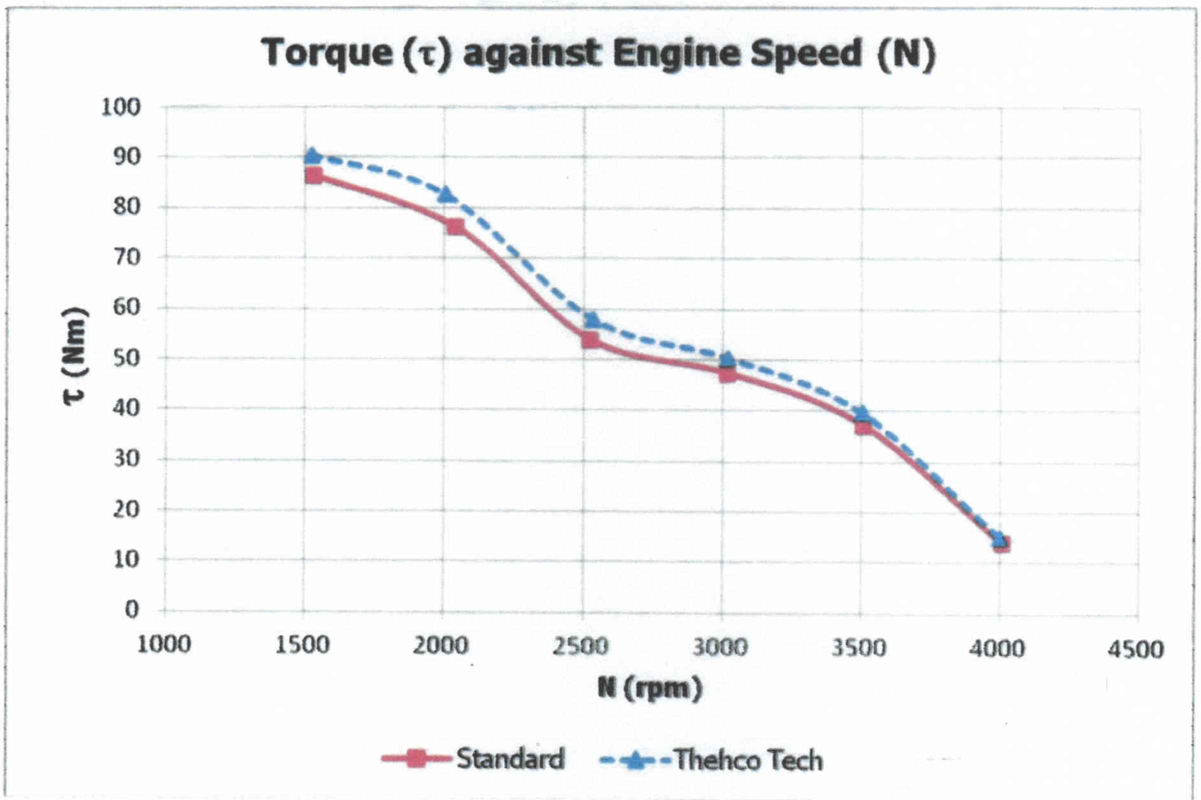


Figure 8: Graph of torque against engine speed

7.1.2 Brake Power (BP)

Figure 9 illustrates the graph of brake power (BP) against engine speed. The BP is being derived from the torque and engine speed measurements. For the engine runs with Thehco Tech, the BP is increased 8.33% (maximum) at the engine speed of 2000 rpm. The average increased is 6.88%.

