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26. ISO 3046 Internal Combustion Engines – Performance

Part 1 - Engines for land, rail-traction and marine use - Standard reference conditions and declarations of power, fuel consumption and lubricating oil consumption.



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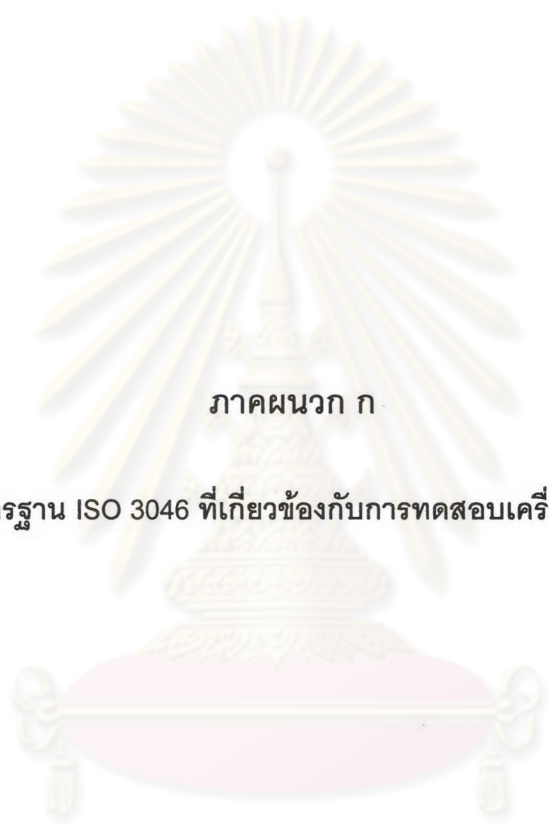
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ภาคผนวก

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ภาคผนวก ก

มาตรฐาน ISO 3046 ที่เกี่ยวข้องกับทดสอบเครื่องยนต์

ศูนย์วิทยทรัพยากร  
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## มาตรฐาน ISO 3046 ที่เกี่ยวข้องกับ การทดสอบเครื่องยนต์ [26]

### International Combustion Engines - Performance

Part 1 - Engines for land, rail-traction and marine use - Standard reference conditions and declarations of power, fuel consumption and lubricating oil consumption

#### ก.1 Scope

This report of ISO 3046 specifies the standard reference conditions and the methods of declaring of power, fuel consumption and lubricating oil consumption for reciprocating internal combustion engines using liquid or gaseous for particular engine applications.

#### ก.2 Field of application

This part of ISO 3046 covers reciprocating internal combustion engines for land, rail-traction and marine use, excluding engines to propel agricultural tractors, road vehicles and aircraft.

This part of ISO 3046 may be applied to engines used to proper road construction and earth-moving machines, industrial trucks and for other applications where no suitable International Standard for these engines exist.

#### ก.3 References

ISO1000, SI units and recommendation for the use of their multiples and of certain other units.

ISO 1204, Reciprocating internal combustion engines - Designation of the direction of rotation.

ISO 1205, Reciprocating internal combustion engines - Designation of the direction of cylinders.

ISO 1585, Road vehicles - Engine test code - Net power.

ISO 2534, Road vehicles - Engine test code - Gross power.

ISO 2710, Reciprocating internal combustion engines - General definitions.

ISO 3046/2, Reciprocating internal combustion engines - Performance - Part 2 : Engine tests.

ISO 3046/4, Reciprocating internal combustion engines - Performance - Part 4 :  
Speed governing.

ISO 3046/6, Reciprocating internal combustion engines - Performance - Part 6 :  
Overspeed protection

#### n.4 Units and terms

n.4.1 The units used are those of the International System of Units (SI Unit) described in ISO 1000.

n.4.2 The general engine terms used are as defined in ISO 2710.

#### n.5 Standard reference conditions

For the purpose of determining the power and fuel consumption of engines, the following standard reference conditions shall be used :

Total barometric pressure :

$$P_r = 100 \text{ kPa}$$

Air temperature :

$$T_r = 300 \text{ K (27 } ^\circ\text{C)}$$

Relative humidity :

$$\phi_r = 60 \%$$

Charge air coolant temperature :

$$T_{cr} = 300 \text{ K (27 } ^\circ\text{C)}$$

If other reference conditions are chosen, these shall be stated.

#### NOTES

1. Relative humidity of 60% corresponds to a water vapor pressure of 2,133 kPa (16 mmHg) at a temperature of 300 K.
2. The air density at the standard reference conditions is equivalent to that at 98 kPa (376 mmHg) and 20 °C and to that at 101 kPa (760 mmHg) and 30 °C
3. For automotive type inboard and outboard marine propulsion engines, the standard reference conditions in ISO 1585 and ISO 2534 may be applied but they shall be stated.



## n.6. Auxiliaries

### n.6.1 Introduction

In order to show alertly the conditions under which a power is determined, it is necessary to distinguish those auxiliaries which affect the final shaft output of the engine and also those which are necessary for the continuous or repeated use of the engine.

Items of equipment fitted to the engine and without which the engine could not in any circumstance operate at its declared power are considered to be engine components and are not therefore, classed as auxiliaries.

(Such as fuel injection pump, exhaust turbocharger and charge air cooler are in this category of engine components.)

**n.6.2 dependent auxiliary :** Item of equipment, the presence or absence of which affects the final shaft output of the engine.

**n.6.3 independent auxiliary :** Item of equipment which uses power supplied from a source other than the engine.

**n.6.4 essential auxiliary :** Item of equipment which is essential for the continued or repeated operation of the engine.

**n.6.5 non-essential auxiliary :** Item of equipment which is not essential for the continued or repeated operation of the engine.

## n.7 Declarations of power

### n.7.1 Introduction

#### n.7.1.1 Purpose of statement of power

Statements of power are required for two main purposes :

a) the declaration by a manufacturer of the value of the power which his engine will deliver under a given set of circumstances. This declared value is known as the "rated power".

b) the verification by measurement that the engine delivers the power which has been declared in a), under the same set of circumstances or after proper allowance has been made for any difference in circumstance.

To specify the set of circumstances under which the declared value of a power would be achieved, the declaration shall state :

- a) the kind of statement of power (see 7.4) and of necessary, the ambient and operating condition (see 7.4.2).
- b) the kind of power output (see 7.3).
- c) the kind of power (see 7.3).
- d) the corresponding engine speed.

#### NOTE

1. The term used in a) to c) may be combined, for example, continuous net brake fuel stop power.
2. Where appropriate to the engine application and the method of manufacture, the power achieved may be subject to a tolerance on the declared power. The existence of and its magnitude shall be stated by the manufacturer.
3. Measurement of the powers referred to in this International Standard shall be determined in accordance with ISO 3046/2.

#### n.7.1.2 Unit of power

Power shall be expressed in kilowatts (kW) The addition of the equivalent metric or imperial "horsepower" is permitted for a transitional period.

#### n.7.1.3 Power and torque

For engines delivering power by a shaft or shafts, any power in this International Standard is a quantity proportional to the mean torque, calculated or shafts transmitting this torque.

For engines delivering power other than by a shaft or shafts, reference shall be made to the appropriate International Standard for the driven for the driven machine.

#### n.7.1.4 Engine speed

The speed of an engine is the mean rotational speed of its crankshaft or crankshatts in revolution per minute, except in the case of “free piston” engines where the speed is the number of cycles per minute of the reciprocating components.

#### n.7.1.5 Engine with integral gearing

When stating the power of an engine fined with an integral (built-in) speed increasing or reducing device, the speed of the driving shaft extremist shall also be given at the declared engine speed.

### n.7.2 Kinds of power

#### n.7.2.1 Indicated power

The total power developed in the working cylinders by the gases on the combustion side of the working pistons.

#### n.7.2.2 Brake power

The power of the sum of the powers measured at the extremity of the engine driving shaft or shafts.

n.7.2.2.1 Any statement of brake powers shall be supported by the following list of auxiliaries :

- a) essential dependent auxiliaries as defined in 6.2 and 6.4;
- b) essential independent as define in 6.3 and 6.4;
- c) non-essential dependent auxiliaries as defined in 6.2 and 6.5.

The power absorbed by the independent and the non-essential dependent auxiliaries may be significant, in such cases, their power requirement shall be declared.

Note - Examples of typical auxiliaries are listed in annex A for guidance purposes. These lists are not necessary complete.

#### n.7.2.3 Net brake power

The brake power measured when the engine is using only the auxiliaries listed in 7.2.2 a).



### ก.7.3 Kinds of power output

#### ก.7.3.1 continuous power

Power which an engine is capable of delivering continuous, between the normal maintenance intervals stated by the manufacturer, at stated speed and under stated ambient conditions, the maintenance prescribed by the manufacturer being carried out.

#### ก.7.3.1 Overload power

Power which an engine may be permitted to deliver, at stated ambient conditions, immediately after working at the continuous power.

The duration and frequency of use of overload power which is permitted will depend on the service application but adequate allowance shall be made in setting the engine fuel stop permit the overload power shall be expressed as a percentage of the continuous power, together with the duration and frequency permitted and the appropriate engine speed.

Unless otherwise stated an overload power of 110% of the continuous power at a speed corresponding to the engine application is permitted for a period of 12 hours of operation.

#### NOTES

1. The power of marine main propulsion engines is normally limited to to continuous power, so that the overload power cannot be given in service. However, for special applications, marine main propulsion engines may develop overload power in service.
2. If the engine application is not determined, the engine manufacturer shall specify the overload power and the corresponding engine speed.

#### ก.7,3.2 Fuel stop power

Power which an engine is capable of delivering during a stated period corresponding to its application, and at stated speed and under stated ambient conditions, with the fuel limit so that the fuel stop power cannot exceeded.

#### n.7.4 Kinds of statements of power

##### n.7.4.1 ISO powers

##### n.7.4.1.1 ISO power

Power determined under the operating conditions of the manufacturer's test bed and adjusted to the standard reference conditions in clause 5.

##### n.7.4.1.2 ISO standard power

The name given of the continuous net brake power which the engine manufacturer declares that an engine is capable of delivering continuously, between the normal maintenance intervals stated by the manufacturer, and under the following conditions :

- a) at a stated speed under the operating conditions of the engine manufacturer's test bed;
- b) with the declared power adjusted to the standard reference conditions given in clause 5;
- c) the maintenance prescribed by the engine manufacturer being carried out.

##### n.7.4.2 Service power

Power determined under the ambient and operating conditions of an engine application.

To establish service power, the following conditions shall be taken into account :

- a) the ambient conditions, or any nominal ambient conditions according to the special requirements of inspecting and/or legislative authorities and/or classification societies, as specified by the customer (see clause 12);
- b) the normal duty of the engine;
- c) the expected interval between maintenance periods;
- d) the nature and amount of the supervision required;
- e) all information relevant to the operation of the engine in service (see clauses 12 and 13).

## n.8. Declarations of fuel consumption

### n.8.1 Definitions

#### n.8.1.1 Fuel consumption

The quantity of fuel consumed by an engine per unit of time at a state power and under stated conditions.

The quantity of liquid fuels shall be expressed in mass units (kg).

The quantity of gaseous fuels shall be expressed in energy units (J).

#### n.8.1.2 Specific fuel consumption

The fuel consumption per unit of power.

#### n.8.1.3 ISO specific fuel consumption

The name given in the specific fuel consumption at the ISO standard power.

If not otherwise specified by the manufacturer, a declared specific fuel consumption shall be considered to be the ISO specific fuel consumption.

### n.8.2 Reference calorific value of fuels

#### n.8.2.1 Liquid fuel engines

The declared specific fuel consumption of a liquid fuel engine shall be related to a reference lower calorific value of 42,000 kJ/kg (10,030 kcal/kg).

#### n.8.2.2 Gas engines

The declared specific fuel consumption of a gas engines shall be related to a stated lower calorific value the gas. The type of gas shall be declared.

#### n.8.2.3 Specific fuel consumption declarations

The specific fuel consumption of an engine shall be declared at :

- a) the ISO standard power;
- b) (if required by special agreement) at any other declared powers and at specific engine speeds appropriate to the particular engine application.

Unless otherwise states, a deviation of +5% is permitted for the specific fuel consumption for the declared power.



## n.9. Declarations of lubricating oil consumption 1 Lubricating oil consumption

### n.9.1 Lubricating oil consumption

The quantity of lubricating oil consumed by an engine per unit of time. This quantity is used for guidance. It shall be expressed in litres or kilograms per engine operating hour at the declared power and engine speed.

n.9.2 The lubricating oil consumption after a stated period of running-in shall be declared.

n.9.3 The oil discarded during an engine oil change shall be not included in the lubricating oil consumption declaration.

## n.10. Adjustment of net brake power for ambient conditions

n.10.1 When it is required to operate the engine under conditions difference from the standard reference conditions given in clause 5, the net brake power output shall be adjusted to or from the standard reference conditions by the following formulae (see note 1) :

$$P_x = \alpha P_r \quad (n-1)$$

$$\alpha = k - 0.7(1-k) \left( \frac{1}{\eta_m} - 1 \right) \quad (\text{see note 2}) \quad (n-2)$$

$$k = \left( \frac{p_x - a\phi_x p_{sx}}{p_r - a\phi_r p_{sr}} \right)^m \left( \frac{T_r}{T_x} \right)^n \left( \frac{T_{cr}}{T_{cx}} \right)^q \quad (n-3)$$

n.10.2 In the case of turbocharged engines in which the limits of turbocharger speed and turbocharger turbine inlet temperature have not been reached at the declared power under standard reference conditions, the manufacturer may declare substitute reference conditions to or from which power adjustments is to be made. The following formulae (4) and (5) will then be used instead of formula (3)

$$k = \left( \frac{p_x}{p_r} \right)^m \left( \frac{T_r}{T_x} \right)^n \left( \frac{T_{cr}}{T_{cx}} \right)^q \quad (n-4)$$

$$p_{ra} = P_r \times \left( \frac{\pi_r}{\pi_{max}} \right) \quad (n-5)$$

Where :

$P_r$  is the brake power;

$p_r$  is the standard reference total barometric pressure;

$p_{sr}$  is the saturation vapour pressure under standard reference conditions;

$\phi_r$  is the standard reference relative humidity;

$T_r$  is the standard reference absolute air temperature;

$T_{cr}$  is the standard reference absolute charge or coolant temperature;

$P_{ra}$  is the substitute reference total barometric pressure given by formula (5);

$T_{ra}$  is the substitute reference absolute air temperature to be stated by the manufacturer;

$\pi_r$  is the boost pressure ratio at declared power under standard reference conditions to be stated by the manufacturer;

$\pi_{max}$  is the maximum available boost pressure ratio to be stated by the manufacturer;

$\alpha$  is the power adjustment factor;

$k$  is the ratio of indicated power;

$\eta_m$  is the mechanical efficiency (see note 4);

$P_x$  is the brake power under the conditions being considered;

$p_x$  is the total barometric pressure condition being considered;

$p_{sx}$  is the saturation vapour pressure under pressure the conditions being considered;

$\phi_x$  is the relative humidity condition being considered;

$T_x$  is the absolute air temperature being considered;

$T_{cr}$  is the absolute charge air coolant temperature at charge air cooler inlet being considered.

The factor  $a$  and exponent  $m$ ,  $n$ , and  $q$  have the numerical value given in table 1 (see note 5).

#### NOTES

1. For the convenience of users of these formulae, reference may be made to tables and nomograms in annexes B to 0, which also include numerical examples.

2. When the ambient conditions are more favourable than the standard reference conditions, the declared power under the ambient conditions may be limited by the manufacturer to the declared power at the standard reference conditions.

3. If the relative humidity is not known, a value of 60% should be assumed in formulae references A, E and G in table 1.

For all other formulae references the power adjustment is independent of humidity ( $a = 0$ ).

4. The value of mechanical efficiency shall be stated by the engine manufacturer. In the absence of any such statement, the value of  $\eta_m = 0.80$  will be assumed.

5. When declaring the ISO standard power the engine manufacturer shall state which of the formulae references in table 1 is applicable.



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Table n-1 - Numerical values for power adjustment

Engine type	Condition		Formula reference	Factor	Exponents		
				a	m	n	q
Compression ignition oil engine and dual-fuel engines	Non - turbocharged	Power limited by air excess	A	1	1	0.75	0
		Power limited by thermal reason	B	0	1	1	0
	Turbocarged without charge air cooling	Low and medium speed	C	0	0.7	2	0
	Turbocarged with charge air cooling	four-stroke engine	D	0	0.7	1.2	1
Spark ignition engines using gaseous fuel	Non - turbocharged		E	1	0.86	0.56	0
	Turbocarged with charge air cooling	Low and medium speed four-speed engine	F	0	0.57	0.55	1.75
Spark ignition engines using liquid fuel	Naturally aspirated		G	1	1	0.5	0

NOTE - The factors and exponents given in table 1 have been established by tests on a number of engines to be generally representative and shall be used in the absence of any other specific information; for example in formula reference D, for an engine with the charge air cooled by engine jacket water, the value for exponent q could be zero. At present, they apply only to the type of engines specified but table 1 will be extended to include other types when sufficient are available.



## n.11 Adjustment of fuel consumption for ambient conditions

n.11.1 When it is required to operate the engine under conditions different from the standard reference conditions given in clause 5, the fuel consumption will differ from that declared for the standard reference conditions and shall be adjusted to or from the standard reference conditions.

The following formulae shall be used if other methods are not declared by the engine manufacturers :

$$b_x = \beta b_r \quad (n-6)$$

where

$$\beta = k/\alpha \quad (n-7)$$

where :

$b$  is the specific fuel consumption

$\beta$  is the fuel consumption adjustment factor

$\alpha$  is the power adjustment factor (see 10.1)

$k$  is the ratio of indicated power (see 10.1)

Subscript  $r$  corresponds to values under the standard reference conditions.

Subscript  $x$  corresponds to values the conditions being considered.

NOTE - For the convenience of users of these formulae, reference may be made to the tables and nomograms in annexes B to 0, which also include numerical examples.

## n.12 Information to be supplied by the customer

The customer shall supply the following information concerning the required power :

- a) The application and the power required from the engine and details arising therefrom.
- b) The expected frequency and duration of the required powered and the corresponding engine speeds.
- c) Site conditions
  - 1) Site barometric pressure (highest and lowest reading available; if no pressure data are available the altitude above sea level).
  - 2) The monthly mean minimum and maximum air temperatures during the hottest and coldest months of the year.

- 3) The highest and lowest ambient air temperatures around the engine.
  - 4) The relative humidity (or alternatively the water vapour pressure or the wet and dry bulb temperature) ruling at the maximum temperature conditions.
  - 5) The maximum and minimum temperature of the cooling water available.
- d) The specification and lower calorific value of the fuel available.
  - e) Whether the engine is to comply with the requirements of any classification society or with special requirements.
  - f) The probable period for which the engine will be running continuously, and the duration of maximum and minimum load.
  - g) Any other information appropriate to the particular engine application.

#### n.13 Information to be supplied by the engine manufacturer

The engine manufacturer shall supply the following information :

- a) The declared powers.
- b) The corresponding crankshaft and output shaft speeds.

**NOTE** - For certain applications of variable engines it is common practice to supply a power/speed diagram covering the ranges of power over which the engine can be used in continuous and in short period operation.

- c) The direction of rotation (see ISO 1204).
- d) The number and arrangement of cylinders (see ISO 1205).
- e) Whether the engine is two-stroke or four-stroke, naturally aspirated, mechanically pressure charge or turboccharged and whether with or without charge air cooler.
- f) The quantity of air required for the operation of the engine for :
  - 1) combustion and scavenging;
  - 2) cooling and ventilation.
- g) The method of starting, apparatus supplied and additional apparatus required.
- h) The type and grade of lubricating oil(s) recommended.

j) The type of governing, with speed droop of required (see ISO 3046/4 and ISO 3046/6).

If for variable speed duties, the working speed range and the idling speed.

If necessary, the critical speed range shall be indicated.

k) The method of cooling and the capacity of the cooling system with the rates of circulation of the cooling fluids.

m) (From air cooled engines only.) Whether hot air discharge ducting can be fitted.

n) A schedule recommended maintenance and overhaul periods.

p) Specifications and lower calorific values of fuels recommended.

q) Maximum permissible back-pressure in the exhaust system and the maximum permissible intake depression.

r) Any other information appropriate to the particular engine application.