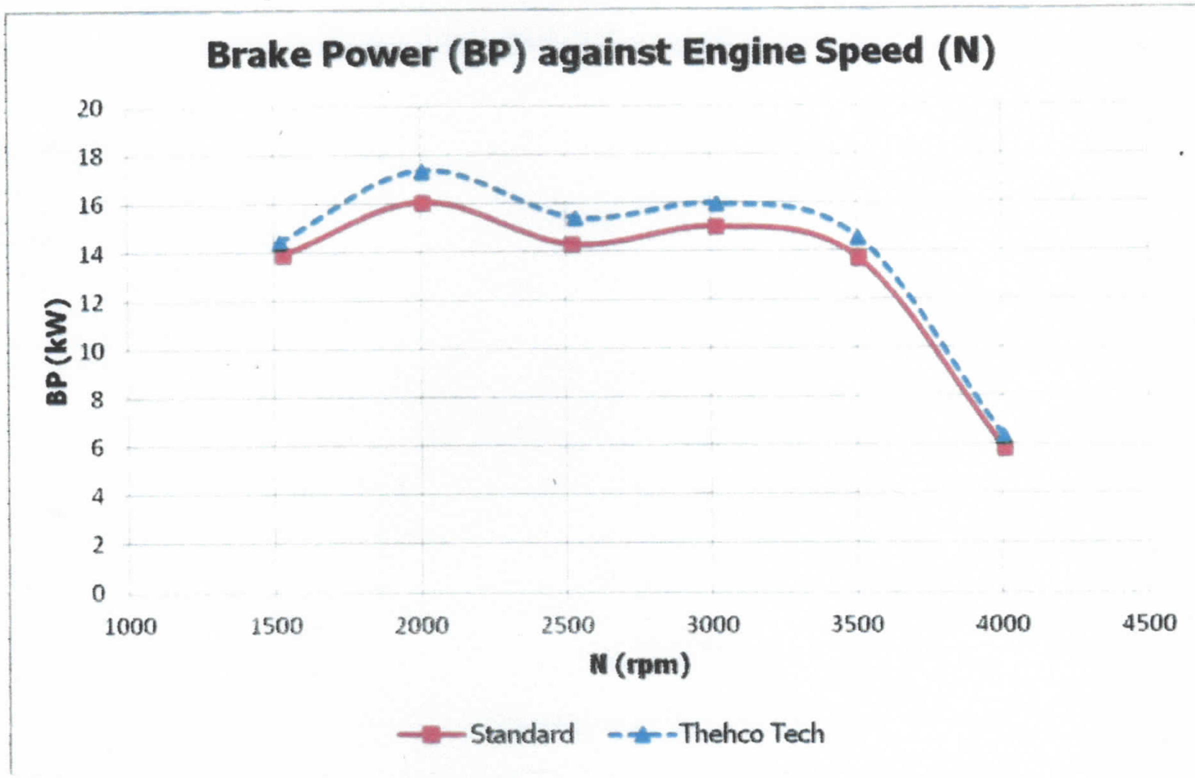


Figure 9: Graph of brake power against engine speed

7.1.3 Brake Specific Fuel Consumption (BSFC)

Figure 10 shows the graph of brake specific fuel consumption (BSFC) against engine speed. BSFC indicates the level of fuel used during engine operation. For the engine installed with Thehco Tech, the BSFC decreased by 5.31% (average) at the range of 1500 - 4000 rpm. The highest improvement is at 2000 rpm which indicates 6.79% decreased of BSFC. Generally minimum BSFC prevails with the used of Thehco Tech.

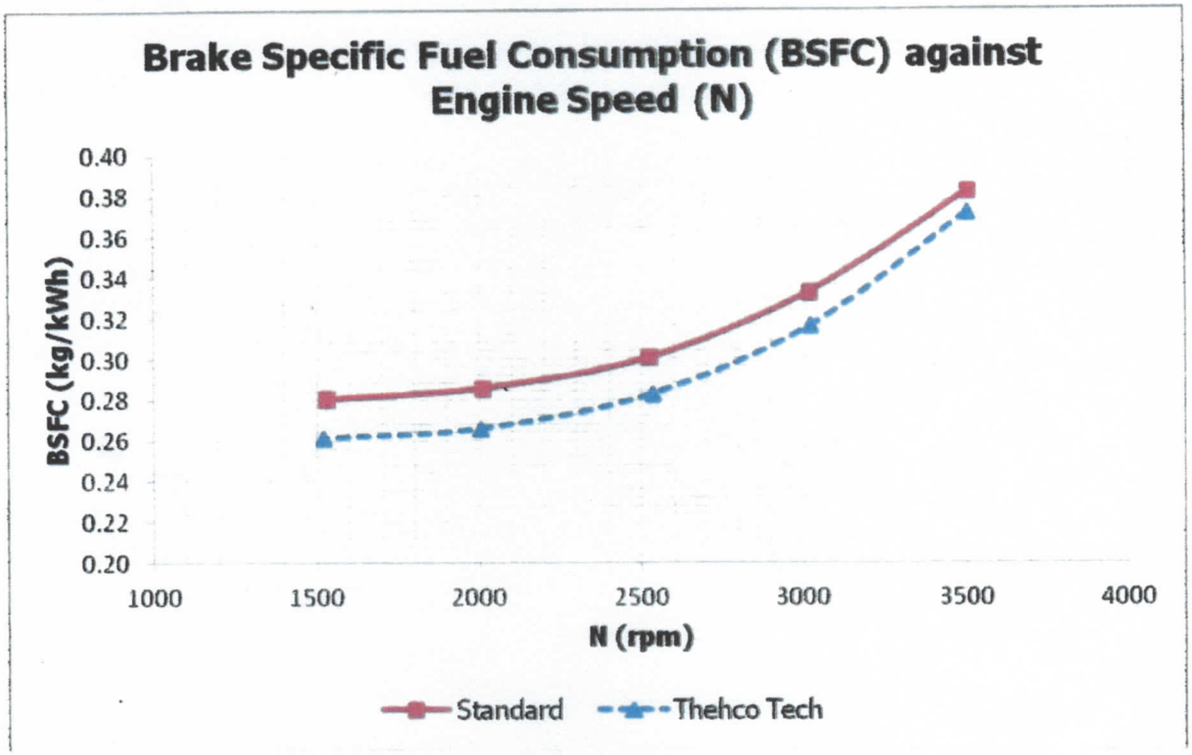


Figure 10: Graph of BSFC against engine speed

7.1.4 Brake Thermal Efficiency (η_{bth})

Brake thermal efficiency is a measurement of the efficiency of the engine to produce brake power from the amount of fuel being supplied. Figure 11 shows the graph of brake thermal efficiency against engine speed. For the engine runs with Thehco Tech, it shows that the brake thermal efficiency is increased at the range of with an average of 7.33%.

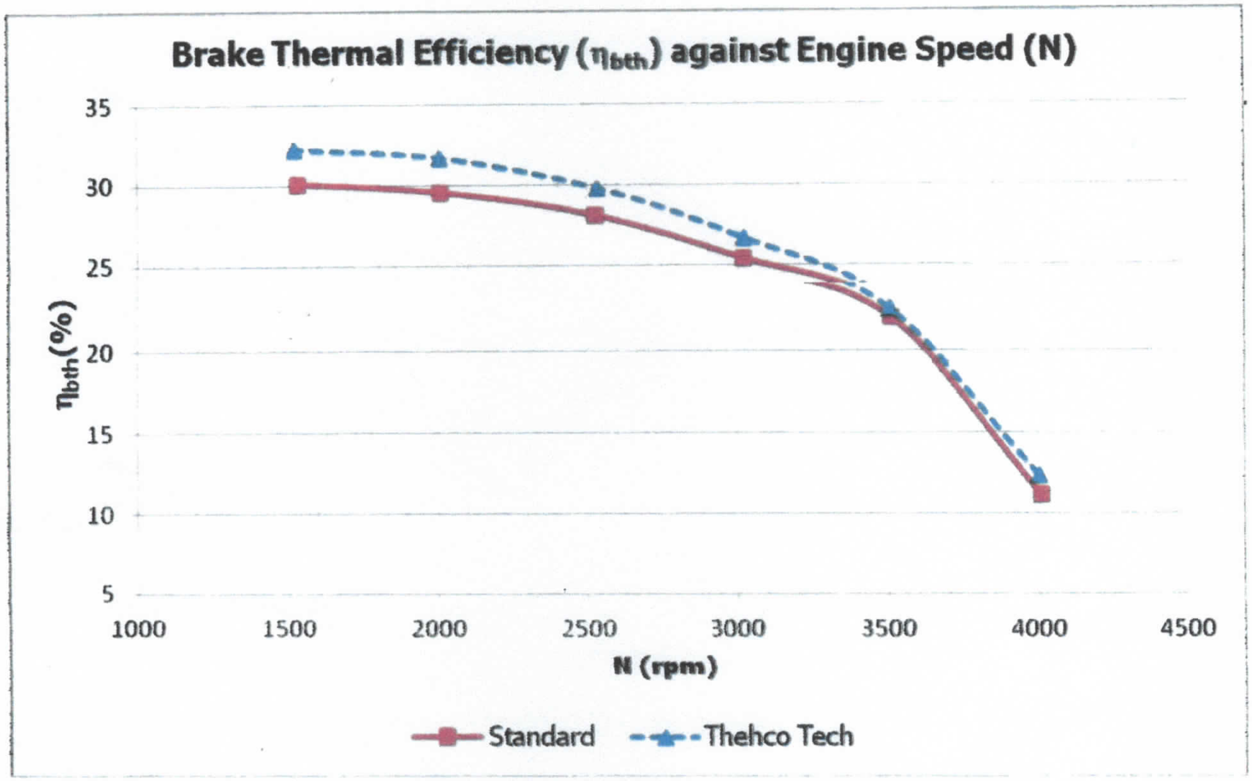


Figure 11: Graph of brake thermal efficiency against engine speed

7.2 Emission gases

7.2.1 Oxygen (O_2) and Carbon Dioxide (CO_2)

Oxygen (O_2) concentration of tailpipe exhaust gas shows excess air (lean mixture) to be present during combustion and this can lead to oxidation of nitrogen (NO_X) and heat loss. The carbon dioxide (CO_2) concentration indicates a product of complete combustion; however a high concentration of this gas will contribute toward global warming.