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



ภาคผนวก ข

การวัดอัตราการใช้ของอากาศ

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

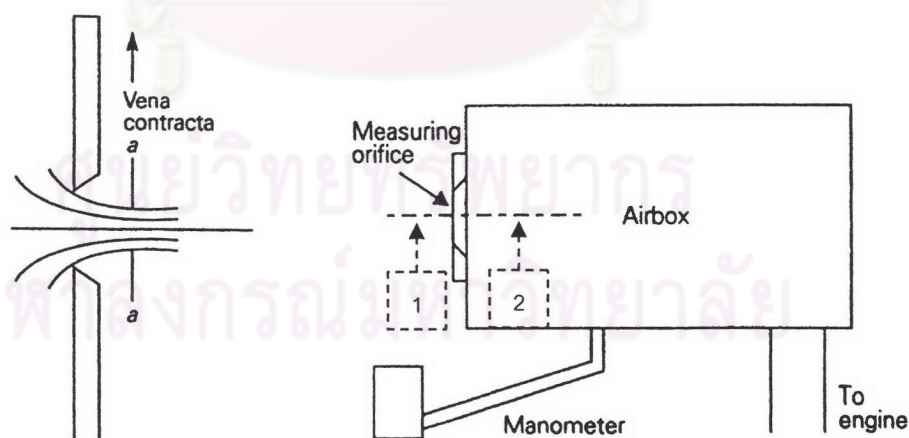
## การวัดอัตราการไหลของอากาศด้วยวิธี Air box method [25]

การวัดอัตราการไหลของอากาศด้วยวิธี Air box method เป็นการวัดโดยใช้แผ่นออริฟิซ ประกอบกับถังพักอากาศ ซึ่งถังพักอากาศจะช่วยลดการกระเพื่อมของอากาศที่ถูกดูดตามจังหวะการทำงานของเครื่องยนต์ ทำให้อากาศที่ไหลผ่านออริฟิซมีอัตราการไหลที่สม่ำเสมอสามารถวัดความดันตกคล่อมได้ถูกต้องมากขึ้น

ขนาดเส้นผ่านศูนย์กลางของแผ่นออริฟิซโดยประมาณ ที่อัตราการไหลต่างๆ แสดงดังตาราง ข-1

ตาราง ข-1 แสดงขนาดเส้นผ่านศูนย์กลางของออริฟิซโดยประมาณที่อัตราการไหลต่างๆ

Orifice diameter (mm.)	Air Flow rate (m <sup>3</sup> /s)	Mass Flow rate (kg/s)
10	0.002	0.002
20	0.008	0.009
50	0.048	0.057
100	0.19	0.23
150	0.43	0.51



รูปที่ ข-1 แสดงภาพการวัดอัตราการไหลของอากาศด้วยวิธี Air box method [25]

ภาพซ้ายแสดงการไหลของอากาศผ่านแผ่น orifice plate

ภาพขวาแสดงภาพ Orifice flow meter



ปริมาตรของถังที่เล็กที่สุดที่จะทำให้ไม่เกิดการกระเพื่อมของอากาศที่ไหล ได้ถูกวิเคราะห์ โดย Kastner [25] ดังสมการ (ข-1)

$$V_b = \frac{417 \times 10^6 K^4 d^2}{N_c V_s n_{\min}^2} \quad (\text{ข-1})$$

- โดยที่  $V_b$  คือ ปริมาตรถังพักอากาศที่เล็กที่สุด ( $\text{m}^3$ )  
 $K$  คือ ค่าคงที่มีค่าเท่ากับ 1 สำหรับเครื่องยนต์ 2 จังหวะ และ  
 มีค่าเท่ากับ 2 สำหรับเครื่องยนต์ 4 จังหวะ  
 $d$  คือ เส้นผ่านศูนย์กลางของ orifice plate (m)  
 $N_c$  คือ จำนวนกระบอกสูบของเครื่องยนต์  
 $V_s$  คือ ปริมาตรช่วงชักลูกสูบ ( $\text{m}^3$ )  
 $N_{\min}$  คือ ความเร็วรอบเครื่องยนต์ที่น้อยที่สุด (rev/min)

สมมติให้อากาศที่ไหลผ่าน orifice plate เป็นของไหลอัดตัวไม่ได้ (Incompressible flow) และพิจารณาให้ความหนาแน่นของอากาศคงที่ จากสมการเบอร์นูลลี จะได้ว่า

$$\frac{p_1}{\gamma_{\text{air}}} + \frac{v_1^2}{2g} + Z_1 = \frac{p_2}{\gamma_{\text{air}}} + \frac{v_2^2}{2g} + Z_2 \quad (\text{ข-2})$$

- โดยที่  $p$  คือ ความดัน (kPa)  
 $v$  คือ ความเร็วอากาศ (m/s)  
 $\gamma_{\text{air}}$  คือ น้ำหนักจำเพาะของอากาศ ( $\text{kg/m}^2 \cdot \text{s}^2$ ) =  $\rho_{\text{air}} g$   
 $\rho_{\text{air}}$  คือ ความหนาแน่นของอากาศ ( $\text{kg/m}^3$ ) เท่ากับ  $1.165 \text{ kg/m}^3$  ที่  $30^\circ\text{C}$   
 $Z$  คือ ระดับความสูง (m)  
 $g$  คือ ค่าความเร่งเนื่องจากแรงโน้มถ่วงของโลก ( $\text{m/s}^2$ ) เท่ากับ  $9.807 \text{ m/s}^2$   
 ตัวห้อย 1 และ 2 คือตำแหน่งสถานะ 1 และ 2 ในรูป ข-1 ขวา ตามลำดับ

เนื่องจากสถานะ 1 เป็นอากาศนิ่ง และทั้งสองสถานะอยู่ในระดับความสูงเดียวกัน ดังนั้น จะได้ความเร็วของอากาศ ตามสมการที่ (ข-5)

$$v_2 = \sqrt{\frac{2\Delta p}{\rho_{\text{air}}}} \quad (\text{ข-3})$$

การไหลผ่าน orifice จะเกิด Vena contracta ซึ่งจะทำให้การไหลจริงน้อยกว่าทฤษฎีเสมอ ดังนั้นเมื่อคิดการไหลแบบคงตัว จะได้อัตราการไหลโดยมวลของอากาศ คือ

$$m_a = C_{DO} \rho_{air} v A_o \quad (ข-4)$$

โดยที่  $C_{DO}$  คือ Discharge coefficient ของ orifice plate

$A_o$  คือขนาดของ orifice ( $m^2$ )

การวัดผลต่างความดันตกคร่อม orifice plate จะวัดโดยใช้मानมิเตอร์ ซึ่งจะได้ค่า head ในหน่วย mm.H<sub>2</sub>O ซึ่งสามารถนำมาคำนวณหาผลต่างความดันตกคร่อม orifice plate ได้จากสมการ

$$\Delta p = \rho_{H_2O} g \Delta h \quad (ข-5)$$

โดยที่  $\Delta h$  คือ ผลต่าง Head ที่อ่านได้จากमानมิเตอร์ (mmH<sub>2</sub>O)

$\rho_{H_2O}$  คือ ความหนาแน่นของอากาศ ( $kg/m^3$ ) เท่ากับ  $997 \text{ kg/m}^3$

เมื่อนำสมการ (ข-5) และ (ข-7) มาแทนลงในสมการ (ข-6) จะได้สมการที่นำไปใช้งาน คือ

$$m_a = C_{DO} A_o \sqrt{2 \rho_{air} \rho_{H_2O} g \Delta h} \quad (ข-6)$$

ดังนั้นจากสมการ (ข-2) และ (ข-8) จะสามารถหาอัตราส่วนผสมเชื้อเพลิงต่ออากาศ และ Equivalent ratio ได้จากสมการดังต่อไปนี้

$$F/A = \frac{\rho_f V/t}{C_{DO} A_o \sqrt{2 \rho_{air} \rho_{H_2O} g \Delta h}} \quad (ข-7)$$

$$\text{Equivalent ratio} = \frac{(F/A)}{(F/A)_s}$$



ภาคผนวก ค

ข้อมูลในการทดสอบสมรรถนะ

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

ตารางที่ ค -1 แสดงข้อมูลจากกราฟทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference Diesel ความเร็วรอบ 1050 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3		
1.	5	31.9	28.6	767	79	114	51	36	79	88	2.2	0.72	119.31	122.88	118.02	0.7	120.07
2.	10	32	28.9	766.8	80	150	46	35	79	88	2.2	0.7	82.34	82.92	83.26	1.0	82.84
3.	15	31.6	28.6	766.8	81	190	44	34	80	86	2.1	0.73	64.88	64.43	64.79	1.1	64.7
4.	20	31.6	29	766.5	79	232	42	34	81	89	2.1	0.69	52.44	52.34	52.11	2.6	52.29667
5.	25	31.8	28.8	766.5	77	283	41	35	82	90	1.6	0.72	42.75	42.87	41.62	4.1	42.41333
6.	30	31.6	28.4	766.5	78	337	40	36	82	88	1.5	0.71	36.01	35.92	35.56	4.7	35.83
7.	35	31.6	28.3	766.2	80	400	39	35	83	89	1.5	0.68	30.32	29.98	30.32	5.7	30.20667
8.	40	31.8	28.8	766	79	420	37	37	84	89	1.5	0.69	26.1	25.42	26.1	6.7	25.87333
9.	42.4	33.3	31	763.5	82	489	34	41	96	90	2	0.4	18.93	19.15	19.03	9.7	19.03667

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m.) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.967018	0.546152	0.00006884	0.00006846	451.2346	17.3558	18.288	0.006134	0.011223	0.162657	1.005651	1.00664	0.999018
2.	10	9.940901	1.093059	0.00009978	0.00009928	326.9809	23.95105	17.78	0.006046	0.016503	0.239174	1.00506	1.005945	0.99912
3.	15	14.88841	1.637066	0.00012776	0.00012695	279.1682	28.05311	18.542	0.006179	0.020678	0.299676	1.006379	1.007495	0.998892
4.	20	19.86033	2.183758	0.00015806	0.00015712	259.0168	30.23563	17.526	0.006006	0.026318	0.38142	1.005985	1.007032	0.99896
5.	25	24.84454	2.7318	0.00019489	0.00019386	255.47	30.6554	18.288	0.006133	0.031778	0.460549	1.005325	1.006257	0.999074
6.	30	29.7905	3.275637	0.00023070	0.00022933	252.0367	31.07299	18.034	0.006092	0.037868	0.548816	1.005985	1.007032	0.99896
7.	35	34.77156	3.823333	0.00027365	0.00027213	256.2309	30.56436	17.272	0.005961	0.045907	0.666319	1.005591	1.006657	0.999028
8.	40	39.78173	4.37423	0.00031948	0.00031799	261.7102	29.92445	17.526	0.006002	0.05323	0.771453	1.004669	1.005487	0.999187
9.	42.4	42.57564	4.681437	0.00043421	0.00043574	335.0853	23.37177	10.16	0.004551	0.095409	1.382741	0.996489	0.995875	1.000617



ตารางที่ ค-2 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference Diesel ที่ความเร็วรอบ 1200 rev/min

Run Number	Torque (N-m)		ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
	T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3			
1.	5	32	29	766	127	49	36	83	89	2.5	0.92	101.5	101.01	100.31	0.5	100.94	
2.	10	32.2	29	765.8	160	48	36	82	87	3	0.9	73.02	73.43	72.23	0.5	72.89333	
3.	15	32.4	29.2	765.5	196	45	37	82	88	2.7	0.89	57.07	56.95	57.44	1.5	57.15333	
4.	20	32.6	29.2	765.5	239	42	34	83	88	2.6	0.89	45.08	44.78	45.28	2.5	45.04667	
5.	25	32.2	29.4	765.5	296	41	37	83	88	2.4	0.88	37	36.6	37.5	4.2	37.03333	
6.	30	32.2	29.2	765.5	343	40	37	84	87	2	0.87	31.8	31.72	31.81	4.6	31.77667	
7.	35	32.2	29.4	765	409	39	36	85	90	1.8	0.88	26.22	26.51	26.03	5.6	26.25333	
8.	40	32.2	29	765	485	38	36	86	88	1.9	0.87	22.13	22.32	22.22	6.0	22.22333	
9.	43	33.4	31	763.5	478	34	40	99	87	2.2	0.58	16.25	16.16	16.16	9.7	16.19	

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.976546	0.625371	0.00008189	0.00008156	469.5245	16.67972	23.368	0.006928	0.01182	0.171306	1.004011	1.004713	0.999301
2.	10	9.963807	1.252089	0.00011340	0.00011305	325.0382	24.0942	22.86	0.006849	0.016556	0.239949	1.003091	1.003632	0.999461
3.	15	14.96409	1.880443	0.00014463	0.00014433	276.3186	28.34241	22.606	0.006807	0.021246	0.307906	1.002042	1.002042	0.999643
4.	20	19.96747	2.509186	0.00018350	0.00018324	262.9061	29.78834	22.606	0.006805	0.026964	0.390787	1.001387	1.001629	0.999758
5.	25	24.92098	3.131663	0.00022320	0.00022260	255.8938	30.60463	22.352	0.006771	0.032963	0.477726	1.002698	1.003171	0.999529
6.	30	29.90518	3.757996	0.00026013	0.00025943	248.5209	31.51258	22.098	0.006733	0.038636	0.559945	1.002698	1.003171	0.999529
7.	35	34.91616	4.387694	0.00031486	0.00031421	257.8045	30.3778	22.352	0.006769	0.046513	0.674107	1.002044	1.002401	0.999643
8.	40	39.90418	5.014508	0.00037195	0.00037119	266.4856	29.38821	22.098	0.006731	0.055263	0.800914	1.002044	1.002401	0.999643
9.	43	43.1947	5.428006	0.00051056	0.00051253	339.9225	23.03918	14.732	0.005479	0.09318	1.350429	0.996164	0.995493	1.000674

ตารางที่ ค-3 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference Diesel ที่ความเร็วจอบ 1400 rev/min

Run Number	Torque (N-m)		ambient condition (°C)				Temperature(°C)					Pressure (inch. H2O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
	T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3	1	2	3		
1.	32.4	29.2	764.8	83	146	49	35	82	90	4	1.25	85.56	84.98	85.59	0.4	85.37667			
2.	32.2	29.2	764.5	82	170	46	36	82	90	4.4	1.24	60.63	64.15	60.71	0.7	61.83			
3.	32	29.2	764.5	79	202	43	35	83	88	4.5	1.23	48.85	49.78	48.58	1.1	49.07			
4.	32.4	29.4	764.5	80	248	42	37	84	89	4.3	1.23	39.16	39.08	38.82	1.6	39.02			
5.	32.4	29.4	764.5	80	299	41	34	85	88	4.2	1.21	32.32	32.16	31.89	2.4	32.12333			
6.	32	29.2	746.5	82	356	39	35	85	89	4	1.2	27.52	27.62	27.27	5.0	27.47			
7.	32.2	29.2	764.5	81	414	38	35	87	89	3.6	1.19	23.17	23.07	22.9	4.0	23.04667			
8.	32	29.2	764.5	81	475	37	36	88	89	3.9	1.16	19.23	19.24	19.15	5.5	19.20667			
9.	33.5	30.8	763.5	80	474	33	40	103	90	4	0.84	13.68	13.67	13.67	9.4	13.67333			

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>f</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	η <sub>fuel</sub> (%)	air ΔP (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio (φ)	Correction Factor		
												k	α	β
1.	5	4.993394	0.73207	0.00009682	0.00009671	475.5733	16.46756	0.008064	0.012006	0.174004	1.001126	1.001323	0.999803	
2.	10	9.983711	1.463688	0.00013369	0.00013350	328.3578	23.85061	0.008033	0.016643	0.241205	1.001389	1.001632	0.999757	
3.	15	14.96404	2.193844	0.00016845	0.00016811	275.8602	28.38951	0.008003	0.021049	0.30506	1.002045	1.002403	0.999643	
4.	20	19.98279	2.929629	0.00021184	0.00021168	260.1235	30.10698	0.007998	0.026488	0.383883	1.000733	1.000861	0.999872	
5.	25	24.97848	3.662037	0.00025732	0.00025713	252.7763	30.98208	0.007932	0.03244	0.470138	1.000733	1.000861	0.999872	
6.	30	30.7793	4.512481	0.00030091	0.00030754	245.349	31.91997	0.007811	0.038524	0.558315	0.978452	0.974681	1.003869	
7.	35	34.94299	5.122909	0.00035866	0.00035817	251.6926	31.11547	0.007869	0.045579	0.660564	1.001389	1.001632	0.999757	
8.	40	39.90412	5.850249	0.00043037	0.00042949	264.2922	29.63211	0.007772	0.055376	0.802553	1.002045	1.002403	0.999643	
9.	43.7	43.9147	6.438232	0.00060453	0.00060706	339.4437	23.07168	0.006593	0.091694	1.328891	0.995839	0.995111	1.000732	



ตารางที่ ค-4 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference Diesel ที่ความเร็วจรอบ 1600 rev/min

Run Number	Torque (N-m)		ambient condition (°C)			Temperature(°C)						Pressure (inch. H2O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
	T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3				
1.	5	32	29.3	764.2	148	47	36	88	89	4	1.55	71.72	72.7	72.78	0.3	72.4		
2.	10	32	29.2	764.2	180	46	35	87	88	4.5	1.56	52.76	52.98	52.29	0.7	52.67667		
3.	15	31.8	28.8	764.2	215	43	35	87	88	4.9	1.55	41.3	41.82	41.74	1.3	41.62		
4.	20	31.8	29.2	764	265	41	35	87	87	5	1.53	33.29	33.74	33.81	1.5	33.61333		
5.	25	31.8	28.7	764	323	39	35	88	88	5	1.49	27.66	27.74	27.61	1.6	27.67		
6.	30	31.8	28.8	764	380	39	35	89	90	5.2	1.48	23.27	23.49	23.57	2.9	23.44333		
7.	35	32.2	29.2	764	445	37	35	90	90	5.5	1.48	20.2	20.05	20.34	4.1	20.19667		
8.	40	32.4	29.2	764	497	36	38	92	88	5.4	1.42	17.28	17.42	17.35	5.2	17.35		
9.	43.8	33.6	31	763.5	500	33	39	106	88	5.5	1.15	13.31	13.32	13.38	8.3	13.33667		

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>g</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.990315	0.836135	0.00011417	0.00011398	490.7565	15.95809	39.37	0.008982	0.012711	0.184219	1.001652	1.001941	0.999712
2.	10	9.98063	1.672271	0.00015692	0.00015666	337.2534	23.22152	39.624	0.009011	0.017414	0.252382	1.001652	1.001941	0.999712
3.	15	14.95942	2.506475	0.00019861	0.00019815	284.5974	27.51794	39.37	0.008985	0.022104	0.320354	1.002309	1.002713	0.999597
4.	20	19.95203	3.342994	0.00024591	0.00024541	264.2791	29.63357	38.862	0.008926	0.027552	0.399298	1.002046	1.002404	0.999643
5.	25	24.94003	4.178743	0.00029874	0.00029813	256.8357	30.4924	37.846	0.008808	0.033916	0.491532	1.002046	1.002404	0.999643
6.	30	29.92804	5.014491	0.00035259	0.00035187	252.6177	31.00152	37.592	0.008779	0.040165	0.582109	1.002046	1.002404	0.999643
7.	35	34.96985	5.859255	0.00040928	0.00040898	251.2796	31.16661	37.592	0.008773	0.046653	0.676127	1.000734	1.000862	0.999872
8.	40	39.9963	6.701445	0.00047643	0.00047639	255.915	30.60209	36.068	0.00859	0.055461	0.80378	1.000079	1.000092	0.999986
9.	43.8	44.03207	7.377645	0.00061980	0.00062259	303.7983	25.77873	29.21	0.007713	0.080358	1.164604	0.995514	0.994729	1.000789

ตารางที่ ค-5 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ  
เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference Diesel ที่ความเร็วจอบ 1800 rev/min

Run Number	Torque (N-m)		ambient condition (°C)		Temperature(°C)					Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
	T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3		
1.	29.2	27.2	768.8	80	155	45	34	86	89	6.2	1.92	60.93	62.43	60.62	0.4	61.32667
2.	29.3	27.2	768.8	83	193	43	33	86	88	7.2	1.93	44.69	43.83	44.77	0.7	44.43
3.	29.4	27.4	768.8	79	231	39	33	87	89	7.7	1.94	35.84	36.05	36.31	0.9	36.06667
4.	29.4	27.4	768.8	83	282	38	34	88	87	7.8	1.92	29.6	29.73	29.39	1.6	29.57333
5.	29.4	27.4	768.5	80	332	36	35	90	90	8.2	1.89	24.61	24.68	24.94	2.2	24.74333
6.	29.4	27.5	768.5	83	392	36	35	92	90	8	1.87	20.82	21	20.94	2.4	20.92
7.	29.4	27.4	768.5	81	440	34	37	89	92	8.2	1.89	18.02	18.08	17.96	3.0	18.02
8.	33.6	31	763.5	83	540	34	37	105	89	8.2	1.6	14.36	14.36	14.36	3.9	14.36

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>l</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.902008	0.924007	0.00013479	0.00013253	516.3533	15.16701	48.768	0.010073	0.013381	0.193926	1.017013	1.01999	0.997081
2.	10	9.807815	1.84873	0.00018605	0.00018299	356.3406	21.97767	49.022	0.010098	0.018425	0.267025	1.016677	1.019595	0.997138
3.	15	14.71742	2.774169	0.00022919	0.00022550	292.6306	26.76253	49.276	0.010122	0.022642	0.328149	1.016341	1.0192	0.997194
4.	20	19.62323	3.698892	0.00027951	0.00027501	267.662	29.25905	48.768	0.01007	0.027757	0.402279	1.016341	1.0192	0.997194
5.	25	24.54026	4.625729	0.00033407	0.00032883	255.9114	30.60252	48.006	0.009989	0.033444	0.484701	1.015944	1.018734	0.997261
6.	30	29.44831	5.550875	0.00039512	0.00038892	252.2348	31.04859	47.498	0.009936	0.039768	0.576343	1.015944	1.018734	0.997261
7.	35	34.35636	6.476021	0.00045871	0.00045151	250.995	31.20196	48.006	0.009989	0.045923	0.665545	1.015944	1.018734	0.997261
8.	41	41.21724	7.769267	0.00057563	0.00057822	267.9266	29.23015	40.64	0.009098	0.063272	0.91698	0.995514	0.994729	1.000789



ตารางที่ ค-6 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 1 ใช้ น้ำมัน Reference Diesel ที่ความเร็วยรอบ 2000 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)				Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)	
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1			2
1.	5	29.4	27.4	768.2	78	162	45	34	90	88	7.7	53.76	53.29	53.83	0.4	53.62667
2.	10	29.4	27.5	768.1	80	206	41	34	89	89	9.3	40.94	40.47	41.01	0.5	40.80667
3.	15	29.5	27.6	768	83	253	39	34	90	89	10.2	31.84	32.98	32.8	0.7	32.54
4.	20	29.4	27.4	768	81	304	37	34	91	89	10.5	26.27	26.27	26.16	1.3	26.23333
5.	25	29.4	27.6	768	79	353	35	35	92	89	10.6	22.15	22.21	22.08	1.8	22.14667
6.	30	29.4	27.6	768	80	409	34	35	93	90	10.8	18.85	18.97	18.55	2.7	18.79
7.	35	29.4	27.6	768	79	477	34	35	94	88	11	15.97	15.92	15.86	3.0	15.91667
8.	36.6	33.7	30.8	763.5	83	471	34	36	104	90	11.2	15.2	15.13	15.2	3.1	15.17667

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>g</sub> /hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor	
												k	$\beta$
1.	5	4.910297	1.02841	0.00015414	0.00015178	531.313	14.73996	54.356	0.010627	0.014505	0.210213	1.015547	1.018268
2.	10	9.822093	2.057134	0.00020256	0.00019949	349.1085	22.43295	55.118	0.0107	0.018931	0.274357	1.015415	1.018113
3.	15	14.7411	3.087368	0.00025403	0.00025028	291.8424	26.83481	55.372	0.010723	0.023691	0.343345	1.014948	1.017563
4.	20	19.64718	4.114897	0.00031510	0.00031035	271.5178	28.84354	54.864	0.010675	0.029517	0.427784	1.015283	1.017958
5.	25	24.55898	5.143621	0.00037324	0.00036762	257.2963	30.43781	53.848	0.010576	0.035292	0.51148	1.015283	1.017958
6.	30	29.47078	6.172345	0.00043991	0.00043329	252.7166	30.98939	52.578	0.01045	0.042096	0.610088	1.015283	1.017958
7.	35	34.38257	7.201069	0.00051933	0.00051151	255.7182	30.62564	52.578	0.01045	0.049695	0.720223	1.015283	1.017958
8.	36.6	36.80803	7.709056	0.00054465	0.00054728	255.5726	30.64309	46.736	0.009755	0.055835	0.809207	0.99519	0.994348

ตารางที่ ค-7 แสดงข้อมูลจากกราฟทดสอบ และผลการคำนวณ  
เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference Diesel ที่ความเร็วรอบ 2200 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)							Pressure (inch. H <sub>2</sub> O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3	1	2		
1.	5	28.6	27.1	767.5	82	179	43	33	89	89	9.5	2.46	46.21	46.06	46.16	0.2	46.14333		
2.	10	28	26.2	767.5	81	222	41	34	91	90	10.9	2.41	35.27	35.38	35.32	0.4	35.32333		
3.	15	27.4	26.4	767.5	82	271	38	34	92	90	12	2.38	28.07	28.02	27.87	0.7	27.98667		
4.	20	27.2	26.4	767.2	83	323	37	34	96	90	12.5	2.38	22.68	23.18	23.12	1.2	22.99333		
5.	25	27.2	26.4	767.1	81	373	35	35	96	90	12.8	2.3	19.53	19.42	19.75	1.2	19.56667		
6.	30	27.4	26.4	767.2	83	429	34	35	96	90	13.4	2.27	16.7	16.75	16.59	2.4	16.68		
7.	35.3	33.8	30.5	763.5	83	471	32	35	101	90	13.6	2.15	13.17	13.17	13.7	3.2	13.34667		

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>l</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.900319	1.128953	0.00017914	0.00017609	561.512	13.94723	62.484	0.011404	0.015709	0.227664	1.017312	1.020342	0.997031
2.	10	9.777817	2.252647	0.00023401	0.00022957	366.8803	21.34629	61.214	0.011298	0.020712	0.300171	1.019339	1.022723	0.996691
3.	15	14.63252	3.37109	0.00029535	0.00028917	308.8103	25.36035	60.452	0.011239	0.026279	0.380861	1.021374	1.025114	0.996351
4.	20	19.50375	4.493341	0.00035950	0.00035188	281.9179	27.77949	60.452	0.011241	0.031982	0.463506	1.021654	1.025444	0.996304
5.	25	24.3634	5.617533	0.00042245	0.00041355	265.0257	29.5501	58.42	0.011049	0.038233	0.554107	1.021521	1.025288	0.996327
6.	30	29.27843	6.745266	0.00049556	0.00048538	259.0525	30.23145	57.658	0.010974	0.045158	0.654458	1.020975	1.024645	0.996418
7.	35.3	35.51425	8.181895	0.00061933	0.00062253	273.9092	28.59172	54.61	0.010543	0.058745	0.851381	0.994866	0.993967	1.000904



ตารางที่ ค-8 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference Diesel ที่ความเร็วรอบ 2400 rev/min

Run Number	Torque (N-m)		ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
	T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3			
1.	5	27.4	26.6	767	194	43	33	96	90	10.4	2.85	41.12	40.13	40.51	0.3	40.58667	
2.	10	26.6	25.8	766.5	237	37	32	92	89	11.7	2.75	30.84	30.88	30.66	0.3	30.79333	
3.	15	26.8	26	766.5	282	36	32	94	90	12.9	2.76	25.49	25.34	24.65	0.6	25.16	
4.	20	27.1	26.6	766.2	338	35	34	95	89	14.5	2.79	20.85	20.9	20.9	1.0	20.88333	
5.	25	27.4	26.4	766.2	389	33	34	97	89	15	2.78	17.25	17.16	17.2	1.5	17.20333	
6.	30	27.2	26.3	766	426	33	35	102	90	15.9	2.73	14.56	14.62	14.77	1.8	14.65	
7.	32.8	33.8	30.6	763.8	421	33	33	97	90	16.5	2.68	13.61	13.62	13.56	1.8	13.59667	

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{low}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.881228	1.226786	0.00020366	0.00019953	585.5229	13.37528	72.39	0.012295	0.116565	0.240072	1.020708	1.024332	0.996462
2.	10	9.739475	2.447797	0.00026843	0.00026246	386.0022	20.28884	69.85	0.012089	0.022204	0.321801	1.022765	1.026749	0.99612
3.	15	14.62062	3.674563	0.00032854	0.00032144	314.9163	24.86862	70.104	0.012107	0.027136	0.393269	1.022083	1.025948	0.996233
4.	20	19.52594	4.907404	0.00039582	0.00038780	284.4881	27.52852	70.866	0.012164	0.032539	0.47158	1.020663	1.024279	0.99647
5.	25	24.43598	6.141432	0.00048049	0.00047123	276.2277	28.35174	70.612	0.012137	0.03959	0.573771	1.019644	1.023081	0.99664
6.	30	29.30929	7.366227	0.00056423	0.00055314	270.3279	28.9705	69.342	0.012029	0.046905	0.679778	1.020056	1.023566	0.996571
7.	32.8	32.98383	8.289741	0.00060794	0.00061084	265.2708	29.5228	68.072	0.011773	0.051639	0.748395	0.995257	0.994427	1.000835

ตารางที่ ค-9 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 1050 rev/min

Run Number	Torque (N-m)	ambient condition (°C)		Temperature(°C)				Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)			
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice			1	2	3
1.	5	30.2	28	765.5	78	115	48	37	76	88	2	0.6	114.38	113.93	113.51	0.6	113.94
2.	10	30.5	28.2	766	79	146	44	37	75	89	2	0.6	82.32	82.55	82.45	1.2	82.44
3.	15	30.3	28.2	766	78	187	42	38	75	87	2.1	0.59	63.05	65.12	64.33	1.7	64.1667
4.	20	30.3	28	766	81	235	40	38	75	90	2	0.59	51.30	50.29	50.06	3.0	50.55
5.	25	30.2	28.4	766.1	82	294	39	39	76	90	1.8	0.58	41.85	41.28	41.62	3.9	41.5833
6.	30	30.4	28.6	766.1	79	340	37	40	77	89	1.6	0.57	34.89	34.99	35.23	4.6	35.0367
7.	35	30.4	28.4	766.2	80	406	36	41	78	89	1.6	0.57	28.97	29.19	29.08	4.6	29.08
8.	40	30.4	28.6	766.2	81	511	35	41	78	90	1.5	0.54	22.23	22.34	22.35	7.9	22.3067
9.	41	33.3	31	763.5	79	490	39	44	88	88	1.8	0.68	18.35	18.35	18.35	9.7	18.35

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>l</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	η <sub>fuel</sub> (%)	air ΔP (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio (φ)	Correction Factor		
												k	α	β
1.	5	4.9459	0.54383	0.00007337	0.00007270	481.2216	16.63101	15.24	0.00561	0.01308	0.189559	1.009309	1.010938	0.998389
2.	10	9.895694	1.088088	0.00010141	0.00010051	332.5279	24.06776	15.24	0.005609	0.01808	0.262033	1.008971	1.010541	0.998447
3.	15	14.83207	1.630871	0.00013029	0.00012904	284.8491	28.09628	14.986	0.005564	0.023417	0.339384	1.009636	1.011322	0.998333
4.	20	19.7761	2.174495	0.00016538	0.00016380	271.1842	29.51204	14.986	0.005564	0.029725	0.430804	1.009636	1.011322	0.998333
5.	25	24.70678	2.716652	0.00020104	0.00019903	263.749	30.344	14.732	0.005518	0.036437	0.528072	1.0101	1.011868	0.998253
6.	30	29.67107	3.262504	0.00023861	0.00023638	260.8294	30.68366	14.478	0.005468	0.043637	0.632426	1.009435	1.011086	0.998367
7.	35	34.61095	3.805672	0.00028748	0.00028476	269.3692	29.71089	14.478	0.005468	0.052573	0.761921	1.009567	1.011241	0.998344
8.	40	39.55537	4.34934	0.00037478	0.00037122	307.2689	26.04641	13.716	0.005322	0.070414	1.020493	1.009567	1.011241	0.998344
9.	41	41.16985	4.526861	0.00045559	0.00045719	363.5826	22.01206	17.272	0.005934	0.076777	1.112711	0.996489	0.995875	1.000617



ตารางที่ ค-10 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ  
เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 1200 rev/min

Run Number	Torque (N-m)		ambient condition (°C)			Temperature(°C)					Pressure (inch. H2O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
	T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3			
1.	5	30.4	28.4	766.2	82	121	47	38	77	89	0.78	101.92	101.72	101.82	0.5	101.82	
2.	10	30.2	27.9	766.2	80	152	44	37	76	90	0.78	71.33	71.34	71.33	0.6	71.3333	
3.	15	30.1	27.9	766.2	79	198	41	37	76	90	0.77	55.27	55.46	55.32	1.3	55.35	
4.	20	30.2	27.8	766.2	80	237	40	38	77	89	0.73	44.50	44.20	44.69	1.9	44.4633	
5.	25	30.2	28.2	766.4	80	290	39	38	77	90	0.75	36.31	36.48	36.31	2.7	36.3667	
6.	30	30.1	27.9	766.2	80	340	37	39	78	88	1.8	30.82	30.91	31.01	3.6	30.9133	
7.	35	30	27.9	766.5	82	420	36	40	79	90	1.7	26.62	26.81	27.00	4.9	26.81	
8.	40	30.1	27.4	766.5	80	488	35	40	80	90	1.7	22.10	22.21	22.04	6.3	22.1167	
9.	42.3	33.4	31	763.5	78	504	38	43	87	89	2	15.76	15.75	15.76	9.7	15.7567	

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	
1.	5	4.944421	0.621334	0.00008211	0.00008133	471.211	16.98433	19.812	0.006397	0.012835	0.186021	1.009567	1.011241	0.998344
2.	10	9.8812	1.241708	0.00011720	0.00011601	336.3377	23.79514	19.812	0.006399	0.018315	0.265435	1.010232	1.012023	0.998231
3.	15	14.81607	1.861842	0.00015104	0.00014946	288.9907	27.69363	19.558	0.006359	0.023753	0.344242	1.010565	1.012414	0.998174
4.	20	19.7624	2.483416	0.00018802	0.00018612	269.7963	29.66386	18.542	0.00619	0.030373	0.440185	1.010232	1.012023	0.998231
5.	25	24.69544	3.10332	0.00022988	0.00022749	263.9029	30.32631	19.05	0.006275	0.036632	0.530894	1.010496	1.012333	0.998186
6.	30	29.63214	3.723684	0.00027043	0.00026761	258.7174	30.93414	18.542	0.006191	0.043679	0.633023	1.010565	1.012414	0.998174
7.	35	34.5416	4.340625	0.00031182	0.00030834	255.7302	31.29549	18.288	0.006151	0.050694	0.734695	1.011295	1.013271	0.998049
8.	40	39.49138	4.962633	0.00037800	0.00037390	271.233	29.50674	17.78	0.006064	0.062334	0.903385	1.010961	1.012879	0.998106
9.	42.3	42.49153	5.339643	0.00053057	0.00053261	359.0884	22.28755	21.59	0.006633	0.079987	1.159231	0.996164	0.995493	1.000674

ตารางที่ ค-11 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ  
 เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 1400 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)				Pressure (inch. H <sub>2</sub> O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)	
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2			3
1.	5	30	27.4	766.5	80	129	46	37	78	90	3.4	1.08	81.77	81.51	81.87	0.5	81.7167
2.	10	30	27.6	766.8	79	163	43	36	78	89	4.2	1.07	60.38	60.54	60.80	0.8	60.5733
3.	15	30	27.6	766.8	79	203	41	36	78	90	4.2	1.06	47.02	47.11	47.45	1.1	47.1933
4.	20	29.9	27.6	766.8	79	243	39	37	79	89	4.1	1.06	38.14	38.39	38.39	1.5	38.3067
5.	25	30	27.6	766.8	78	298	38	37	80	89	3.9	1.04	31.71	31.55	31.72	3.3	31.66
6.	30	30	27.6	766.5	79	351	36	38	81	90	3.8	1.03	27.35	26.76	26.83	3.8	26.98
7.	35	30	27.8	766.5	79	410	35	39	81	90	3.7	0.99	22.65	22.74	22.65	3.9	22.68
8.	40	29.9	27.6	766.5	81	490	35	39	82	88	3.7	0.99	19.58	19.49	20.26	4.9	19.7767
9.	43.4	33.5	30.8	763.5	81	520	37	43	91	90	3.8	1.12	13.32	13.26	13.23	9.6	13.27

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>f</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	η <sub>fuel</sub> (%)	air ΔP (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio (φ)	Correction Factor		
												k	α	β
1.	5	4.934514	0.723437	0.00010230	0.00010116	503.4072	15.89807	27.432	0.007534	0.01358	0.19681	1.011295	1.013271	0.998049
2.	10	9.8645	1.446211	0.00013801	0.00013642	339.5846	23.56762	27.178	0.0075	0.018402	0.266693	1.01169	1.013736	0.997982
3.	15	14.79675	2.169317	0.00017714	0.00017510	290.5745	27.54268	26.924	0.007465	0.02373	0.343915	1.01169	1.013736	0.997982
4.	20	19.72137	2.891304	0.00021824	0.00021565	268.5034	29.8067	26.924	0.007466	0.02923	0.42363	1.012024	1.014128	0.997925
5.	25	24.66125	3.615528	0.00026406	0.00026100	259.8834	30.79535	26.416	0.007394	0.035711	0.517556	1.01169	1.013736	0.997982
6.	30	29.60708	4.340625	0.00030986	0.00030640	254.1189	31.49393	26.162	0.007357	0.042117	0.610393	1.011295	1.013271	0.998049
7.	35	34.5416	5.064062	0.00036861	0.00036449	259.1129	30.88693	25.146	0.007213	0.051104	0.740644	1.011295	1.013271	0.998049
8.	40	39.46084	5.785261	0.00042272	0.00041786	260.023	30.77882	25.146	0.007214	0.058597	0.849235	1.011628	1.013663	0.997992
9.	43.4	43.61323	6.394034	0.00062999	0.00063262	356.1835	22.46932	28.448	0.007613	0.082753	1.199318	0.995839	0.995111	1.000732



ตารางที่ ค-12 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 1600 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch, H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)	
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2			3
1.	5	29.7	27.6	766.5	79	137	45	35	76	89	4.2	1.37	71.06	70.39	71.74	0.5	71.0633
2.	10	29.6	27.6	766.3	79	177	42	35	77	89	4.8	1.38	52.59	52.46	52.52	0.6	52.5233
3.	15	29.6	27.6	766.3	79	216	40	35	77	89	4.9	1.38	40.85	41.14	41.13	1.0	41.04
4.	20	29.6	27.6	766.3	78	258	38	36	79	88	5	1.34	32.91	33.07	33.67	1.0	33.2167
5.	25	29.4	27.4	766.3	79	314	38	36	81	88	5	1.32	27.60	27.75	27.67	1.8	27.6733
6.	30	29.5	27.4	766.3	78	370	35	38	83	88	5.2	1.29	23.64	23.48	23.19	3.1	23.4367
7.	35	29.6	27.5	766.2	80	441	35	38	84	89	5.3	1.28	19.75	19.96	19.82	3.6	19.8433
8.	40	29.5	27.5	766.1	79	500	34	39	84	90	5.4	1.25	17.35	17.34	17.35	4.8	17.3467
9.	43.5	33.6	31	763.5	78	565	37	44	92	87	5	1.4	12.86	12.93	12.87	8.5	12.8667

Run Number	Torque (N-m)	Torque corrected	Power corrected (kw)	Fuel flow (m <sub>f</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	η <sub>fuel</sub> (%)	air ΔP (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio (φ)	Correction Factor		
												k	α	β
1.	5	4.928788	0.825826	0.00011764	0.00011621	506.6019	15.79781	34.798	0.008489	0.013858	0.20084	1.012296	1.014448	0.997879
2.	10	9.856775	1.651519	0.00015917	0.00015722	342.7167	23.35223	35.052	0.00852	0.018681	0.270737	1.012366	1.014531	0.997867
3.	15	14.78516	2.477278	0.00020370	0.00020122	292.4078	27.37	35.052	0.00852	0.023908	0.346492	1.012366	1.014531	0.997867
4.	20	19.71355	3.303037	0.00025168	0.00024861	270.9577	29.53672	34.036	0.008396	0.029976	0.434442	1.012366	1.014531	0.997867
5.	25	24.62285	4.125599	0.00030210	0.00029821	260.2169	30.75588	33.528	0.008336	0.036241	0.525228	1.013036	1.015317	0.997753
6.	30	29.55887	4.952637	0.00035671	0.00035223	256.0326	31.25853	32.766	0.008239	0.043294	0.627448	1.012701	1.014924	0.99781
7.	35	34.50399	5.781199	0.00042130	0.00041621	259.1762	30.87938	32.512	0.008205	0.051345	0.74413	1.012234	1.014375	0.997889
8.	40	39.4239	6.605537	0.00048194	0.00047602	259.4279	30.84942	31.75	0.008109	0.05943	0.861299	1.012437	1.014613	0.997855
9.	43.5	43.73049	7.327113	0.00064873	0.00065166	320.1752	24.99632	35.56	0.00851	0.076231	1.104792	0.995514	0.994729	1.000789

ตารางที่ ค-13 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 1800 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3		
1.	5	29.2	27.4	766.1	79	152	46	35	83	89	5.8	1.82	59.21	59.01	60.66	0.4	59.6267
2.	10	29.2	27.4	766	79	188	42	34	83	89	6.9	1.8	44.63	44.17	44.62	0.5	44.4733
3.	15	29.2	27.4	766	80	231	41	35	83	90	7.5	1.79	35.78	35.31	35.44	0.9	35.51
4.	20	29.2	27.6	766	78	276	39	35	83	90	8	1.77	28.92	28.93	28.93	0.9	28.9267
5.	25	29.2	27.5	766	79	322	38	35	83	90	8.1	1.76	24.60	24.80	24.59	1.7	24.6633
6.	30	29.2	27.6	766	80	381	36	36	86	90	8	1.74	20.81	20.87	20.81	3.4	20.83
7.	35	29.2	27.8	766	78	449	35	38	87	88	8	1.71	17.82	17.81	17.68	4.2	17.77
8.	40	29.2	27.6	766	79	537	34	38	89	89	7.7	1.68	14.75	14.70	14.76	4.2	14.7367
9.	41	33.6	31	763.5	81	535	37	42	92	89	7.8	1.87	13.97	14.02	13.96	3.7	13.9833