Figure 12 illustrates the graph of O_2 and CO_2 against engine speed for the tested engine before and after the used of Thehco Tech. The used of Thehco Tech does not give noticeable difference in O_2 and CO_2 gases

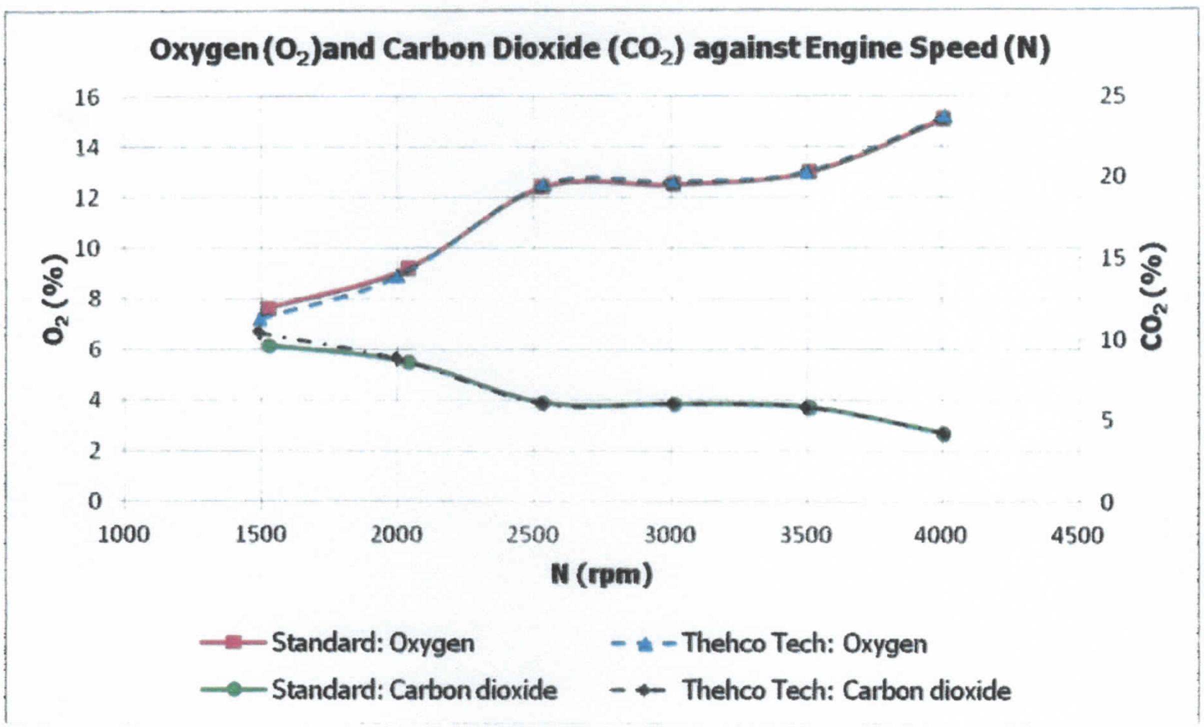


Figure 12: Graph of oxygen and carbon dioxide against engine speed

7.2.2 Oxides of Nitrogen (NO_X)

The concentration of oxides of nitrogen (NO_X) is directly proportional to combustion temperature. High cylinder temperature that occurs during the combustion process can cause nitrogen to react with oxygen to form NO_X.

Figure 13 shows the graph of NO_X and engine block temperature against engine speed. As the engine installed with Thehco Tech, the graph shows NO_X was decreased at the average of 6.76%. The NO_X level was reduced due to the reduction of engine block's temperature. The average decreased is 5.83%.