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.922261	0.927824	0.00014021	0.00013835	536.7894	14.90939	46.228	0.00979	0.014321	0.207555	1.013441	1.015793	0.997684
2.	10	9.846028	1.855933	0.00018798	0.00018551	359.8364	22.24122	45.72	0.009735	0.019309	0.279835	1.013309	1.015638	0.997707
3.	15	14.76904	2.783899	0.00023543	0.00023233	300.4435	26.63796	45.466	0.009708	0.02425	0.351448	1.013309	1.015638	0.997707
4.	20	19.69206	3.711865	0.00028901	0.00028521	276.6154	28.9326	44.958	0.009654	0.029937	0.433863	1.013309	1.015638	0.997707
5.	25	24.61507	4.639831	0.00033896	0.00033451	259.5452	30.83549	44.704	0.009627	0.035211	0.510305	1.013309	1.015638	0.997707
6.	30	29.53808	5.567798	0.00040134	0.00039607	256.0909	31.2514	44.196	0.009572	0.04193	0.607679	1.013309	1.015638	0.997707
7.	35	34.4611	6.495764	0.00047046	0.00046428	257.3056	31.10387	43.434	0.009489	0.049579	0.718543	1.013309	1.015638	0.997707
8.	40	39.38411	7.42373	0.00056729	0.00055984	271.4848	29.47937	42.672	0.009405	0.060316	0.874146	1.013309	1.015638	0.997707
9.	41	41.21724	7.769267	0.00059785	0.00060055	278.2726	28.76029	47.498	0.009835	0.060786	0.880955	0.995514	0.994729	1.000789



ตารางที่ ค-14 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ  
เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 2000 rev/min

Run Number	Torque (N-m)		ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
	T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3			
1.	5	32	29.4	766	161	44	35	84	90	8.5	2.14	54.00	54.19	54.67	0.3	54.2867	
2.	10	32	29.6	766	200	42	36	84	90	9.4	2.15	39.80	39.14	39.80	0.4	39.58	
3.	15	31.9	29.4	765.5	250	40	36	85	90	9.8	2.15	31.90	31.65	31.30	0.8	31.6167	
4.	20	31.8	29.6	765.5	298	39	37	86	90	10.1	2.15	26.1	25.97	25.80	1.2	25.9567	
5.	25	32	29.6	765.3	353	38	38	87	88	10.2	2.14	21.72	21.60	21.55	1.5	21.6233	
6.	30	32.2	29.6	765.2	410	37	39	88	90	10.4	2.14	18.44	18.31	18.49	2.1	18.4133	
7.	35	32.2	29.6	765.1	475	36	39	89	88	10.8	2.08	15.74	15.68	15.74	2.6	15.72	
8.	36.4	33.7	30.8	763.5	528	38	42	93	90	10.8	2.13	14.60	14.66	14.61	4.3	14.6233	

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>3</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor	
												k	$\alpha$
1.	5	4.976546	1.042285	0.00015400	0.00015338	529.7738	15.10683	54.356	0.010566	0.014574	0.211222	1.004011	1.004713
2.	10	9.953092	2.084571	0.00021122	0.00021037	363.3105	22.02855	54.61	0.010591	0.019943	0.289031	1.004011	1.004713
3.	15	14.93534	3.12805	0.00026442	0.00026345	303.1948	26.39624	54.61	0.010589	0.02497	0.361889	1.003685	1.004329
4.	20	19.90612	4.169128	0.00032208	0.00032079	276.9969	28.89274	54.61	0.010591	0.03041	0.440728	1.004014	1.004716
5.	25	24.90946	5.217025	0.00038662	0.00038543	265.9634	30.09137	54.356	0.010562	0.036606	0.530529	1.003093	1.003635
6.	30	29.91895	6.26621	0.00045402	0.00045297	260.2383	30.75335	54.356	0.010557	0.043005	0.623261	1.002305	1.002709
7.	35	34.9108	7.311701	0.00053181	0.00053065	261.273	30.63157	52.832	0.010408	0.051098	0.740548	1.002175	1.002555
8.	36.4	36.60689	7.66693	0.00057169	0.00057445	269.7335	29.67077	54.102	0.010495	0.054471	0.789441	0.99519	0.994348

ตารางที่ ค-15 แสดงข้อมูลจากกราฟทดสอบ และผลการคำนวณ  
 เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 2200 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)				Pressure (inch. H <sub>2</sub> O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)	
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2			3
1.	5	32.6	30.2	765	81	177	44	37	83	86	9.9	2.48	47.20	47.37	47.28	0.2	47.2833
2.	10	32.8	30.2	764.5	80	220	42	37	84	90	10.9	2.44	35.16	35.10	35.05	0.5	35.1033
3.	15	33.1	29.9	764.5	79	276	40	37	87	89	11.6	2.44	28.09	27.97	27.26	0.6	27.7733
4.	20	33.1	29.7	764.4	80	326	39	38	88	90	12.2	2.47	23.13	22.96	23.18	0.6	23.09
5.	25	33.2	30	764.3	80	382	38	38	89	90	12.9	2.49	18.94	18.93	19.32	1.5	19.0633
6.	30	33.4	30	764.3	80	440	38	40	91	90	13.4	2.49	16.69	16.53	16.54	2.4	16.5867
7.	35	33.4	30.4	764.3	80	512	37	40	92	90	13.8	2.49	13.76	13.70	13.71	2.8	13.7233
8.	35.2	33.8	30.5	763.5	81	502	37	42	92	89	13.7	2.45	13.55	13.55	13.55	4.3	13.55

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kw-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.9957	1.150927	0.00017681	0.00017668	552.6307	14.48201	62.992	0.011356	0.015569	0.22564	1.000733	1.000861	0.999872
2.	10	10.00676	2.305393	0.00023815	0.00023829	372.1049	21.50792	61.976	0.011257	0.021156	0.306613	0.999425	0.999324	1.000101
3.	15	15.02744	3.462075	0.00030101	0.00030148	313.4873	25.52959	61.976	0.011251	0.026753	0.387725	0.998446	0.998174	1.000272
4.	20	20.03967	4.616809	0.00036206	0.00036267	282.7973	28.30013	62.738	0.01132	0.031985	0.463557	0.998315	0.99802	1.000295
5.	25	25.06306	5.774114	0.00043854	0.00043948	274.0031	29.20843	63.246	0.011363	0.038594	0.55934	0.997859	0.997484	1.000376
6.	30	30.09875	6.934255	0.00050402	0.00050543	262.4002	30.49998	63.246	0.011359	0.044372	0.643069	0.997208	0.996719	1.00049
7.	35	35.11521	8.089964	0.00060918	0.00061089	271.8422	29.44061	63.246	0.011359	0.05363	0.777243	0.997208	0.996719	1.00049
8.	35.2	35.41364	8.158717	0.00061697	0.00062016	273.6422	29.24695	62.23	0.011254	0.054822	0.794519	0.994866	0.993967	1.000904



ตารางที่ ค-16 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ  
เครื่องยนต์ที่ 1 ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 2400 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch. H2O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3		
1.	5	33.6	30.8	764.2	78	197	45	39	89	87	10.6	2.95	40.82	40.28	40.99	0.2	40.6967
2.	10	33.4	30.8	764	79	240	42	38	90	90	11.6	2.91	31.49	31.43	31.32	0.2	31.4133
3.	15	33.4	30.6	764	79	290	40	38	91	87	13.3	2.96	24.80	24.90	24.64	0.5	24.78
4.	20	33.8	30.8	763.8	81	347	39	39	92	90	14.1	3	20.49	19.95	19.75	1.1	20.0633
5.	25	34	31	763.8	79	403	38	40	94	90	15.3	2.92	16.81	16.96	16.88	2.3	16.8833
6.	30	33.9	31	763.8	80	457	38	41	95	89	16	2.86	14.26	14.26	14.25	3.5	14.2567
7.	31.9	33.8	30.6	763.8	80	430	37	39	89	90	17	3	13.41	13.37	13.31	2.8	13.3633

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>l</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor	
												k	$\beta$
1.	5	5.021079	1.261935	0.00020542	0.00020616	588.1221	13.60806	74.93	0.012359	0.016621	0.240889	0.996427	0.995802
2.	10	10.03755	2.522711	0.00026613	0.00026698	380.9887	21.0064	73.914	0.012277	0.021677	0.314153	0.996816	0.996259
3.	15	15.05632	3.784067	0.00033737	0.00033845	321.9834	24.85594	75.184	0.012382	0.027246	0.39487	0.996816	0.996259
4.	20	20.11209	5.05472	0.00041668	0.00041867	298.1765	26.84048	76.2	0.012456	0.033452	0.484817	0.995257	0.994427
5.	25	25.15938	6.323242	0.00049516	0.00049785	283.4383	28.23613	74.168	0.012285	0.040307	0.584162	0.994609	0.993665
6.	30	30.1797	7.584986	0.00058639	0.00058938	279.7322	28.61023	72.644	0.01216	0.048224	0.698894	0.994933	0.994046
7.	31.9	32.07879	8.062279	0.00062559	0.00062857	280.6733	28.5143	76.2	0.012456	0.050224	0.72789	0.995257	0.994427

ตารางที่ ค-17 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ  
เครื่องยนต์ที่ 2 ใช้ น้ำมัน Reference Diesel ความเร็วรอบ 1050 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature (°C)						Pressure (inch. H <sub>2</sub> O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3			
1.	5	28.4	25.8	767.5	80	91	43	36	75	87	1.6	0.66	113.8	112.67	113.92	0.3	113.4633	
2.	10	29	26.4	768.5	82	115	42	32	75	88	1.6	0.67	85.08	84.95	84.36	0.9	84.79667	
3.	15	29	26.2	768.5	80	143	41	35	75	89	1.8	0.66	66.01	66.13	66.25	0.9	66.13	
4.	20	28.8	26.2	768.2	82	176	40	36	77	90	1.8	0.64	52.2	52.2	52.21	1.3	52.20333	
5.	25	28.8	26.3	768	80	212	38	33	78	90	1.95	0.64	42.86	42.5	42.86	2.7	42.74	
6.	30	28.6	26.2	768	82	258	37	37	79	89	2.1	0.65	36.57	36.8	36.68	4.1	36.68333	
7.	35	29.2	26.2	768	81	311	36	38	80	88	2.2	0.62	31.21	31.23	31.21	6.1	31.21667	
8.	40	28.8	26.4	767.5	83	366	35	39	81	90	2.4	0.6	25.49	25.52	25.51	6.1	25.50667	
9.	41.9	33	28.2	766.5	80	416	37	40	88	88	1.4	7.8	19.67	19.56	19.56	9.6	19.59667	

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>p</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	η <sub>fuel</sub> (%)	air ΔP (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio (φ)	Correction Factor		
												k	α	β
1.	5	4.89651493	0.5384	0.00007285	0.00007156	478.5146	16.36634	16.764	0.005909	0.01233	0.17869	1.017987	1.021134	0.996917
2.	10	9.80089892	1.077665	0.00009748	0.00009582	320.1039	24.4656	17.018	0.005951	0.01638	0.237389	1.017289	1.020315	0.997035
3.	15	14.7013484	1.616498	0.00012500	0.00012287	273.6402	28.61982	16.764	0.005907	0.021162	0.306694	1.017289	1.020315	0.997035
4.	20	19.5955598	2.154644	0.00015834	0.00015561	259.993	30.12209	16.256	0.005817	0.027219	0.394483	1.017565	1.020639	0.996988
5.	25	24.5019226	2.694127	0.00019340	0.00019011	254.0365	30.82839	16.256	0.005817	0.03325	0.481891	1.017301	1.020328	0.997033
6.	30	29.3794945	3.230444	0.00022533	0.00022136	246.6777	31.74805	16.51	0.005864	0.038428	0.556935	1.017975	1.02112	0.996919
7.	35	34.3559391	3.777633	0.00026479	0.00026064	248.3804	31.53041	15.748	0.005721	0.046284	0.670778	1.015955	1.018747	0.997259
8.	40	39.2329993	4.313894	0.00032407	0.00031877	266.0164	29.44005	15.24	0.00563	0.057562	0.83423	1.016638	1.01955	0.997144
9.	41.9	41.8319364	4.599662	0.00042181	0.00042122	329.6771	23.75517	15.6	0.005653	0.074614	1.081359	1.001385	1.001627	0.999758



ตารางที่ ค-18 แสดงข้อมูลจากกราฟทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 2 ใช้น้ำมัน Reference Diesel ที่ความเร็วรอบ 1200 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)	
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2			3
1.	5	28.5	25.8	767.3	80	95	42	33	75	88	1.8	0.85	99.13	99.81	100.03	0.2	99.65667
2.	10	28.5	25.8	767.1	84	122	42	33	76	89	1.8	0.84	75.13	74.03	74.13	0.4	74.43
3.	15	28.4	25.4	767	83	154	39	35	77	89	2	0.85	56.26	56.17	57.15	0.7	56.52667
4.	20	28.4	25.8	767	82	191	38	36	78	90	1.9	0.84	44.88	44.57	44.88	1.3	44.77667
5.	25	28.2	26	767	83	216	37	36	79	89	2	0.82	38.48	38.49	38.49	2.2	38.48667
6.	30	28.5	26	767.2	83	264	36	37	79	89	2	0.82	31.69	31.62	31.61	4.0	31.64
7.	35	28.6	25.6	767.2	83	314	34	37	79	90	1.4	0.8	27.4	27.31	27.4	4.6	27.37
8.	40	28.6	25.8	767.2	83	371	34	38	79	90	1.4	0.79	23.21	23.22	23.21	5.5	23.21333
9.	42.8	33	28.2	766.8	80	434	37	41	89	89	1.2	10.4	17.03	17.04	17.02	9.5	17.03

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sup>3</sup> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.89991286	0.615741	0.00008294	0.00008153	476.6596	16.43004	264.16	0.023268	0.003565	0.051664	1.017384	1.020426	0.997019
2.	10	9.80281907	1.231859	0.00011106	0.00010919	319.093	24.54311	21.59	0.006703	0.016567	0.240103	1.017119	1.020115	0.997063
3.	15	14.7007631	1.847352	0.00014623	0.00014374	280.1146	27.95833	21.336	0.006663	0.021947	0.318067	1.017324	1.020355	0.997029
4.	20	19.6010175	2.463137	0.00018461	0.00018146	265.2153	29.52897	21.59	0.006703	0.02754	0.399124	1.017324	1.020355	0.997029
5.	25	24.4822368	3.076529	0.00021478	0.00021098	246.8763	31.72251	21.336	0.006664	0.032231	0.467109	1.017999	1.021149	0.996915
6.	30	29.4039665	3.695011	0.00026125	0.00025682	250.2173	31.29894	20.828	0.006586	0.039667	0.574885	1.017252	1.020271	0.997041
7.	35	34.3179513	4.312521	0.00030201	0.00029699	247.9177	31.58926	20.828	0.006584	0.045872	0.664817	1.016914	1.019874	0.997098
8.	40	39.2205158	4.928595	0.00035609	0.00035017	255.7719	30.61922	20.32	0.006502	0.054767	0.793731	1.016914	1.019874	0.997098
9.	42.8	42.7108372	5.367202	0.00048538	0.00048452	324.9858	24.09808	20.8	0.006529	0.074342	1.077416	1.001777	1.002088	0.99969

ตารางที่ ค-19 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 2 ใช้น้ำมัน Reference Diesel ที่ความเร็วรอบ 1400 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch. H2O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)	
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2			3
1.	5	28.9	26.6	767.4	82	102	42	32	77	88	3.2	1.18	86.7	85.23	85.14	0.4	85.69
2.	10	28.8	26.4	767.4	84	130	40	35	79	90	3.6	1.17	63.54	63.79	64.12	0.5	63.81667
3.	15	28.7	26.4	767.4	82	163	39	31	80	90	3.4	1.17	47.7	47.47	47.55	0.6	47.57333
4.	20	28.9	26.2	767.3	82	198	37	30	81	89	3.6	1.14	38.55	38.46	38.47	0.8	38.49333
5.	25	29	25.8	767.5	78	233	35	31	82	88	3.4	1.12	32.82	32.83	32.74	1.5	32.79667
6.	30	28.7	25.9	767.5	78	274	34	37	82	87	3.4	1.11	27.78	27.7	27.8	3.2	27.76
7.	35	28.6	25.8	767.6	84	322	34	37	81	90	3.4	1.1	23.93	23.94	23.93	4.5	23.93333
8.	40	28.6	25.8	767.4	83	374	33	31	78	89	3.4	1.1	19.92	19.91	19.91	6.1	19.91333
9.	44.3	32.6	28.1	766.8	77	471	36	39	92	87	3.2	1.4.8	14.18	14.18	14.26	9.4	14.20667

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m.) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.90677705	0.719371	0.00009646	0.00009493	475.0603	16.48535	29.972	0.007694	0.012221	0.17711	1.016169	1.018999	0.997223
2.	10	9.80974735	1.438184	0.00012953	0.00012742	318.9624	24.55316	29.718	0.007661	0.116477	0.23879	1.016506	1.019394	0.997166
3.	15	14.7089116	2.156439	0.00017375	0.00017087	285.2617	27.45386	29.718	0.007663	0.022099	0.320269	1.016842	1.01979	0.99711
4.	20	19.6301055	2.877924	0.00021474	0.00021135	264.377	29.6226	28.956	0.007758	0.027679	0.401149	1.016037	1.018843	0.997245
5.	25	24.539656	3.597701	0.00025204	0.00024808	248.2357	31.54879	28.448	0.007689	0.032777	0.475029	1.015965	1.018759	0.997258
6.	30	29.4133326	4.31222	0.00029777	0.00029280	244.4372	32.03905	28.194	0.007659	0.038879	0.563459	1.016975	1.019946	0.997087
7.	35	34.2970013	5.028203	0.00034538	0.00033945	243.0363	32.22373	27.94	0.007626	0.045289	0.656362	1.017445	1.020497	0.997009
8.	40	39.2085407	5.748272	0.00041510	0.00040809	255.5754	30.64276	27.94	0.007625	0.054439	0.788967	1.017179	1.020186	0.997053
9.	44.3	44.1398814	6.471245	0.00058184	0.00058005	322.6853	24.26988	29.6	0.007794	0.074655	1.081951	1.003087	1.003628	0.999462



ตารางที่ ค-20 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 2 ใช้น้ำมัน Reference Diesel ที่ความเร็วรอบ 1600 rev/min

Run Number	Torque (N-m)		ambient condition (°C)			Temperature(°C)				Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke		Fuel Flow
	T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3	Number	Number	avg. (sec.)
1.	28.4	25.8	767.5	82	130	42	32	83	88	3.8	1.5	67.88	67.52	67.42	0.2	0.2	67.60667
2.	28.2	25.6	767.5	80	141	39	32	81	90	4	1.52	54.47	54.9	54.86	0.7	0.7	54.74333
3.	28	25.6	767.5	82	170	37	33	81	89	4.2	1.47	42.29	42.96	43.01	1.0	1.0	42.75333
4.	28.5	25.8	767.4	83	221	36	32	84	89	3.8	1.47	33.06	33.14	33.07	0.8	0.8	33.09
5.	28.5	26.6	767.3	84	251	35	31	85	90	3.6	1.45	28.71	28.71	28.7	1.4	1.4	28.70667
6.	28.6	26.4	767.2	83	295	35	34	85	89	3.6	1.44	24.46	24.38	24.38	2.4	2.4	24.40667
7.	28.8	26.3	767.3	80	354	33	34	83	88	3.8	1.41	20.42	20.41	20.42	3.2	3.2	20.41667
8.	28.8	26.4	767.2	84	388	33	34	81	89	4.2	1.12	18.17	18.17	18.17	3.3	3.3	18.17
9.	32.4	28	767	81	499	36	44	94	90	3.6	1.8	12.87	12.86	12.87	9.0	9.0	12.86667

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>l</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor	
												k	$\alpha$
1.	5.5	5.38616642	0.902461	0.00012227	0.00012011	479.1129	16.34591	0.008908	0.013726	0.198826	1.017987	1.021134	0.996917
2.	10	9.78542248	1.639563	0.00015100	0.00014823	325.4679	24.06239	0.00897	0.016834	0.243966	1.018662	1.021928	0.996804
3.	15	14.6667252	2.457433	0.00019334	0.00018967	277.861	28.18508	0.008824	0.021911	0.317549	1.019339	1.022723	0.996691
4.	20	19.5966595	3.283452	0.00024980	0.00024550	269.1714	29.09497	0.008816	0.028335	0.41065	1.017517	1.020582	0.996996
5.	25	24.4995643	4.104941	0.00028795	0.00028303	248.2123	31.55177	0.008755	0.032888	0.476638	1.017384	1.020426	0.997019
6.	30	29.4153868	4.928595	0.00033868	0.00033304	243.2663	32.19326	0.008723	0.038825	0.562686	1.016914	1.019874	0.997098
7.	35	34.3393587	5.753615	0.00040487	0.00039834	249.2407	31.42157	0.008629	0.046917	0.67995	1.016373	1.019239	0.997189
8.	40	39.2509751	6.576564	0.00045493	0.00044766	245.0458	31.95947	0.007691	0.059154	0.857306	1.016241	1.019083	0.997211
9.	44.5	44.2915365	7.421118	0.00064244	0.00063987	310.4033	25.23019	0.008788	0.073103	1.059466	1.004006	1.004707	0.999302

ตารางที่ ค-21 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 2 ใช้น้ำมัน Reference Diesel ที่ความเร็วรอบ 1800 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)						Pressure (inch. H2O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3		
1.	5	28.7	27.2	768.2	80	140	41	34	84	89	5.8	1.94	62.89	62.83	62.95	0.2	62.89
2.	10	28.5	25.4	768	80	159	39	32	85	88	6	1.88	46.22	46.36	46.36	0.5	46.31333
3.	15	28.4	25.2	768	80	189	37	30	87	89	6.2	1.93	36.99	36.85	36.98	0.8	36.94
4.	20	28	25.1	767.9	78	226	35	34	87	88	6.6	1.91	29.8	29.86	29.39	1.1	29.68333
5.	25	28.1	25.7	767.8	78	265	34	34	88	88	6.9	1.87	25.14	25.26	25.21	1.3	25.20333
6.	30	28.2	25.8	767.7	80	316	33	36	87	88	6.8	1.85	21.29	21.21	21.35	1.7	21.28333
7.	35	28.2	25.8	767.6	81	369	32	36	86	88	7	1.85	18.55	18.56	18.55	2.1	18.55333
8.	40	28.4	26	767.6	81	417	32	35	84	88	8	1.84	16.06	16.03	16.03	3.0	16.04
9.	43.2	31.9	27.6	767.2	81	477	36	41	95	91	5.9	25.4	14.49	14.49	14.49	4.5	14.49

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>f</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	η <sub>fuel</sub> (%)	air ΔP (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio (φ)	Correction Factor		
												k	α	β
1.	5	4.89698946	0.923061	0.00013144	0.00012912	503.5932	15.55131	49.276	0.01013	0.012975	0.188045	1.017903	1.021035	0.996932
2.	10	9.78936339	1.845252	0.00017848	0.00017527	341.9443	22.90296	47.752	0.009974	0.017895	0.259342	1.018312	1.021517	0.996863
3.	15	14.6783436	2.766803	0.00022377	0.00021967	285.8235	27.3999	49.022	0.010107	0.022139	0.320856	1.01865	1.021914	0.996806
4.	20	19.5437051	3.683902	0.00027847	0.00027305	266.8286	29.35044	48.514	0.010061	0.027679	0.40114	1.01987	1.023347	0.996602
5.	25	24.4428589	4.60737	0.00032797	0.00032173	251.3869	31.15331	47.498	0.009953	0.032953	0.477581	1.019399	1.022794	0.996681
6.	30	29.3473103	5.531838	0.00038838	0.00038116	248.0535	31.57196	46.99	0.009897	0.039242	0.568723	1.018928	1.02224	0.99676
7.	35	34.2437529	6.454795	0.00044553	0.00043731	243.8971	32.11	46.99	0.009896	0.045019	0.65245	1.018795	1.022084	0.996782
8.	40	39.1661418	7.382644	0.00051534	0.00050617	246.8215	31.72955	46.736	0.009866	0.052232	0.756982	1.018119	1.02129	0.996895
9.	43.2	42.9019017	8.086818	0.00057046	0.00056711	252.4592	31.02099	50.8	0.010225	0.055793	0.808601	1.005914	1.006948	0.998972



ตารางที่ ค-22 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 2 ใช้น้ำมัน Reference Diesel ที่ความเร็วรอบ 2000 rev/min

Run Number	Torque (N-m)		ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
	T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3			
1.	5	28.2	26.5	768.9	83	148	44	31	90	90	6.4	2.12	57.18	57.21	57.14	0.2	57.17667
2.	10	28	26.4	769	83	173	41	31	92	89	7.4	2.12	43.52	42.74	42.92	0.4	43.06
3.	15	28.2	26.6	769	82	208	39	32	93	89	7.8	2.11	33.51	33.28	33.45	0.5	33.41333
4.	20	28.3	26.7	768.9	83	244	37	34	94	90	8.2	2.11	28.2	28.19	28.13	1.0	28.17333
5.	25	28.4	26.7	768.8	84	302	36	35	94	90	8.6	2.07	22.32	22.27	22.38	1.1	22.32333
6.	30	28.6	26.8	768.8	83	339	35	35	93	90	9.2	2.04	19.38	19.38	19.39	1.6	19.38333
7.	35	28.6	26.8	768.8	84	390	33	34	91	90	9.8	2.01	16.39	16.45	16.33	1.9	16.39
8.	36.5	31.8	27.4	767.5	81	423	37	41	96	90	6.7	29.5	15.89	15.85	15.86	2.7	15.86667

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>l</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.88228038	1.022542	0.00014457	0.00014166	498.7421	15.70258	53.848	0.010603	0.013635	0.197606	1.020521	1.024112	0.996493
2.	10	9.75548828	2.043185	0.00019196	0.00018796	331.169	23.64815	53.848	0.010607	0.018098	0.262285	1.021331	1.025064	0.996358
3.	15	14.644611	3.06716	0.00024739	0.00024238	284.4877	27.52856	53.594	0.010579	0.023386	0.338921	1.020653	1.024268	0.996471
4.	20	19.5367099	4.091759	0.00029340	0.00028759	253.03	30.95102	53.594	0.010576	0.027741	0.40205	1.020182	1.023714	0.99655
5.	25	24.4340951	5.117465	0.00037029	0.00036313	255.4506	30.65773	52.578	0.010473	0.035356	0.512407	1.019711	1.02316	0.996629
6.	30	29.3436897	6.145728	0.00042645	0.00041848	245.1359	31.94773	51.816	0.010393	0.041031	0.594648	1.019035	1.022366	0.996742
7.	35	34.2343047	7.170016	0.00050433	0.00049491	248.4904	31.51645	51.054	0.010317	0.048885	0.708478	1.019035	1.022366	0.996742
8.	36.5	36.2175649	7.585389	0.00052097	0.00051753	245.6188	31.88492	59	0.011023	0.047262	0.684963	1.006637	1.007798	0.998848

ตารางที่ ค-23 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ  
เครื่องยนต์ที่ 2 ใช้น้ำมัน Reference Diesel ที่ความเร็วรอบ 2200 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2		
1.	6	28	26.3	768.5	83	155	44	29	93	90	7.2	44.85	44.97	44.73	0.3	44.85
2.	10	28	26.2	768.8	82	185	40	29	94	89	8.6	37.79	36.51	37.67	0.3	37.32333
3.	15	28.5	27	768.8	82	225	38	29	95	87	9.4	29.72	29.66	29.7	0.3	29.69333
4.	20	28.5	26.4	768.9	84	266	37	31	96	90	10	24.27	24.71	24.8	0.6	24.59333
5.	25	28.5	26.4	768.9	83	326	35	34	96	90	11	20.24	20.35	20.4	1.2	20.33
6.	30	28.4	26.5	769	82	380	33	31	95	90	11.6	16.87	16.81	16.92	1.7	16.86667
7.	35.2	28.4	27.2	769	82	438	33	30	92	89	12.8	14.19	14.2	14.15	2.7	14.18
8.	36.5	31.8	27.2	767.5	81	455	35	40	97	91	8.5	13.92	12.92	12.82	2.9	13.22

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>g</sub> /hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	
1.	6	5.85775187	1.349529	0.00018430	0.00018057	481.6916	16.2584	60.452	0.011235	0.016404	0.237742	1.020667	1.024284	0.996469
2.	10	9.75845953	2.248188	0.00022147	0.00021690	347.3212	22.54839	60.96	0.011284	0.019626	0.284436	1.021065	1.024752	0.996403
3.	15	14.6661506	3.378839	0.00027838	0.00027309	290.9634	26.91588	60.96	0.011275	0.02469	0.357822	1.019373	1.022763	0.996685
4.	20	19.5518892	4.504432	0.00033611	0.00032968	263.482	29.72323	61.468	0.011323	0.029684	0.430208	1.019506	1.022919	0.996663
5.	25	24.4398615	5.63054	0.00040659	0.00039881	254.9887	30.71327	61.468	0.011323	0.035909	0.520425	1.019506	1.022919	0.996663
6.	30	29.3119845	6.752996	0.00049008	0.00048048	256.1427	30.57489	60.96	0.011278	0.043453	0.62975	1.019976	1.023472	0.996584
7.	35.2	34.3927285	7.923516	0.00058293	0.00057152	259.6651	30.16013	60.706	0.011255	0.051794	0.750633	1.019976	1.023472	0.996584
8.	36.5	36.2175649	8.343928	0.00062526	0.00062114	267.9928	29.22293	69	0.01192	0.052453	0.760191	1.006637	1.007798	0.998848



ตารางที่ ค-24 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ  
เครื่องยนต์ที่ 2 ใช้น้ำมัน Reference Diesel ที่ความเร็วรอบ 2400 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)	
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2			3
1.	5	31.6	28	766	81	169	44	36	98	90	8.8	2.82	39.53	39.72	40.47	0.2	39.90667
2.	10	31.6	28	766	83	202	42	36	98	88	9.6	2.89	32.19	32.4	32.28	0.1	32.29
3.	15	31.4	28.8	766	83	243	41	37	98	90	11	2.84	25.84	25.84	25.84	0.2	25.84
4.	20	31.4	27.8	766.2	81	294	38	37	98	90	12.4	2.91	21.12	21.35	21.3	0.6	21.25667
5.	25	31.6	27.8	766.5	83	347	37	37	98	89	13.6	2.84	18.15	18.3	18.07	0.9	18.17333
6.	30	31	27.2	766.5	79	398	34	38	92	89	14.2	2.82	15.27	15.35	15.22	1.8	15.28
7.	33.3	32	27.2	767.5	81	445	35	40	95	90	11.4	41.3	13.71	13.71	13.71	2.1	13.71

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>f</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor	
												k	$\alpha$
1.	5	4.9688802	1.248818	0.00020713	0.00020604	593.9437	13.18565	71.628	0.012137	0.017066	0.247328	1.005329	1.006261
2.	10	9.9377604	2.497636	0.00025599	0.00025464	367.0225	21.33803	73.406	0.012287	0.020834	0.301944	1.005329	1.006261
3.	15	14.8951811	3.743567	0.00031989	0.00031799	305.7923	25.61064	72.136	0.012184	0.026254	0.380496	1.005989	1.007037
4.	20	19.8541568	4.989894	0.00038887	0.00038645	278.8077	28.08938	73.914	0.012335	0.031525	0.456881	1.006252	1.007346
5.	25	24.8254174	6.239308	0.00045484	0.00045214	260.8767	30.02006	72.136	0.012184	0.03733	0.541014	1.005985	1.007032
6.	30	29.7216796	7.469873	0.00054097	0.00053669	258.6509	30.2784	71.628	0.012153	0.044512	0.645099	1.00797	1.009364
7.	33.3	33.0677629	8.310835	0.00060292	0.00059934	259.6137	30.1661	82.6	0.013038	0.046243	0.670183	1.005977	1.007023



ตารางที่ ค-25 แสดงข้อมูลจากการทดสอบ และผลถ่วงน้ำหนัก

เครื่องยนต์ที่ 2 ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 1050 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)	
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2			3
1.	5	31.2	27.8	767.5	79	97	48	38	78	86	1.9	0.64	111.68	112.08	111.67	0.3	111.81
2.	10	31.4	28.2	767.5	79	121	46	38	77	87	1.6	0.65	81.33	81.3	81.34	0.6	81.32333
3.	15	31	28.1	767.2	79	149	43	38	77	88	1.7	0.64	63.97	64.39	63.63	1.2	63.99667
4.	20	30.2	28.6	767	80	185	41	38	78	90	1.6	0.64	50.62	50.76	50.75	1.0	50.71
5.	25	31.4	28.4	767	78	227	40	39	79	90	1.7	0.66	41.8	41.74	42.06	2.9	41.87667
6.	30	31.6	28.7	767	79	272	39	40	80	89	1.6	0.66	35.57	35.57	35.58	5.0	35.57333
7.	35	32	29	766.5	80	326	38	41	82	90	1.2	0.62	29.88	29.99	29.98	4.7	29.95
8.	40	32.2	29	766.5	80	420	37	41	83	89	1.2	0.64	23.34	23.45	23.45	7.5	23.41333
9.	41.5	30.6	27.8	768	79	422	35	42	86	87	1.3	0.58	19.25	19.26	19.26	9.6	19.25667

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>l</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.94985757	0.544265	0.00007477	0.00007413	490.331	16.32204	16.256	0.005792	0.01291	0.1871	1.008621	1.01013	0.998506
2.	10	9.90734853	1.08937	0.00010280	0.00010199	337.0353	23.74588	16.51	0.005835	0.017618	0.255338	1.007959	1.009352	0.99862
3.	15	14.8449323	1.632286	0.00013063	0.00012948	285.5692	28.02543	16.256	0.005792	0.022552	0.326843	1.00889	1.010446	0.99846
4.	20	19.7382264	2.170331	0.00016486	0.00016302	270.405	29.59709	16.256	0.005799	0.028427	0.411991	1.011287	1.013262	0.998051
5.	25	24.7873192	2.725508	0.00019963	0.00019819	261.7757	30.57274	16.764	0.005878	0.033965	0.492249	1.007302	1.00858	0.998733
6.	30	29.7677085	3.273131	0.00023501	0.00023346	256.7711	31.16862	16.764	0.005876	0.039997	0.579662	1.006641	1.007803	0.998847
7.	35	34.8091425	3.827465	0.00027913	0.00027784	261.3237	30.62562	15.748	0.005689	0.049063	0.711059	1.004666	1.005483	0.999188
8.	40	39.8124923	4.377612	0.00035706	0.00035564	292.463	27.36483	16.256	0.005778	0.061793	0.895544	1.004008	1.00471	0.999302
9.	41.5	40.957531	4.503516	0.00043414	0.00042930	343.1689	23.32146	14.732	0.005521	0.078637	1.139672	1.011272	1.013245	0.998053

ตารางที่ ค-26 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 2 ใช้น้ำมัน Reference CPO diesel ความเร็วรอบ 1200 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)						Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3		
1.	5	32.4	29.2	766.5	77	102	48	39	82	87	1.7	0.87	98.64	99.63	96.55	0.2	98.27333
2.	10	32.3	29.4	766.5	79	128	46	38	80	89	1.8	0.88	71.36	71.57	71.54	0.7	71.49
3.	15	32.4	29.2	766.2	79	157	43	38	81	89	2.1	0.87	55.96	55.67	55.68	1.1	55.77
4.	20	32.6	29.8	765.5	79	200	42	40	81	90	2	0.86	44.49	44.39	44.2	0.9	44.36
5.	25	32.6	29.6	765.5	80	236	40	39	82	89	1.6	0.82	37.51	37.72	37.7	2.5	37.64333
6.	30	32.6	30	765.2	79	280	40	41	82	89	1.6	0.86	31.22	31.62	31.02	3.5	31.28667
7.	35	32.6	29.8	765	79	334	39	39	85	90	1	0.85	27.03	27.1	27.01	5.0	27.04667
8.	40	32.5	29.6	765	80	403	38	42	84	90	1.1	0.83	23.03	23.11	23.06	6.8	23.06667
9.	43.6	30.8	27.4	768	80	441	34	42	87	89	1.6	0.76	16.78	16.75	16.76	9.6	16.76333

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.98038931	0.625854	0.00008507	0.00008478	487.6935	16.41031	22.098	0.006735	0.012631	0.183057	1.003351	1.003938	0.999416
2.	10	9.95695063	1.251227	0.00011694	0.00011651	335.2217	23.87435	22.352	0.006775	0.017261	0.250164	1.00368	1.004324	0.999359
3.	15	14.9480382	1.878426	0.00014990	0.00014946	286.4383	27.9404	22.098	0.006734	0.022262	0.322632	1.002958	1.003476	0.999484
4.	20	19.9674664	2.509186	0.00018846	0.00018820	270.0117	29.6402	21.844	0.00669	0.028172	0.408289	1.001387	1.001629	0.999758
5.	25	24.959333	3.136482	0.00022208	0.00022178	254.5517	31.44037	20.828	0.006532	0.033999	0.492735	1.001387	1.001629	0.999758
6.	30	29.9649946	3.765512	0.00026721	0.00026694	255.2077	31.35956	21.844	0.006688	0.039952	0.579008	1.000994	1.001168	0.999826
7.	35	34.9698981	4.394447	0.00030910	0.00030887	253.0304	31.6294	21.59	0.006648	0.046492	0.673793	1.000733	1.000861	0.999872
8.	40	39.9502418	5.020295	0.00036243	0.00036204	259.6179	30.82685	21.082	0.006571	0.055157	0.799383	1.00106	1.001246	0.999815
9.	43.6	43.0633105	5.411495	0.00049871	0.00049347	328.2834	24.37894	19.304	0.006318	0.07894	1.144065	1.010607	1.012463	0.998167



ตารางที่ ค-27 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ  
เครื่องยนต์ที่ 2 ใช้น้ำมัน Reference CPO diesel ที่ความเร็วจอบ 1400 rev/min

Run Number	Torque (N-m)		ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke		Fuel Flow avg. (Sec.)
	T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3	Number			
1.	5	32.5	29.4	764.8	80	113	47	38	81	90	3	1.21	85.42	85.42	82.4	0.2	84.41333	
2.	10	32.5	29.8	765	79	134	45	36	81	89	3.1	1.18	61.91	61.16	61.16	0.5	61.41	
3.	15	32	29.9	765.2	78	170	42	35	83	88	3.1	1.18	48.14	48.19	48.19	0.6	48.17333	
4.	20	32.3	29.8	764.9	76	208	40	36	82	88	3.1	1.17	38.61	38.92	38.93	0.9	38.82	
5.	25	31.8	29.6	765.3	78	238	39	35	84	90	3.2	1.17	32.61	32.45	32.23	2.3	32.43	
6.	30	31.6	29.4	765.3	80	281	38	35	85	89	3.2	1.14	27.24	27.34	27.24	3.5	27.27333	
7.	35	31.6	29.2	765.4	78	340	37	36	86	88	3	1.13	23.22	23.98	23.65	4.6	23.61667	
8.	40	31.4	29.2	765.5	78	396	36	37	88	88	3	1.11	19.82	19.8	19.83	4.9	19.81667	
9.	43.5	30.8	27.6	768	78	478	34	42	91	88	3.2	1.01	14.02	14.02	14.01	9.5	14.01667	

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>l</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kw-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	
1.	5	4.99531445	0.732351	0.00009904	0.00009896	486.4427	16.45251	30.734	0.007933	0.012485	0.180939	1.000798	1.000938	0.99986
2.	10	9.98756046	1.464253	0.00013613	0.00013599	334.344	23.93703	29.972	0.007835	0.017376	0.251825	1.00106	1.001246	0.999815
3.	15	14.9479684	2.191487	0.00017354	0.00017303	284.2357	28.15692	29.972	0.007842	0.022129	0.320715	1.002962	1.003481	0.999483
4.	20	19.9628328	2.926704	0.00021535	0.00021501	264.4763	30.26056	29.718	0.007803	0.027597	0.39996	1.001585	1.001862	0.999723
5.	25	24.8902872	3.649107	0.00025779	0.00025682	253.3665	31.58745	29.718	0.007812	0.032999	0.478251	1.003751	1.004408	0.999346
6.	30	29.8453452	4.375556	0.00030653	0.00030518	251.0882	31.87407	28.956	0.007714	0.039739	0.575921	1.00441	1.005182	0.999232
7.	35	34.8142283	5.104032	0.00035399	0.00035239	248.5472	32.19992	28.702	0.00768	0.046091	0.667986	1.004541	1.005336	0.999209
8.	40	39.7509392	5.827792	0.00042187	0.00041963	259.2176	30.87445	28.194	0.007615	0.0554	0.802901	1.005332	1.006266	0.999073
9.	43.5	42.9645415	6.298931	0.00059643	0.00059017	337.299	23.72732	25.654	0.007283	0.081896	1.186896	1.010607	1.012463	0.998167



ตารางที่ ค-28 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 2 ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 1600 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)	
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2			3
1.	5	31	29.2	765.9	79	118	45	34	85	89	3.8	1.48	73.81	72.38	74.03	0.4	73.40667
2.	10	31.2	28.6	765.8	78	147	43	37	86	88	3.8	1.49	54.55	54.31	54.43	0.4	54.43
3.	15	31	28.8	765.8	78	183	41	37	88	88	4.2	1.45	43.03	42.51	42.42	0.8	42.65333
4.	20	31	28.8	765.5	79	219	39	37	89	90	3.9	1.44	33.78	33.81	33.74	0.8	33.77667
5.	25	30.8	28.8	765.5	79	263	38	35	89	89	5.8	1.43	28.6	28.64	28.62	0.8	28.62
6.	30	30.7	28.6	765.5	81	319	38	36	89	89	4	1.43	24.16	24.24	24.57	2.7	24.32333
7.	35	31.2	29	765.5	82	346	38	36	88	90	4	1.41	20.19	20.18	20.05	3.5	20.14
8.	40	31.2	29	765.5	81	409	35	34	85	90	4.2	1.42	17.94	17.67	17.67	3.8	17.76
9.	45.5	30.2	27.4	768.2	81	508	33	41	93	89	4.8	1.43	12.71	12.72	12.72	9.2	12.71667