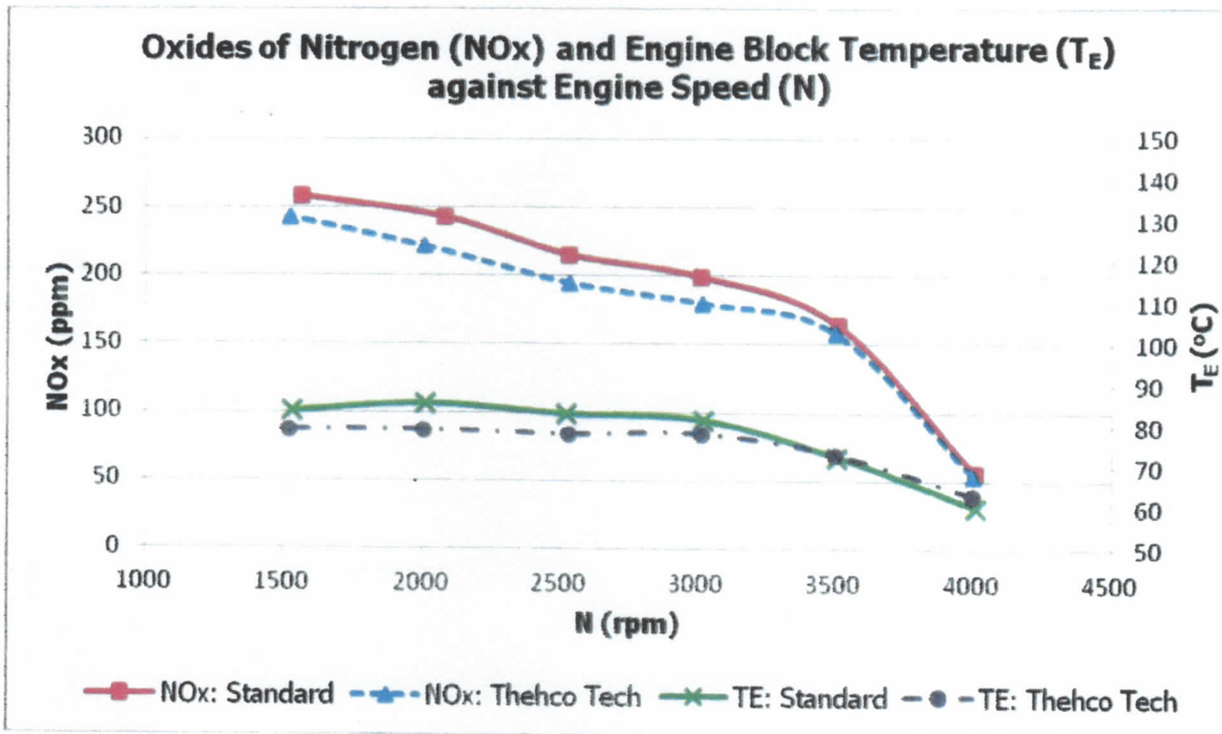


Figure 13: Graph of oxides of nitrogen against engine speed

7.2.3 Carbon Monoxide (CO) and Hydrocarbon (HC)

Carbon monoxides (CO) is a product of incomplete combustion and will be generated when carbon in the fuel is partially oxidized rather than fully oxidize to CO_2. It is also a highly toxicity gas. Excess hydrocarbon (HC) constituent indicates incompleteness of combustion (or partially burnt) and this may result in soot and particulate being formed.

Figure 14 and 15 illustrate the graph of CO and HC respectively against engine speed. The used of Thehco Tech does not give noticeable difference in CO and HC compared to the standard condition.