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>l</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	η <sub>fuel</sub> (%)	air ΔP (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio (φ)	Correction Factor		
												k	α	β
1.	5	4.95816731	0.830749	0.00011389	0.00011307	490.0001	16.33306	37.592	0.008801	0.01294	0.187538	1.007181	1.008437	0.998754
2.	10	9.92550875	1.663035	0.00015359	0.00015262	330.3725	24.22478	37.846	0.008827	0.0174	0.252171	1.006387	1.007505	0.998891
3.	15	14.8767814	2.492629	0.00019600	0.00019463	281.0914	28.47188	36.83	0.008711	0.022501	0.326097	1.007049	1.008283	0.998777
4.	20	19.844832	3.325034	0.00024751	0.00024587	266.2046	30.0641	36.576	0.008679	0.028518	0.413305	1.006655	1.007819	0.998844
5.	25	24.7868981	4.153085	0.00029210	0.00028998	251.3635	31.83915	36.322	0.008652	0.033763	0.489315	1.007317	1.008597	0.99873
6.	30	29.7327945	4.981778	0.00034370	0.00034109	246.486	32.46919	36.322	0.008653	0.03972	0.575656	1.007648	1.008987	0.998673
7.	35	34.7552608	5.8233	0.00041509	0.00041262	255.0852	31.37463	35.814	0.008585	0.048349	0.700717	1.005993	1.007042	0.998959
8.	40	39.7202981	6.6552	0.00047072	0.00046792	253.1103	31.61943	36.068	0.008616	0.054635	0.791816	1.005993	1.007042	0.998959
9.	45.5	44.8222276	7.510036	0.00065740	0.00064905	311.1287	25.72312	36.322	0.008675	0.075777	1.098224	1.012869	1.015121	0.997781

ตารางที่ ค-29 แสดงข้อมูลจากกาการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 2 ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 1800 rev/min

Run Number	Torque (N-m)		ambient condition (°C)			Temperature (°C)					Pressure (Inch. H <sub>2</sub> O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
	T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3			
1.	5	32.2	29	768.5	78	131	48	36	92	88	5.8	1.93	61.13	63.06	63.25	0.2	62.48
2.	10	32.2	29.1	768.5	81	164	44	36	89	88	6	1.97	44.56	44.56	44.42	0.4	44.51333
3.	15	32.2	29.2	768.4	82	195	42	36	89	90	6.5	1.96	35.98	35.58	35.78	0.7	35.78
4.	20	31.2	28.7	768.5	80	235	38	36	87	90	7.7	1.84	28.46	28.34	28.66	0.8	28.48667
5.	25	31.2	28.6	768.5	81	277	36	34	89	90	6.7	1.87	24.15	24.41	24.14	1.4	24.23333
6.	30	31.4	28.6	768.5	81	317	36	34	91	90	6.8	1.86	20.81	20.75	20.69	1.4	20.75
7.	35	31.6	28.5	768.5	81	386	36	39	94	91	7.1	1.85	17.82	17.83	17.82	2.0	17.82333
8.	40	32	28.8	768.5	81	453	35	40	95	90	7.4	1.84	15.16	15.1	15.15	3.3	15.13667
9.	43.5	30.4	27.2	768.2	81	494	34	39	95	88	7.3	1.85	14.02	14.03	13.9	5.0	13.98333

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m.) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{\text{low}}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.9613612	0.935195	0.00013380	0.00013292	511.678	15.64109	49.022	0.010048	0.013317	0.192999	1.006628	1.007788	0.998849
2.	10	9.9227224	1.870389	0.00018781	0.00018657	359.1019	22.28672	50.038	0.010151	0.018501	0.268134	1.006628	1.007788	0.998849
3.	15	14.886357	2.806012	0.00023365	0.00023214	297.8286	26.87184	49.784	0.010125	0.023077	0.334452	1.006497	1.007634	0.998872
4.	20	19.7692099	3.726408	0.00029347	0.00029058	280.7263	28.50891	46.736	0.009827	0.029865	0.432824	1.009936	1.011674	0.998281
5.	25	24.7115124	4.65801	0.00034498	0.00034159	263.9985	30.31532	47.498	0.009906	0.034824	0.504694	1.009936	1.011674	0.998281
6.	30	29.6766749	5.593921	0.00040289	0.00039919	256.9011	31.15285	47.244	0.009877	0.040792	0.591194	1.009272	1.010895	0.998395
7.	35	34.6494636	6.53127	0.00046905	0.00046504	256.3297	31.22229	46.99	0.009847	0.047635	0.690355	1.00861	1.010117	0.998508
8.	40	39.6603818	7.475806	0.00055230	0.00054831	264.0383	30.31076	46.736	0.009814	0.056278	0.81563	1.007288	1.008563	0.998735
9.	43.5	42.8851466	8.08366	0.00059785	0.00059065	263.0407	30.42572	46.99	0.009864	0.060608	0.878373	1.012202	1.014337	0.997895



ตารางที่ ค-30 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ  
เครื่องยนต์ที่ 2 ใช้ น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 2000 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3		
1.	5	33.4	30.8	766	78	148	45	36	89	89	7.5	2.17	56.03	56.04	56.03	0.1	56.03333
2.	10	33.4	31.4	766	83	179	44	36	90	90	8.2	2.21	40.77	40.56	40.35	0.3	40.56
3.	15	32.1	29.2	768.2	79	212	40	37	89	89	7.8	2.14	31.72	31.91	31.95	0.6	31.86
4.	20	32.4	29.2	768	80	253	38	35	91	90	8.1	2.17	26.27	26.33	26.28	0.8	26.29333
5.	25	32.2	29.2	768	81	297	37	38	92	90	8.4	2.15	22.08	22.15	22.01	1.6	22.08
6.	30	32.2	29.2	768	80	345	37	36	93	90	9	2.11	18.85	18.8	18.79	2.3	18.81333
7.	35	32.4	29.2	768	82	400	37	39	93	90	9.2	2.07	16.1	16.04	16.04	3.1	16.06
8.	36.7	30.4	27	768.2	80	426	34	38	96	90	9.5	2.12	15.51	15.5	15.56	3.0	15.52333

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	5.00337614	1.047905	0.00014920	0.00014928	512.8496	15.60536	55.118	0.010616	0.014054	0.203684	0.999426	0.999325	1.000101
2.	10	10.0067523	2.095809	0.00020611	0.00020623	354.2489	22.59203	56.134	0.010713	0.019239	0.27883	0.999426	0.999325	1.000101
3.	15	14.8851824	3.117545	0.00026240	0.00026069	301.0291	26.58614	54.356	0.01058	0.024802	0.359448	1.006565	1.007714	0.99886
4.	20	19.8758811	4.162795	0.00031795	0.00031627	273.5118	29.2609	55.118	0.010647	0.029863	0.432795	1.005315	1.006245	0.999076
5.	25	24.8257629	5.199496	0.00037862	0.00037638	260.5926	30.71154	54.61	0.010601	0.035715	0.517604	1.005973	1.007018	0.998962
6.	30	29.7909154	6.239395	0.00044437	0.00044173	254.8673	31.40144	53.594	0.010502	0.042311	0.613209	1.005973	1.007018	0.998962
7.	35	34.7827919	7.284891	0.00052055	0.00051780	255.8811	31.27703	52.578	0.010399	0.050058	0.725483	1.005315	1.006245	0.999076
8.	36.7	36.1812616	7.577786	0.00053854	0.00053205	252.7635	31.66281	53.848	0.01056	0.051	0.739133	1.012202	1.014337	0.997895



ตารางที่ ค-31 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยี่ห้อที่ 2 ใช้น้ำมัน Reference CPO diesel ความเร็วรอบ 2200 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)						Pressure (inch. H <sub>2</sub> O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3			
1.	5	31.6	29.2	767.8	81	155	45	35	94	90	7.2	2.4	46.05	46.01	46.09	0.1	46.05	
2.	9.5	33.3	31.2	766	81	184	44	35	92	90	7.9	2.46	36.94	36.62	36.83	0.2	36.79667	
3.	15	33.4	29.8	766.9	81	229	41	39	94	90	9	2.42	28.56	28.59	28.62	0.3	28.59	
4.	20	33.2	29.6	767	81	279	39	40	96	90	9.8	2.4	23.5	23.41	23.61	0.5	23.50667	
5.	25	33	29.6	767	80	323	38	40	96	89	10.5	2.42	19.68	19.75	19.59	0.9	19.67333	
6.	30	33.2	29.6	767.1	81	404	37	40	95	91	11.2	2.37	16.65	16.7	16.53	1.3	16.62667	
7.	35	32.7	29.6	767	80	463	36	35	93	90	12.2	2.36	13.98	13.87	13.82	1.7	13.89	
8.	36.4	30.4	27	768.2	81	460	33	39	97	88	11.4	2.35	13.82	13.82	13.81	3.6	13.81667	

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{lum}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.95521886	1.1416	0.00018154	0.00018016	568.1167	14.08725	60.96	0.01121	0.016194	0.234698	1.007691	1.009037	0.998666
2.	9.5	9.50277073	2.189281	0.00022719	0.00022725	373.6857	21.41693	62.484	0.011305	0.020097	0.291264	0.999752	0.999708	1.000043
3.	15	14.9894327	3.453317	0.00029241	0.00029223	304.6475	26.27036	61.468	0.011217	0.026068	0.377796	1.0006	1.000705	0.999895
4.	20	19.9675339	4.60019	0.00035564	0.00035515	277.9339	28.79535	60.96	0.011175	0.031824	0.461224	1.001384	1.001626	0.999758
5.	25	24.9402779	5.745828	0.00042494	0.00042408	265.7015	30.12102	61.468	0.011225	0.037856	0.548632	1.002038	1.002395	0.999644
6.	30	29.9467143	6.899228	0.00050281	0.00050205	261.9666	30.55046	60.198	0.011106	0.045274	0.656147	1.001514	1.001779	0.999735
7.	35	34.8762076	8.034901	0.00060187	0.00060006	268.8537	29.76787	59.944	0.011091	0.054268	0.786495	1.003021	1.003549	0.999473
8.	36.4	35.885502	8.267426	0.00060507	0.00059777	260.2963	30.7465	59.69	0.011118	0.054424	0.788748	1.012202	1.014337	0.997895

ตารางที่ ค-32 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ  
เครื่องยนต์ที่ 2 ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 2400 rev/min

Run Number	Torque (N-m)	ambient condition (°C)		Temperature(°C)						Pressure (inch. H2O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)	
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2			3
1.	5	33.4	31	766.1	81	166	45	36	94	90	7.4	2.82	39.63	39.67	39.59	0.2	39.63
2.	10	33.4	29.6	766.2	81	200	42	38	92	90	8.4	2.95	31.93	32.03	31.93	0.2	31.96333
3.	15	33.4	29.4	766.1	82	240	41	37	95	90	9.9	2.98	25.39	25.49	25.34	0.2	25.40667
4.	20	33.4	29.6	766.5	81	294	38	37	94	90	11	2.95	20.75	20.55	20.75	0.5	20.68333
5.	25	33.2	29.6	766.5	80	345	38	40	97	90	12.2	2.79	17.46	17.46	17.45	0.8	17.45667
6.	30	33.4	29.7	766.4	81	421	37	40	98	90	13	2.77	14.75	14.67	14.67	1.6	14.69667
7.	33	33.2	29.6	766.4	81	452	37	40	99	90	14.1	2.78	13.36	13.36	13.37	2.6	13.36333

Run Number	Torque (N-m)	Torque corrected	Power corrected (kw)	Fuel flow (ml) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kw-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	
1.	5	5.0026087	1.257293	0.00021095	0.00021104	604.284	13.24411	71.628	0.012103	0.01743	0.252614	0.999556	0.999479	1.000078
2.	10	10.003683	2.5142	0.00026155	0.00026163	374.6218	21.36342	74.93	0.012379	0.021128	0.306206	0.999687	0.999632	1.000055
3.	15	15.0078261	3.771878	0.00032905	0.00032919	314.1928	25.47226	75.692	0.012441	0.026448	0.38331	0.999556	0.999479	1.000078
4.	20	19.998165	5.026087	0.00040419	0.00040416	289.4838	27.64645	74.93	0.012382	0.032644	0.473108	1.000078	1.000092	0.999986
5.	25	24.9785456	6.277793	0.00047890	0.00047855	274.4246	29.16357	70.866	0.012045	0.039759	0.576218	1.000731	1.000859	0.999872
6.	30	30.0018466	7.540286	0.00056884	0.00056887	271.5969	29.4672	70.358	0.011997	0.047414	0.687166	0.999948	0.999938	1.000009
7.	33	32.9767347	8.287957	0.00062559	0.00062522	271.5725	29.46985	70.612	0.012023	0.052034	0.754122	1.0006	1.000706	0.999895



ตารางที่ ค-33 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 2 หลังผ่านการทดสอบความทนทานที่ 320 ชั่วโมง ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 1050 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch. H2O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3		
1.	5	28.9	26.6	761.5	-	118	43	38	66	88	2	14.5	101.36	103.04	102.51	-	102.3033
2.	10	28.9	26.6	761.5	-	150	42	38	67	89	2	14.4	75.71	75.61	75.61	-	75.64333
3.	15	29.2	26.6	761.5	-	190	42	38	68	89	1.7	14.3	58.37	58.26	58.5	-	58.37667
4.	20	29.5	26.8	761.4	-	226	41	38	60	88	1.6	14.3	48.24	48.22	48.24	-	48.23333
5.	25	30	26.8	761.4	-	268	41	38	64	90	1.5	14.2	40.7	40.59	40.6	-	40.63
6.	30	30.3	27	761.4	-	329	42	38	69	89	1.4	14.1	33.51	33.52	33.51	-	33.51333
7.	35	30.4	27	761.2	-	392	42	39	75	89	1.5	13.8	29.29	29.3	29.3	-	29.29667
8.	40	30.4	27.6	761.2	-	483	41	39	62	89	1.6	13.8	24.28	24.39	24.4	-	24.35667
9.	40.5	30.7	27.8	761.2	-	508	41	40	67	88	1.7	13.8	18.24	18.23	18.24	-	18.23667

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>l</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kw-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.951382	0.544433	0.00008172	0.00008104	535.8713	14.93493	14.5	0.005469	0.014941	0.216543	1.008357	1.009819	0.998552
2.	10	9.902765	1.088866	0.00011052	0.00010960	362.3678	22.08585	14.4	0.00545	0.020278	0.293878	1.008357	1.009819	0.998552
3.	15	14.87146	1.635202	0.00014321	0.00014216	312.9788	25.57106	14.3	0.005429	0.02638	0.38232	1.007356	1.008643	0.998724
4.	20	19.85477	2.183146	0.00017332	0.00017225	284.0426	28.17606	14.3	0.005426	0.031946	0.462981	1.006225	1.007315	0.998918
5.	25	24.8666	2.734225	0.00020576	0.00020482	269.6804	29.67662	14.2	0.005402	0.038089	0.552008	1.004566	1.005365	0.999205
6.	30	29.87459	3.284883	0.00024945	0.00024856	272.4096	29.37929	14.1	0.00538	0.046363	0.67193	1.003573	1.004198	0.999377
7.	35	34.87794	3.835029	0.00028536	0.00028451	267.0732	29.96633	13.8	0.005321	0.053626	0.777181	1.002978	1.0035	0.999481
8.	40	39.8605	4.382891	0.00034323	0.00034221	281.0856	28.47247	13.8	0.005321	0.064502	0.934809	1.002978	1.0035	0.999481
9.	40.5	40.40561	4.442828	0.00045842	0.00045751	370.7159	21.58851	13.8	0.005319	0.08619	1.249136	1.001988	1.002336	0.999653



ตารางที่ ค-34 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 2 หลังผ่านการทดสอบความทนทานที่ 320 ชั่วโมง ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 1200 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch. H <sub>2</sub> O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3		
1.	5	29	26.7	762	-	123	42	36	55	88	1.6	18.9	89.85	89.65	89.54	-	89.68
2.	10	29	26.7	762	-	159	41	36	59	88	1.6	18.8	65.84	65.65	65.75	0.5	65.74667
3.	15	29	26.7	761.9	-	194	40	36	61	88	1.8	18.8	52.08	52.09	52.08	-	52.08333
4.	20	29	26.7	761.8	-	240	39	36	64	89	2.3	18.8	42.2	42.21	42.21	1.9	42.20667
5.	25	29	26.7	761.8	-	288	38	36	57	87	2	18.7	35.21	35.12	35.22	-	35.18333
6.	30	28.8	26.7	761.8	-	354	37	36	57	89	1.8	18.4	29.33	29.33	29.32	5.5	29.32667
7.	35	28.8	26.7	761.8	-	436	37	36	56	89	1.8	18.1	24.23	24.24	24.34	-	24.27
8.	40	28.6	26.7	761.8	-	553	36	36	56	90	2	18	17.75	17.75	17.76	9.3	17.75333
9.	41.6	28.6	26.6	761.8	-	530	38	35	58	89	2.1	18	15.45	15.45	15.46	-	15.45333

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>l</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kw-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.949493	0.621972	0.00009322	0.00009242	534.918	14.96155	18.9	0.006245	0.014927	0.216332	1.008685	1.010205	0.998496
2.	10	9.898985	1.243943	0.00012715	0.00012606	364.8203	21.93738	18.8	0.006229	0.020415	0.295866	1.008685	1.010205	0.998496
3.	15	14.85076	1.866202	0.00016051	0.00015915	307.0103	26.06819	18.8	0.006228	0.025772	0.373507	1.008552	1.010049	0.998518
4.	20	19.80407	2.488653	0.00019807	0.00019642	294.1332	28.16707	18.8	0.006228	0.031805	0.460941	1.00842	1.009893	0.998541
5.	25	24.75509	3.110816	0.00023761	0.00023563	272.6817	29.34997	18.7	0.006211	0.038256	0.554431	1.00842	1.009893	0.998541
6.	30	29.68304	3.73008	0.00028506	0.00028250	272.6459	29.35383	18.4	0.006163	0.046253	0.670332	1.009088	1.010678	0.998426
7.	35	34.63021	4.35176	0.00034446	0.00034136	282.3872	28.34123	18.1	0.006113	0.056351	0.816681	1.009088	1.010678	0.998426
8.	40	39.54663	4.969576	0.00047090	0.00046635	337.8258	23.69032	18	0.006098	0.077224	1.119184	1.009757	1.011464	0.998312
9.	41.6	41.1285	5.168359	0.00054098	0.00053576	373.179	21.44601	18	0.006098	0.088717	1.285758	1.009757	1.011464	0.998312

ตารางที่ ค-35 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 2 หลังผ่านการทดสอบความทนทานที่ 320 ชั่วโมง ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 1600 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)				Pressure (inch. H <sub>2</sub> O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)	
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2			3
1.	5	29.1	27.4	762.6	-	141	41	34	61	89	3.8	36.5	64.51	64.51	64.51	-	64.53667
2.	10	29.1	27.4	762.5	-	173	40	34	57	89	4	36.4	49.46	49.52	0.2	49.52667	
3.	15	29.2	27.3	762.5	-	214	39	34	67	88	4	36	38.37	38.45	-	38.33	
4.	20	29.2	27.4	762.5	-	255	39	34	67	89	4.1	35.4	31.71	31.71	1.1	31.64	
5.	25	29.2	27.6	762.4	-	300	38	34	67	90	4.1	35.2	27.14	27.07	-	27.11667	
6.	30	29.2	27.8	762.3	-	350	37	35	65	90	4.3	34.7	22.89	22.89	3.3	22.89	
7.	35	29.2	27.8	762.3	-	419	36	35	64	89	4.3	34.5	19.52	19.53	-	19.5	
8.	40	29.1	27.8	762.2	-	520	35	35	67	88	4.5	34.4	16.23	16.23	5.4	16.23	
9.	42.6	29.1	27.8	762.2	-	599	35	35	66	89	5	34.4	13.2	13.15	-	13.17333	

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>l</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	$\eta_{fuel}$ (%)	air $\Delta P$ (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio ( $\phi$ )	Correction Factor		
												k	$\alpha$	$\beta$
1.	5	4.946844	0.828852	0.00012954	0.00012836	557.5346	14.35463	36.5	0.006681	0.014923	0.21627	1.009145	1.010745	0.998417
2.	10	9.895211	1.657959	0.00016880	0.00016729	363.2448	22.03253	36.4	0.008668	0.019473	0.28222	1.009013	1.01059	0.998439
3.	15	14.84858	2.487903	0.00021811	0.00021623	312.8841	25.5788	36	0.008619	0.025305	0.366741	1.008679	1.010198	0.998497
4.	20	19.7981	3.317204	0.00026422	0.00026195	284.2806	28.15248	35.4	0.008547	0.030914	0.448034	1.008679	1.010198	0.998497
5.	25	24.75144	4.147143	0.00030830	0.00030568	265.3551	30.16034	35.2	0.008522	0.036176	0.524288	1.008547	1.010042	0.998519
6.	30	29.7063	4.977338	0.00036522	0.00036218	261.9551	30.55181	34.7	0.008461	0.043166	0.625599	1.008414	1.009887	0.998542
7.	35	34.65735	5.806894	0.00042872	0.00042514	263.5671	30.36495	34.5	0.008436	0.050817	0.736482	1.008414	1.009887	0.998542
8.	40	39.59912	6.634897	0.00051510	0.00051070	277.0961	28.8824	34.4	0.008425	0.061138	0.886064	1.008616	1.010123	0.998507
9.	42.6	42.17306	7.066165	0.00063462	0.00062919	320.5558	24.96664	34.4	0.008425	0.075325	1.091662	1.008616	1.010123	0.998507