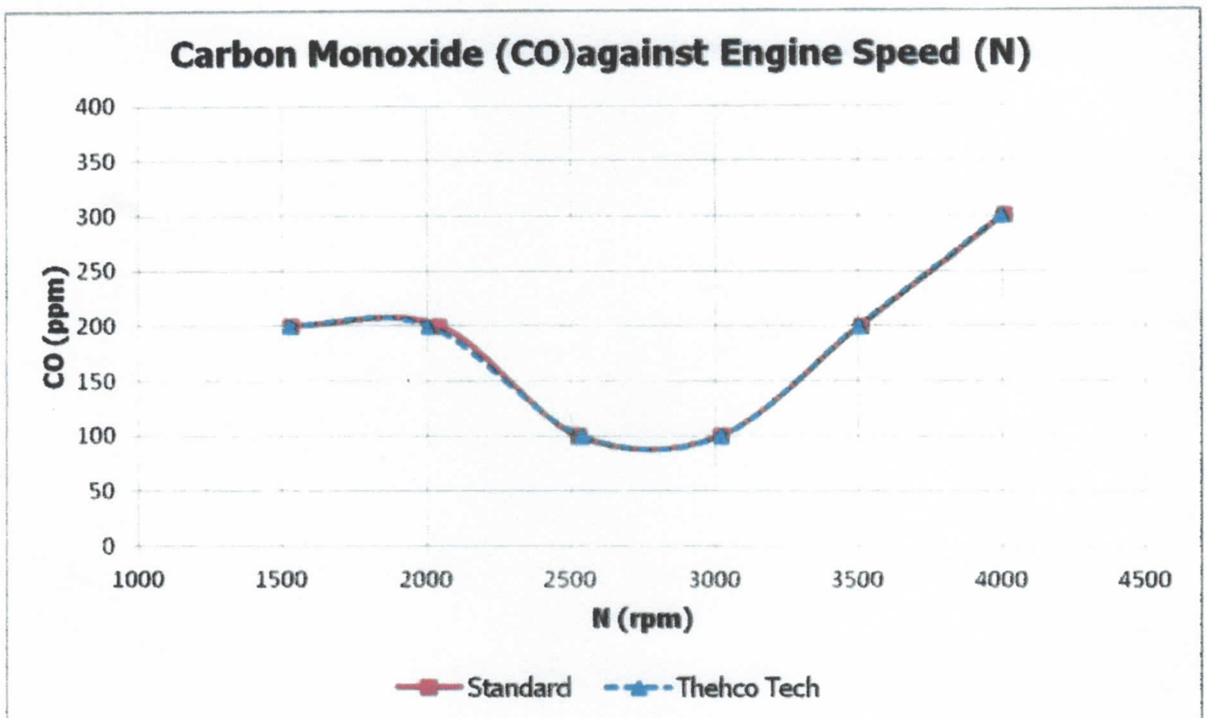


Figure 14: Graph of Carbon Monoxide against Engine Speed

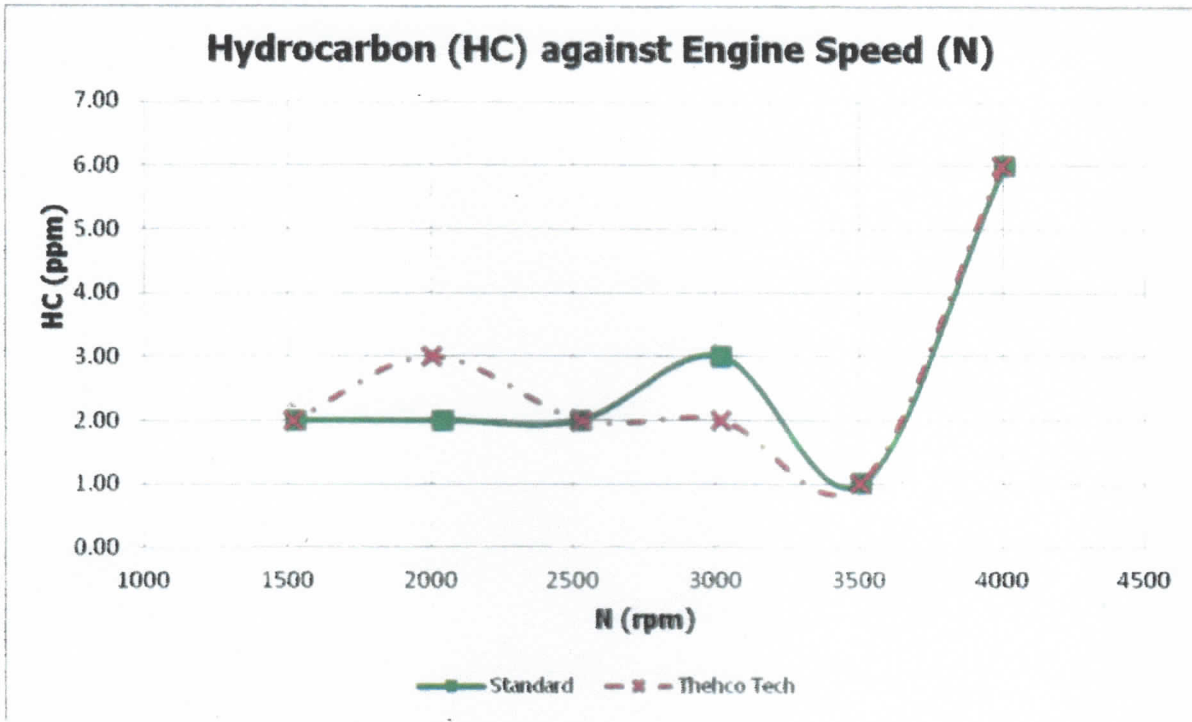


Figure 15: Graph of Hydrocarbon against Engine Speed

7.2.3 Smoke Index

The smoke index is used as soot test of the exhaust gas. For smoke index evaluation, the exhaust gas was trapped through a filter paper under specified engine condition. Then the blackening of the paper is assessed by visually against a reference smoke index numbers of No. 0 to No. 9.

Figure 16 shows the reference smoke index of Rubzahl-Scale Comparative 177 (TUV-12-RgD-018 Certified). The chart is certified by TUV (Technical Inspection Association of Germany Safety and Standards Institute). This is soot comparison chart for evaluation of exhaust emission precipitation on TUV certified filter paper.