ตารางที่ ค-36 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 2 หลังผ่านการทดสอบความทนทานที่ 320 ชั่วโมง ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 2000 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)					Pressure (inch. H2O)			Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1	2	3		
1.	5	30.8	28.4	763.8	-	159	45	34	59	90	5.8	50	51.97	51.78	51.84	-	51.863333
2.	10	30.8	28.2	764	-	199	44	34	59	90	6.6	50	37.66	37.69	37.63	0.4	37.66
3.	15	30.8	28.2	764	-	243	43	34	60	90	7.4	49.6	30.82	30.7	30.94	-	30.82
4.	20	30.8	28.2	764	-	283	42	34	62	90	8	49.2	25.43	25.74	25.15	1.3	25.44
5.	25	30.7	28	764	-	341	41	34	59	90	8.5	49	21.36	21.43	21.12	-	21.30333
6.	30	30.4	28	764	-	399	40	34	62	89	9	48.2	18.31	18.32	18.37	2.2	18.33333
7.	35	30.2	28	764	-	473	40	34	62	89	11.2	48.2	15.81	15.81	15.86	2.8	15.82667
8.	36	30.2	27.9	764	-	535	38	35	57	90	11.4	48.1	14.97	14.94	15.02	-	14.97667

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>f</sub> ) (g/hr.)	mf corrected (g/hr.)	bsfc (g/kW-hr)	η <sub>fuel</sub> (%)	air ΔP (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio (φ)	Correction Factor		
												k	α	β
1.	5	4.970333	1.040984	0.00016119	0.00016038	554.6304	14.42979	50	0.01014	0.015898	0.230399	1.00508	1.005969	0.999116
2.	10	9.937611	2.081328	0.00022199	0.00022081	381.921	20.95512	50	0.010141	0.02189	0.317251	1.005343	1.006278	0.999071
3.	15	14.90642	3.121992	0.00027125	0.00026981	311.1215	25.72372	49.6	0.0101	0.026856	0.38922	1.005343	1.006278	0.999071
4.	20	19.87522	4.162657	0.00032862	0.00032687	282.6876	28.31111	49.2	0.010059	0.032668	0.473444	1.005343	1.006278	0.999071
5.	25	24.83443	5.201311	0.00039243	0.00039021	270.0792	29.63279	49	0.010041	0.039084	0.566437	1.005674	1.006667	0.999014
6.	30	29.76679	6.234341	0.00045600	0.00045298	261.5716	30.5966	48.2	0.009963	0.045769	0.663312	1.006668	1.007885	0.998842
7.	35	34.70107	7.267774	0.00052822	0.00052438	259.744	30.81189	48.2	0.009966	0.053	0.768116	1.007332	1.008615	0.998728
8.	36	35.69252	7.475425	0.00055820	0.00055414	266.8611	29.99014	48.1	0.009956	0.056066	0.812553	1.007332	1.008615	0.998728



ตารางที่ ค-37 แสดงข้อมูลจากการทดสอบ และผลการคำนวณ

เครื่องยนต์ที่ 2 หลังผ่านการทดสอบความทนทานที่ 320 ชั่วโมง ใช้น้ำมัน Reference CPO diesel ที่ความเร็วรอบ 2400 rev/min

Run Number	Torque (N-m)	ambient condition (°C)			Temperature(°C)				Pressure (Inch. H2O)		Fuel Flow rate (sec./10c.c.)			Smoke Number	Fuel Flow avg. (sec.)		
		T db	T wb	P atm	Water out	Exhaust	Fuel	Air intake	Oil	Water Tank	Exhaust	Orifice	1			2	3
1.	30.5	31	28.4	765		479	41	34	60	90	13.5	70.4	14.03	14.03	14.02	3.5	14.02667

Run Number	Torque (N-m)	Torque corrected	Power corrected (kW)	Fuel flow (m <sub>f</sub> ) (g/hr.)	m <sub>f</sub> corrected (g/hr.)	bsfc (g/kW-hr)	η <sub>comb</sub> (%)	air ΔP (mm. H <sub>2</sub> O)	Air flow rate (kg/s)	Fuel/Air	Equivalence Ratio (φ)	Correction Factor		
												k	α	
1.	30.5	30.28659	7.611849	0.00059601	0.00059245	280.1995	28.56251	70.4	0.012037	0.049515	0.717607	1.005997	1.007046	0.998958



ภาคผนวก ง

ข้อมูลการทดสอบความทนทาน

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



ตารางที่ ง-1 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 1

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	0.00	14.59	14.66	14.62	14.62	2.46	105	30	94	214	48
	1.00	14.59	14.66	14.62	14.62	2.46	105	30	94	214	48
	2.00	14.59	14.66	14.62	14.62	2.46	105	30	94	214	48
	2.92	14.59	14.66	14.62	14.62	2.46	105	30	94	214	48
	3.00	15.96	15.93	15.94	15.94	2.26	99	28	91	201	52
	3.50	15.38	15.43	15.53	15.45	2.33	103	28	92	203	52
	3.92	15.34	15.56	15.44	15.45	2.33	104	28	94	205	52
	4.00	16.50	16.34	16.53	16.46	2.19	100	28	95	194	56
	4.50	16.69	16.66	16.72	16.69	2.16	97	26	93	193	55
	4.92	16.37	16.53	16.56	16.49	2.18	102	28	93	193	56
Commercial Diesel	0.00	15.09	14.97	15.00	15.02	2.40	108	30	97	204	47
	1.00	15.09	14.97	15.01	15.02	2.40	108	30	97	204	47
	2.00	15.09	14.97	15.02	15.02	2.40	108	30	97	204	47
	2.92	15.09	14.97	15.03	15.02	2.40	108	30	97	204	47
	3.00	16.37	16.28	16.37	16.34	2.20	102	29	95	191	50
	3.50	16.34	16.38	16.22	16.31	2.21	106	29	95	192	50
	3.92	16.22	16.47	16.25	16.31	2.21	107	29	97	193	50
	4.00	17.50	17.30	17.44	17.41	2.07	106	28	95	184	51
	4.50	17.70	17.43	17.66	17.60	2.05	102	28	95	183	50
	4.92	17.59	17.50	17.63	17.57	2.05	105	29	95	184	51

ตารางที่ ง-2 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 2

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	5.00	14.78	14.69	14.75	14.74	2.44	107	27	98	220	47
	6.00	14.71	14.47	14.63	14.60	2.47	107	27	96	221	47
	7.00	14.44	14.50	14.50	14.48	2.49	107	26	97	218	50
	7.92	14.31	14.62	14.50	14.48	2.49	106	26	97	217	50.5
	8.00	15.38	15.38	15.37	15.38	2.34	104	26	95	206	52
	8.50	15.41	15.47	15.40	15.43	2.33	106	26	95	206	52
	8.92	15.32	15.40	15.32	15.35	2.35	104	26	95	207	52
	9.00	18.16	18.19	18.19	18.18	1.98	99	26	92	182	50
	9.50	18.19	18.19	18.21	18.20	1.98	101	26	90	182	50
	9.92	17.90	18.19	18.12	18.07	1.99	96	25	91	183	50
Commercial Diesel	5.00	15.22	15.22	15.29	15.24	2.36	107	29	99	205	48
	6.00	15.44	15.40	15.25	15.36	2.34	108	29	100	206	48
	7.00	15.34	15.25	15.28	15.29	2.35	107	27	98	204	49
	7.92	15.06	15.16	15.16	15.13	2.38	107	27	99	204	49.5
	8.00	17.07	17.10	17.29	17.15	2.10	105	27	98	187	48
	8.50	17.12	17.09	17.06	17.09	2.11	104	27	96	186	49
	8.92	17.00	17.09	17.12	17.07	2.11	105	27	96	187	49
	9.00	19.53	19.69	19.41	19.54	1.84	101	26	93	170	47
	9.50	19.07	19.12	19.00	19.06	1.89	102	27	92	172	48
	9.92	19.09	19.19	19.12	19.13	1.88	99	27	93	172	48

ตารางที่ ง-3 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 3

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	10.00	14.44	14.43	14.37	14.41	2.50	102	25	93	217	47
	11.00	14.50	14.47	14.50	14.49	2.48	108	26	94	222	48
	12.00	14.56	14.44	14.53	14.51	2.48	110	26	92	222	48
	12.92	14.59	14.37	14.41	14.46	2.49	104	24	96	220	48
	13.00	15.03	14.94	15.00	14.99	2.40	103	25	94	212	50
	13.50	14.47	14.44	14.47	14.46	2.49	107	25	92	214	50
	13.92	15.06	14.88	14.87	14.94	2.41	107	25	92	214	50
	14.00	16.40	16.43	16.37	16.40	2.20	104	26	92	198	50.5
	14.50	15.69	15.75	15.66	15.70	2.29	104	25	94	204	52
	14.92	15.56	15.63	15.65	15.61	2.31	105	26	94	205	52
Commercial Diesel	10.00	15.13	15.09	15.29	15.17	2.37	105	27	97	203	46
	11.00	15.50	15.47	15.44	15.47	2.33	110	27	100	205	48
	12.00	15.28	15.38	15.34	15.33	2.35	109	27	94	202	48
	12.92	15.50	15.56	15.47	15.51	2.32	107	27	98	202	48
	13.00	15.16	15.22	15.13	15.17	2.37	105	27	97	201	52
	13.50	15.28	15.18	15.12	15.19	2.37	108	26	97	202	52
	13.92	15.28	15.28	15.12	15.23	2.36	110	26	96	202	52
	14.00	15.37	15.53	15.59	15.50	2.32	109	26	97	199	52
	14.50	15.66	15.56	15.66	15.63	2.30	109	26	99	201	52
	14.92	15.50	15.53	15.41	15.48	2.33	109	27	98	201	52

ตารางที่ ง-4 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 4

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	15.00	14.06	14.16	14.12	14.11	2.55	105	28	88	256	49
	16.00	14.87	14.81	14.78	14.82	2.43	110	30	98	255	46
	17.00	14.75	14.90	14.81	14.82	2.43	108	30	96	253	46
	17.92	15.16	15.25	15.25	15.22	2.37	110	30	95	252	46
	18.00	14.81	15.00	14.87	14.89	2.42	103	29	94	247	47
	18.50	15.56	15.43	15.47	15.49	2.32	106	30	94	248	48
	18.92	15.59	15.60	15.63	15.61	2.31	106	30	91	244	48
	19.00	15.47	15.41	15.44	15.44	2.33	104	29	91	243	52
	19.50	15.41	15.37	15.47	15.42	2.34	105	30	91	242	51
	19.92	15.31	15.31	15.35	15.32	2.35	107	31	94	244	52
Commercial Diesel	15.00	15.06	14.87	15.03	14.99	2.40	106	30	91	248	49
	16.00	15.75	15.66	15.72	15.71	2.29	111	31	101	244	45
	17.00	15.37	15.47	15.30	15.38	2.34	112	32	100	243	46.5
	17.92	15.56	15.84	15.53	15.64	2.30	105	31	101	249	46
	18.00	15.50	15.56	15.50	15.52	2.32	109	30	101	247	52
	18.50	16.65	16.37	16.28	16.43	2.19	108	30	100	234	48
	18.92	16.65	16.44	16.50	16.53	2.18	110	30	97	230	48
	19.00	17.25	17.35	17.31	17.30	2.08	108	29	97	221	50
	19.50	17.25	17.22	17.13	17.20	2.09	108	30	96	222	50
	19.92	17.31	17.31	17.25	17.29	2.08	107	31	97	222	50



ตารางที่ ง-5 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 5

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	20.00	14.66	14.59	14.66	14.64	2.46	110	30	95	257	48
	21.00	14.72	14.69	14.62	14.68	2.45	108	29	94	255	48
	22.00	14.59	14.63	14.75	14.66	2.46	109	30	97	257	47
	22.92	14.59	14.75	14.65	14.66	2.46	107	29	95	257	48
	23.00	16.04	16.09	16.00	16.04	2.24	104	30	94	240	48.5
	23.50	16.00	16.03	16.00	16.01	2.25	105	30	91	237	48.5
	23.92	16.06	15.91	16.00	15.99	2.25	99	28	94	239	48.5
	24.00	16.56	16.56	16.50	16.54	2.18	104	29	93	231	51
	24.50	16.53	16.47	16.50	16.50	2.18	98	28	90	229	51
	24.92	16.47	16.37	16.31	16.38	2.20	103	29	93	230	51
Commercial Diesel	20.00	15.46	15.34	15.47	15.42	2.33	108	30	99	246	48
	21.00	15.04	15.13	15.28	15.15	2.38	110	29	98	247	49
	22.00	15.34	15.41	15.28	15.34	2.35	110	30	101	246	48
	22.92	15.31	15.37	15.25	15.31	2.35	109	29	101	248	48
	23.00	16.28	16.41	16.50	16.40	2.20	109	30	101	233	48.5
	23.50	16.32	16.28	16.28	16.29	2.21	109	29	98	234	48.5
	23.92	16.22	16.09	16.25	16.19	2.22	106	29	100	234	49
	24.00	17.56	17.50	17.50	17.52	2.05	106	29	99	221	50
	24.50	17.40	17.32	17.40	17.37	2.07	105	29	96	220	50
	24.92	17.53	17.35	17.56	17.48	2.06	107	29	98	220	50

ตารางที่ ง-6 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 6

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	25.00	14.65	14.63	14.60	14.63	2.46	107	28	92	255	47
	26.00	14.87	14.87	14.88	14.87	2.42	109	28	96	254	48
	27.00	14.85	14.78	14.78	14.80	2.43	107	27	96	257	44
	27.92	14.78	14.94	14.70	14.81	2.43	107	27	95	254	46
	28.00	15.46	15.34	15.28	15.36	2.34	107	27	94	250	48
	28.50	15.53	15.44	15.47	15.48	2.33	106	28	93	251	47.5
	28.92	15.44	15.40	15.56	15.47	2.33	107	27	92	247	48
	29.00	15.75	15.75	15.84	15.78	2.28	105	27	93	240	51
	29.50	15.72	15.75	15.75	15.74	2.29	105	27	93	242	50
	29.92	16.07	16.10	16.06	16.08	2.24	103	27	93	235	50
Commercial Diesel	25.00	15.25	15.19	15.16	15.20	2.37	109	29	95	252	48.5
	26.00	15.50	15.44	15.53	15.49	2.32	109	29	99	246	48
	27.00	15.22	15.50	15.53	15.42	2.34	108	28	99	248	48
	27.92	15.25	15.22	15.38	15.28	2.36	108	28	99	247	48
	28.00	16.03	15.87	16.03	15.98	2.25	107	28	98	238	49
	28.50	16.15	16.19	16.16	16.17	2.23	107	28	97	236	49.5
	28.92	15.97	16.22	16.03	16.07	2.24	110	29	97	238	49.5
	29.00	16.94	16.91	17.04	16.96	2.12	105	28	97	222	50.5
	29.50	16.97	17.06	17.03	17.02	2.12	104	27	97	223	50
	29.92	16.93	16.97	17.00	16.97	2.12	104	28	96	222	50



ตารางที่ ง-7 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 7

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	30.00	14.65	14.59	14.59	14.61	2.46	107	27	93	258	46
	31.00	14.72	14.72	14.75	14.73	2.44	108	27	95	258	47
	32.00	15.19	15.25	15.28	15.24	2.36	108	26	94	257	46.5
	32.92	15.25	14.88	15.10	15.08	2.39	107	26	95	254	46
	33.00	14.75	14.69	14.85	14.76	2.44	105	27	94	244	48
	33.50	15.53	15.38	15.40	15.44	2.33	106	27	93	248	49
	33.92	15.40	15.31	15.38	15.36	2.34	106	27	93	247	48
	34.00	16.10	16.12	16.07	16.10	2.24	106	27	94	238	50
	34.50	16.13	16.06	16.07	16.09	2.24	106	28	94	239	50
	34.92	15.96	16.12	16.09	16.06	2.24	106	28	93	238	50
Commercial Diesel	30.00	15.60	15.56	15.78	15.65	2.30	106	27	96	243	48
	31.00	15.44	15.75	15.91	15.70	2.29	107	27	97	243	48
	32.00	15.72	15.59	15.46	15.59	2.31	106	27	97	245	48
	32.92	15.57	15.22	15.63	15.47	2.33	107	27	97	244	48
	33.00	15.25	15.38	15.40	15.34	2.35	107	27	98	242	51
	33.50	15.91	15.81	16.06	15.93	2.26	107	28	96	236	50
	33.92	16.04	16.00	15.97	16.00	2.25	106	28	97	237	50
	34.00	17.34	17.25	17.12	17.24	2.09	106	28	96	223	50
	34.50	17.34	17.19	17.12	17.22	2.09	105	29	96	224	50.5
	34.92	17.22	17.15	17.28	17.22	2.09	107	29	96	224	50

ตารางที่ ง-8 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 8

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	35.00	14.53	14.60	14.53	14.55	2.47	105	30	92	257	48
	36.00	14.59	14.69	14.50	14.59	2.47	106	28	93	256	48
	37.00	14.63	14.59	14.56	14.59	2.47	107	28	93	255	47
	37.92	14.84	14.78	14.65	14.76	2.44	108	28	87	255	49
	38.00	16.25	16.18	16.31	16.25	2.22	105	28	91	237	49
	38.50	16.38	16.38	16.35	16.37	2.20	106	28	92	237	48.5
	38.92	16.21	16.19	16.25	16.22	2.22	103	28	92	237	49.5
	39.00	18.06	18.07	18.09	18.07	1.99	98	26	88	218	49
	39.50	17.78	17.84	17.84	17.82	2.02	100	28	90	222	49
	39.92	17.78	17.68	17.85	17.77	2.03	101	27	89	222	49
Commercial Diesel	35.00	15.81	15.63	15.88	15.77	2.28	106	31	96	246	48
	36.00	15.81	15.63	15.72	15.72	2.29	107	30	96	245	48
	37.00	15.71	15.40	15.75	15.62	2.30	106	30	95	245	48
	37.92	15.50	15.37	15.41	15.43	2.33	104	29	96	247	49.5
	38.00	16.31	16.38	16.16	16.28	2.21	103	30	96	234	50
	38.50	16.50	16.56	16.53	16.53	2.18	103	29	96	235	50
	38.92	16.56	16.41	16.47	16.48	2.18	104	29	95	231	48.5
	39.00	18.28	18.29	18.47	18.35	1.96	100	29	92	212	49
	39.50	18.41	18.37	18.25	18.34	1.96	101	29	93	212	49
	39.92	18.56	18.38	18.31	18.42	1.95	102	28	92	212	49

ตารางที่ ง-9 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 9

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	40.00	14.66	14.59	14.69	14.65	2.46	108	28	91	260	50
	41.00	14.65	14.66	14.63	14.65	2.46	105	28	94	258	50
	42.00	14.59	14.59	14.59	14.59	2.47	106	27	89	258	50
	42.92	14.56	14.62	14.69	14.62	2.46	104	28	92	260	50
	43.00	16.22	16.09	16.15	16.15	2.23	104	27	92	240	50.5
	43.50	16.06	16.16	16.15	16.12	2.23	103	27	90	237	51
	43.92	16.12	16.16	16.19	16.16	2.23	102	27	90	237	50
	44.00	17.38	17.34	17.43	17.38	2.07	101	27	88	223	50
	44.50	17.41	17.31	17.37	17.36	2.07	100	27	86	223	50
44.92	17.56	17.50	17.50	17.52	2.05	99	27	86	220	50	
Commercial Diesel	40.00	15.53	15.71	15.72	15.65	2.30	105	29	94	245	50
	41.00	15.66	15.72	15.78	15.72	2.29	105	29	96	245	50
	42.00	15.44	15.65	15.53	15.54	2.32	106	29	94	246	50
	42.92	15.66	15.62	15.56	15.61	2.31	105	28	96	246	50
	43.00	16.81	16.75	16.72	16.76	2.15	104	28	96	230	51
	43.50	16.72	16.66	16.69	16.69	2.16	103	28	95	230	51
	43.92	16.72	16.63	16.75	16.70	2.16	103	28	94	230	50.5
	44.00	16.21	18.28	18.18	17.56	2.05	102	28	94	213	51
	44.50	18.35	18.85	18.38	18.53	1.94	102	28	92	210	50
44.92	18.93	18.72	18.78	18.81	1.91	101	28	92	209	50	