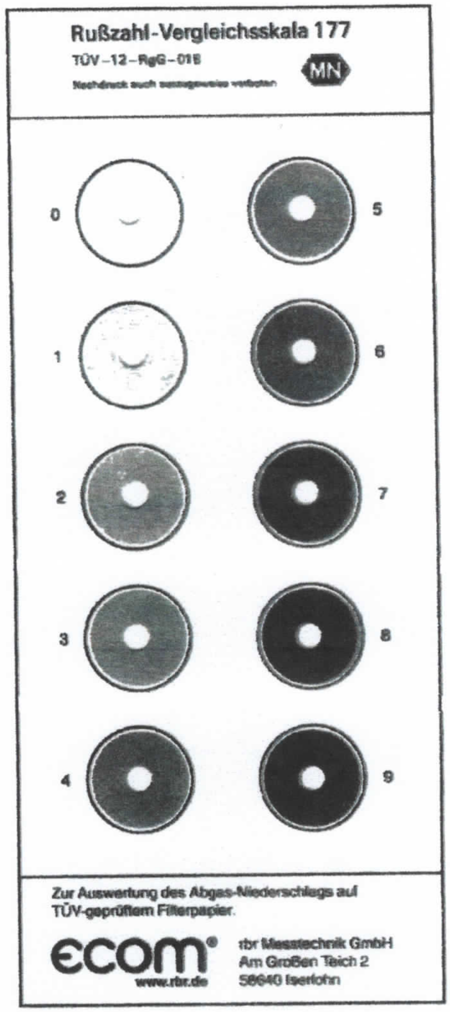


Figure 16: Rubzahl-Scale Comparative 177

Figure 17 shows smoke index against engine speed for both conditions of testing. The blackening of the exhaust smoke of the engine runs with Thehco Tech decreased one index at 2500 rpm and 4000 rpm respectively. The result of the soot test can be referred to Figure 19 in the Appendixes.

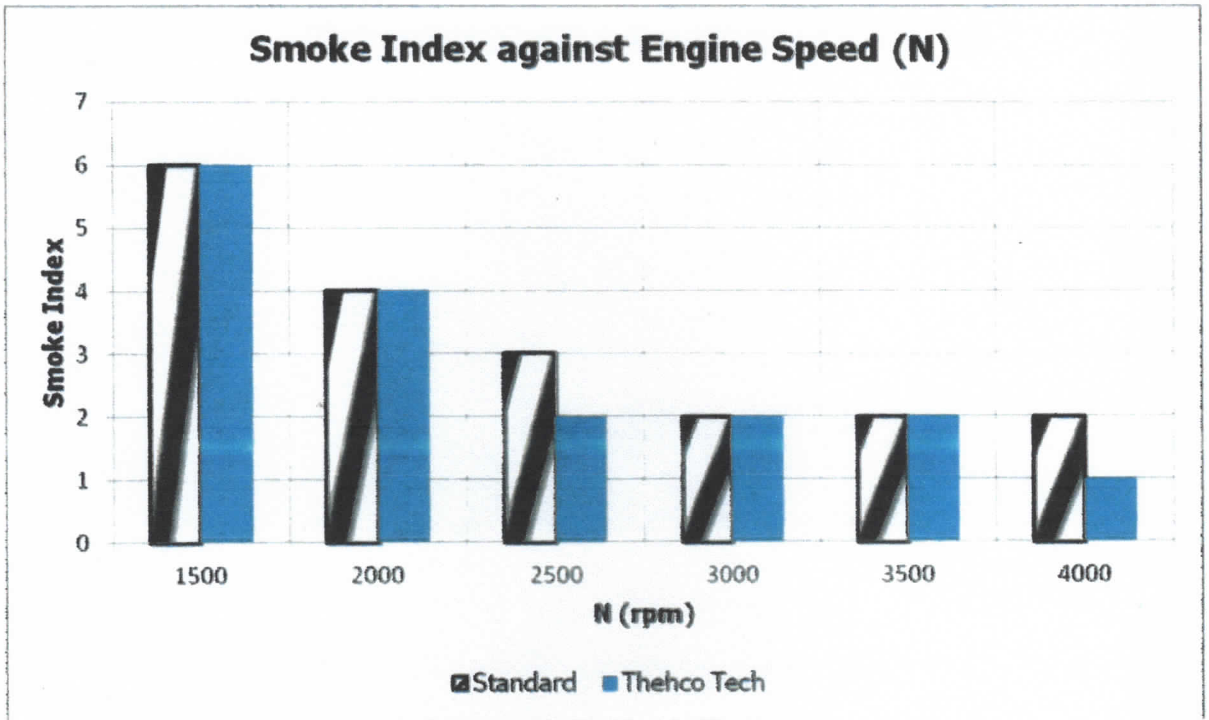


Figure 17: Graph of Smoke Index against Engine Speed

8.0 CONCLUSIONS

The salient points of this test work are derived as follows:

8.1 The results show the positive impact of the compression ignition engine performance for torque and BP when the engine equipped with Thehco Tech. The average increment of the torque and BP are 7.03% (maximum is 8.57% at 2000 rpm) and 6.88% (maximum is 8.33% at 2000 rpm) respectively.

8.2 When the engine is operated with Thehco Tech, it shows the average reduction of BSFC of 5.31% (maximum is 7.33% at 2000 rpm). This indicates that the fuel consumption is lower than the standard condition. In general, the observation indicates improvement in BSFC with the use of Thehco Tech.

8.3 Brake thermal efficiency (η_{bth}) of the engine used Thehco Tech indicates improved result compared to standard condition. The average increased is 7.33%.

8.4 The O_2, CO_2, CO and HC of both engine conditions do not give noticeable differences. This result indicates the engine installed with Thehco Tech does not have any adverse effect on the exhaust gas emissions except for the NO_X emissions. The used of Thehco Tech will decrease NO_X level at the average of 6.76% which shows a good indication.

8.5 As for the engine equipped with Thehco Tech, the smoke index is on par with standard condition for all engine speeds except for the speed of 2500 rpm and 4000 rpm, which decreased by one index.

APPENDIXES

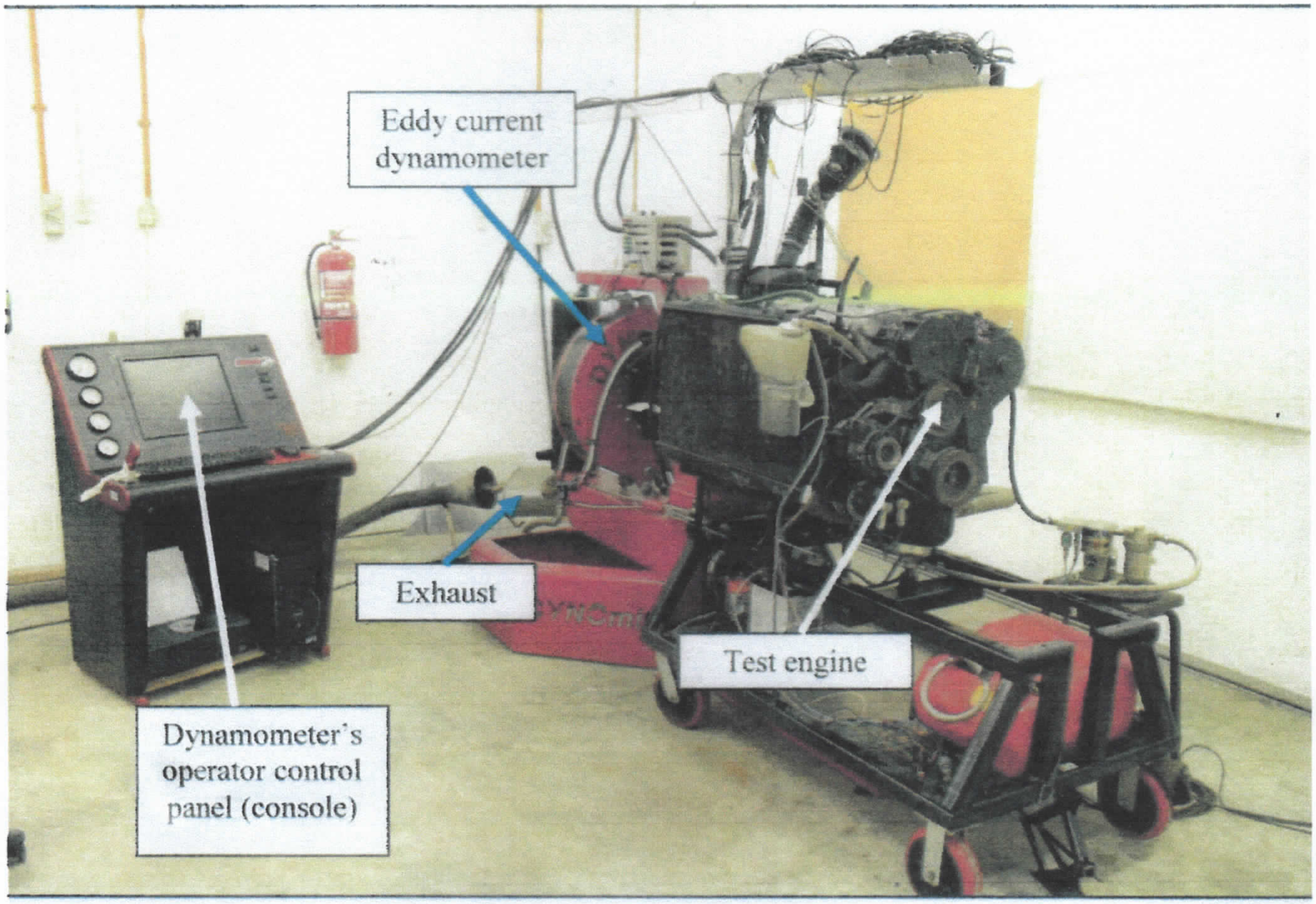


Figure 18: Engine trial using the Dynomite engine test facility

Standard		Thehco Tech	
Soot test	**Index Number**	**Soot test**	**Index Number**
	2		1
	2		2
	2		2
	3		2
	4		4
	6		6

Figure 19: Soot test specimens

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