ตารางที่ ง-10 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 10

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	45.00	14.81	14.65	14.81	14.76	2.44	105	27	87	258	48
	46.00	14.91	14.78	14.84	14.84	2.43	107	27	90	256	50
	47.00	14.78	14.75	14.78	14.77	2.44	105	27	90	253	50
	47.92	14.75	14.66	14.63	14.68	2.45	104	27	89	256	50
	48.00	15.82	15.78	15.81	15.80	2.28	103	26	87	240	51
	48.50	15.78	15.66	15.69	15.71	2.29	104	26	87	240	51
	48.92	15.63	15.63	15.72	15.66	2.30	104	26	87	243	51
	49.00	16.47	16.66	16.57	16.57	2.17	101	26	86	229	52
	49.50	17.60	17.62	17.56	17.59	2.05	100	26	86	221	50
49.92	17.57	17.59	17.53	17.56	2.05	99	26	83	220	50	
Commercial Diesel	45.00	15.60	15.65	15.50	15.58	2.31	106	28	94	247	50
	46.00	15.59	15.66	15.59	15.61	2.31	107	28	95	245	51
	47.00	15.84	15.82	15.82	15.83	2.27	106	28	96	245	51
	47.92	15.75	15.75	15.62	15.71	2.29	106	28	96	245	51
	48.00	16.53	16.40	16.35	16.43	2.19	106	27	96	235	53
	48.50	16.22	16.21	16.28	16.24	2.22	105	27	95	235	53
	48.92	16.34	16.35	16.28	16.32	2.21	106	27	95	236	53
	49.00	18.85	18.95	19.00	18.93	1.90	103	27	94	209	50.5
	49.50	19.13	19.12	19.12	19.12	1.88	104	27	92	208	50.5
49.92	19.09	18.94	19.12	19.05	1.89	102	27	92	209	50.5	



ตารางที่ ง-11 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 11

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	50.00	14.88	14.88	14.78	14.85	2.42	106	31	95	244	50
	51.00	14.81	14.84	14.81	14.82	2.43	107	31	97	244	50
	52.00	14.78	14.88	14.81	14.82	2.43	106	32	97	242	52
	52.92	14.75	14.72	14.75	14.74	2.44	107	31	92	242	52
	53.00	16.00	16.06	15.96	16.01	2.25	104	31	91	224	52.5
	53.50	15.91	16.00	15.97	15.96	2.26	103	30	89	223	53
	53.92	15.82	16.00	16.00	15.94	2.26	103	30	90	224	53
	54.00	17.37	17.40	17.31	17.36	2.07	99	30	89	210	53.5
	54.50	17.47	17.47	17.41	17.45	2.06	106	30	88	210	53.5
	54.92	17.44	17.43	17.34	17.40	2.07	100	30	88	210	53
Commercial Diesel	50.00	15.84	15.68	15.56	15.69	2.29	107	32	98	224	49
	51.00	15.66	15.62	15.50	15.59	2.31	111	32	100	225	49
	52.00	15.90	15.91	15.88	15.90	2.26	112	32	100	225	50
	52.92	15.63	15.75	15.62	15.67	2.30	111	32	96	223	50.5
	53.00	16.46	16.59	16.53	16.53	2.18	111	32	95	212	51
	53.50	16.44	16.34	16.28	16.35	2.20	109	31	95	212	52
	53.92	16.69	16.69	16.50	16.63	2.17	111	31	95	212	52
	54.00	17.69	17.72	17.97	17.79	2.02	106	31	94	198	52.5
	54.50	17.85	17.72	17.62	17.73	2.03	106	31	94	199	52.5
	54.92	17.69	17.81	17.94	17.81	2.02	106	31	94	198	52

ตารางที่ ง-12 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 12

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	55.00	14.88	14.85	14.82	14.85	2.42	106	30	90	242	52
	56.00	14.85	14.87	14.88	14.87	2.42	107	30	94	243	52
	57.00	14.84	14.78	14.81	14.81	2.43	106	29	92	244	52
	57.92	14.82	14.79	14.88	14.83	2.43	106	29	91	242	52
	58.00	16.16	16.10	16.13	16.13	2.23	104	28	91	227	52.5
	58.50	15.91	15.97	15.91	15.93	2.26	103	28	89	224	52.5
	58.92	16.03	15.91	15.97	15.97	2.25	103	28	89	225	52.5
	59.00	17.47	17.50	17.50	17.49	2.06	100	28	89	210	49
	59.50	17.59	17.56	17.57	17.57	2.05	102	28	87	209	50
	59.92	17.78	17.71	17.69	17.73	2.03	102	29	88	208	50
Commercial Diesel	55.00	15.54	15.69	15.28	15.50	2.32	112	31	95	226	52
	56.00	15.46	15.53	15.56	15.52	2.32	112	31	99	225	52
	57.00	15.15	15.22	15.03	15.13	2.38	111	30	97	225	52
	57.92	15.15	15.16	15.13	15.15	2.38	109	30	96	226	53
	58.00	16.75	16.47	16.50	16.57	2.17	109	30	96	212	51.5
	58.50	16.69	16.40	16.44	16.51	2.18	107	30	96	211	51
	58.92	16.53	16.41	16.57	16.50	2.18	108	29	95	211	51.5
	59.00	18.31	18.12	18.09	18.17	1.98	106	29	95	195	51
	59.50	18.28	18.28	18.31	18.29	1.97	106	29	94	195	51
	59.92	18.47	18.31	18.38	18.39	1.96	106	29	95	196	51

ตารางที่ ง-13 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 13

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	60.00	14.78	14.62	14.65	14.68	2.45	105	28	90	243	52
	61.00	14.84	14.78	14.72	14.78	2.44	106	28	92	242	52
	62.00	14.75	14.72	14.65	14.71	2.45	104	28	90	240	51.5
	62.92	14.65	14.72	14.71	14.69	2.45	105	28	90	242	52
	63.00	15.72	15.69	15.65	15.69	2.29	103	27	89	226	53
	63.50	15.72	15.69	15.65	15.69	2.29	103	27	89	226	53
	63.92	15.72	15.69	15.65	15.69	2.29	103	27	89	226	53
	64.00	15.72	15.69	15.65	15.69	2.29	103	27	89	226	53
	64.50	15.72	15.69	15.65	15.69	2.29	103	27	89	226	53
	64.92	15.72	15.69	15.65	15.69	2.29	103	27	89	226	53
Commercial Diesel	60.00	15.65	15.84	15.41	15.63	2.30	109	29	97	224	52
	61.00	15.41	15.75	15.75	15.64	2.30	111	29	99	222	50
	62.00	15.10	15.13	15.04	15.09	2.39	108	29	99	227	52
	62.92	15.50	15.07	15.18	15.25	2.36	112	29	99	230	52.5
	63.00	16.16	16.15	16.12	16.14	2.23	110	29	98	214	52.5
	63.50	16.16	16.15	16.12	16.14	2.23	110	29	98	214	52.5
	63.92	16.16	16.15	16.12	16.14	2.23	110	29	98	214	52.5
	64.00	16.16	16.15	16.12	16.14	2.23	110	29	98	214	52.5
	64.50	16.16	16.15	16.12	16.14	2.23	110	29	98	214	52.5
	64.92	16.16	16.15	16.12	16.14	2.23	110	29	98	214	52.5

ตารางที่ ง-14 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 14

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	65.00	14.93	14.97	14.97	14.96	2.41	110	34	89	244	50
	66.00	14.78	14.69	14.54	14.67	2.45	108	32	89	242	53
	67.00	14.69	14.72	14.75	14.72	2.45	108	31	92	244	53
	67.92	14.63	14.56	14.68	14.62	2.46	109	31	91	246	53
	68.00	15.59	15.57	15.56	15.57	2.31	105	31	91	230	54
	68.50	15.91	15.96	15.94	15.94	2.26	105	31	88	226	53
	68.92	16.09	16.00	16.00	16.03	2.25	104	30	87	224	53
	69.00	17.75	17.81	17.75	17.77	2.03	99	30	86	207	53
	69.50	17.91	17.84	17.78	17.84	2.02	100	30	82	206	53
	69.92	17.84	17.84	17.88	17.85	2.02	99	30	81	205	53
Commercial Diesel	65.00	15.50	15.50	15.38	15.46	2.33	106	34	94	234	50
	66.00	15.62	15.94	15.78	15.78	2.28	103	31	92	223	54
	67.00	15.50	15.75	15.68	15.64	2.30	104	31	95	226	54
	67.92	15.69	15.72	15.75	15.72	2.29	102	32	94	217	54
	68.00	17.44	17.47	17.50	17.47	2.06	101	31	94	204	53.5
	68.50	17.19	17.06	17.15	17.13	2.10	99	31	91	202	53
	68.92	17.31	17.31	17.22	17.28	2.08	101	30	92	204	53.5
	69.00	17.53	17.25	17.31	17.36	2.07	99	30	92	204	53
	69.50	17.31	17.22	17.18	17.24	2.09	100	30	90	203	53
	69.92	17.31	17.25	17.20	17.25	2.09	99	30	89	202	53



ตารางที่ ง-15 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 15

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	70.00	14.47	14.37	14.50	14.45	2.49	107	30	85	244	53
	71.00	14.03	13.93	13.90	13.95	2.58	108	30	88	253	52
	72.00	14.00	14.13	14.09	14.07	2.56	104	29	85	248	51
	72.92	13.88	13.97	13.87	13.91	2.59	99	27	83	247	51
	73.00	14.66	14.47	14.62	14.58	2.47	98	28	84	233	52
	73.50	14.72	14.53	14.59	14.61	2.46	102	29	83	238	52
	73.92	14.57	14.57	14.47	14.54	2.48	102	28	80	236	52
	74.00	16.09	16.11	15.94	16.05	2.24	97	28	82	220	51
	74.50	15.50	15.60	15.47	15.52	2.32	97	28	81	222	52
	74.92	15.72	15.63	15.69	15.68	2.30	96	27	80	222	52
Commercial Diesel	70.00	15.50	15.56	15.47	15.51	2.32	104	30	92	225	50
	71.00	15.71	15.85	15.75	15.77	2.28	104	30	93	224	50
	72.00	15.78	15.81	15.94	15.84	2.27	103	29	93	224	50.5
	72.92	16.41	16.41	16.47	16.43	2.19	99	29	91	224	52
	73.00	17.60	17.34	17.41	17.45	2.06	101	29	92	208	50
	73.50	16.84	17.06	17.00	16.97	2.12	103	29	92	211	51
	73.92	16.94	16.68	16.75	16.79	2.14	101	28	91	211	52
	74.00	17.79	17.91	17.69	17.80	2.02	102	29	92	210	52
	74.50	16.81	16.41	16.87	16.70	2.16	102	29	93	214	53
	74.92	17.62	16.88	16.96	17.15	2.10	102	28	92	212	53

ตารางที่ ง-16 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 16

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	75.00	13.47	13.35	13.40	13.41	2.69	104	26	72	257	52
	76.00	14.13	14.16	14.25	14.18	2.54	108	27	90	248	51
	77.00	14.47	14.37	14.25	14.36	2.51	108	28	92	249	50
	77.92	14.25	14.19	14.19	14.21	2.53	108	28	92	248	51
	78.00	15.40	15.41	15.47	15.43	2.33	106	28	93	234	50
	78.50	15.47	15.34	15.40	15.40	2.34	107	29	92	233	50
	78.92	15.31	15.35	15.25	15.30	2.35	105	29	89	234	50.5
	79.00	15.10	15.25	15.22	15.19	2.37	107	29	90	235	50
	79.50	15.00	15.10	15.09	15.06	2.39	106	29	90	234	50.5
	79.92	15.34	15.31	15.25	15.30	2.35	108	30	90	232	49
Commercial Diesel	75.00	14.40	14.43	14.62	14.48	2.49	106	28	77	235	50
	76.00	16.63	16.81	16.69	16.71	2.15	107	28	91	220	49
	77.00	16.88	16.85	16.81	16.85	2.14	106	29	93	216	49
	77.92	16.97	16.88	16.81	16.89	2.13	106	29	93	217	49.5
	78.00	17.09	17.41	17.09	17.20	2.09	104	29	93	213	52
	78.50	17.35	17.59	17.53	17.49	2.06	105	30	93	215	51.5
	78.92	16.59	16.04	15.41	16.01	2.25	108	30	95	232	56
	79.00	17.87	18.28	18.31	18.15	1.98	104	30	94	206	51
	79.50	17.88	17.68	17.29	17.62	2.04	108	30	93	209	52
	79.92	18.28	17.88	18.18	18.11	1.99	104	31	91	208	52

ตารางที่ ง-17 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 17

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	80.00	14.47	14.43	14.53	14.48	2.49	107	32	88	251	49
	81.00	14.56	14.63	14.56	14.58	2.47	108	33	91	250	49
	82.00	14.50	14.50	14.50	14.50	2.48	107	33	93	249	49
	82.92	14.47	14.53	14.63	14.54	2.48	107	33	92	249	49
	83.00	15.18	15.13	15.09	15.13	2.38	107	33	93	238	49.5
	83.50	14.97	14.90	14.88	14.92	2.41	107	33	91	244	50
	83.92	15.37	15.47	15.47	15.44	2.33	106	33	92	238	49.5
	84.00	16.88	16.59	16.59	16.69	2.16	103	33	91	222	52
	84.50	16.50	16.60	16.53	16.54	2.18	102	34	90	222	52
	84.92	16.59	16.78	16.53	16.63	2.16	104	32	88	221	52
Commercial Diesel	80.00	16.81	16.91	16.73	16.82	2.14	105	33	91	224	49
	81.00	16.81	16.79	16.85	16.82	2.14	104	33	93	221	49
	82.00	16.88	16.84	16.63	16.78	2.14	107	33	95	223	49
	82.92	16.93	16.78	16.68	16.80	2.14	105	33	93	220	48
	83.00	17.41	17.82	17.44	17.56	2.05	107	33	95	221	51
	83.50	17.78	17.22	17.53	17.51	2.06	106	34	95	233	54
	83.92	17.22	17.72	17.54	17.49	2.06	107	34	95	233	54
	84.00	18.31	18.13	18.19	18.21	1.98	103	33	94	211	52
	84.50	17.22	17.94	17.47	17.54	2.05	103	33	94	210	52
	84.92	17.19	17.09	17.03	17.10	2.10	105	33	94	212	53

ตารางที่ ง-18 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 18

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	85.00	13.90	14.03	13.94	13.96	2.58	108	32	90	255	51
	86.00	14.40	14.40	14.37	14.39	2.50	109	32	88	248	50
	87.00	13.84	13.91	14.13	13.96	2.58	108	31	88	252	50
	87.92	14.10	14.16	14.09	14.12	2.55	106	30	89	252	50.5
	88.00	14.78	14.78	14.81	14.79	2.43	104	29	89	239	50
	88.50	15.81	15.78	15.81	15.80	2.28	102	29	86	227	50
	88.92	15.56	15.65	15.75	15.65	2.30	100	30	87	226	50
	89.00	17.31	17.31	17.12	17.25	2.09	98	30	86	210	51
	89.50	16.94	16.81	16.94	16.90	2.13	98	29	84	214	51
	89.92	16.97	16.91	16.91	16.93	2.13	97	29	84	212	51
Commercial Diesel	85.00	16.13	16.41	16.66	16.40	2.20	106	32	92	224	52
	86.00	16.31	16.15	16.60	16.35	2.20	106	32	91	222	52
	87.00	15.16	15.19	15.85	15.40	2.34	140	31	92	232	54
	87.92	15.63	15.50	16.00	15.71	2.29	104	31	93	230	53
	88.00	16.90	16.63	16.41	16.65	2.16	104	31	92	219	53
	88.50	16.38	16.03	16.18	16.20	2.22	103	31	92	223	54
	88.92	16.41	16.22	16.03	16.22	2.22	103	31	94	224	55
	89.00	17.93	17.44	17.38	17.58	2.05	101	31	93	209	53
	89.50	17.57	17.66	17.29	17.51	2.06	101	31	91	210	54
	89.92	17.94	17.50	17.56	17.67	2.04	99	30	91	209	54



ตารางที่ ง-19 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 19

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	90.00	14.34	14.41	14.31	14.35	2.51	104	29	85	249	47
	91.00	14.47	14.41	14.38	14.42	2.50	105	30	89	246	48
	92.00	14.25	14.29	14.28	14.27	2.52	105	29	88	249	48
	92.92	14.16	14.15	14.06	14.12	2.55	106	28	89	250	49
	93.00	15.00	15.06	15.00	15.02	2.40	103	28	89	238	48
	93.50	15.00	15.00	15.03	15.01	2.40	104	28	88	236	48.5
	93.92	15.03	15.03	14.93	15.00	2.40	103	28	87	236	49
	94.00	15.31	15.29	15.31	15.30	2.35	100	28	86	229	51
	94.50	15.03	15.31	15.22	15.19	2.37	99	28	86	230	51
	94.92	15.34	15.54	15.38	15.42	2.33	101	28	86	230	51
Commercial Diesel	90.00	16.72	16.28	16.29	16.43	2.19	102	30	91	219	54
	91.00	16.89	16.72	16.72	16.78	2.15	102	30	92	218	54
	92.00	16.18	16.41	16.72	16.44	2.19	103	30	91	220	54
	92.92	16.12	16.25	16.41	16.26	2.21	103	30	92	222	55
	93.00	17.28	17.92	17.72	17.64	2.04	99	29	91	208	54
	93.50	17.50	17.53	17.38	17.47	2.06	100	29	90	209	54
	93.92	17.91	17.87	17.94	17.91	2.01	101	29	90	205	52
	94.00	19.47	19.35	19.25	19.36	1.86	98	29	89	206	52
	94.50	18.12	17.97	18.22	18.10	1.99	98	28	90	206	54
	94.92	18.47	18.19	18.15	18.27	1.97	99	29	89	206	54

ตารางที่ ง-20 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 20

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	95.00	14.56	14.56	14.53	14.55	2.47	107	31	91	250	48
	96.00	14.59	14.60	14.56	14.58	2.47	107	31	91	250	48
	97.00	14.53	14.56	14.53	14.54	2.48	109	32	91	250	47.5
	97.92	14.43	14.50	14.44	14.46	2.49	108	32	91	250	47
	98.00	14.94	14.97	15.09	15.00	2.40	107	32	90	241	50
	98.50	15.06	15.09	15.10	15.08	2.39	106	32	92	243	50
	98.92	15.12	15.09	15.06	15.09	2.39	107	32	91	243	50
	99.00	15.66	15.71	15.69	15.69	2.29	104	32	90	235	52
	99.50	16.03	15.97	16.04	16.01	2.25	103	32	88	229	51
	99.92	16.16	16.19	16.07	16.14	2.23	102	32	87	230	51.5
Commercial Diesel	95.00	17.84	17.66	17.88	17.79	2.02	105	31	91	222	48
	96.00	17.75	17.82	17.37	17.65	2.04	103	31	91	222	48
	97.00	17.13	16.53	16.75	16.80	2.14	107	33	93	220	48
	97.92	16.50	16.50	17.66	16.89	2.13	105	33	93	221	48.5
	98.00	17.87	17.87	17.88	17.87	2.01	107	33	93	216	50.5
	98.50	17.50	17.50	17.88	17.63	2.04	108	33	94	218	49.5
	98.92	17.91	17.72	17.60	17.74	2.03	108	33	94	218	50
	99.00	19.12	18.53	18.59	18.75	1.92	105	33	93	205	49
	99.50	19.87	18.06	18.25	18.73	1.92	106	33	92	212	54
	99.92	19.07	19.66	19.28	19.34	1.86	106	33	92	210	53.5

ตารางที่ ง-21 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 21

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	100.00	14.40	14.47	14.47	14.45	2.49	104	28	90	247	52
	101.00	14.44	14.44	14.44	14.44	2.49	108	29	94	248	52
	102.00	14.84	14.66	14.69	14.73	2.44	107	29	98	245	51
	102.92	14.81	14.75	14.72	14.76	2.44	106	29	97	245	51
	103.00	15.41	15.38	15.28	15.36	2.34	104	29	97	240	53
	103.50	15.06	15.12	15.10	15.09	2.39	104	29	97	237	53
	103.92	15.00	15.19	15.16	15.12	2.38	105	29	95	236	54
	104.00	15.72	15.68	15.69	15.70	2.29	103	28	95	228	55
	104.50	15.56	15.79	15.69	15.68	2.30	102	28	95	227	55.5
104.92	15.91	15.97	15.91	15.93	2.26	104	28	94	226	55	
Commercial Diesel	100.00	14.84	14.72	14.69	14.75	2.44	107	30	96	237	52
	101.00	15.53	15.41	15.50	15.48	2.33	109	29	98	233	51
	102.00	16.72	16.90	16.87	16.83	2.14	108	30	98	226	49
	102.92	16.44	16.75	16.53	16.57	2.17	109	29	98	227	49.5
	103.00	17.34	17.18	17.03	17.18	2.10	108	29	98	225	47
	103.50	16.94	17.00	17.41	17.12	2.10	108	29	98	229	52.5
	103.92	17.03	16.97	17.19	17.06	2.11	106	29	99	225	52
	104.00	17.68	17.90	17.41	17.66	2.04	106	29	97	222	54
	104.50	17.41	17.53	17.50	17.48	2.06	107	29	97	223	54
104.92	17.84	17.84	17.65	17.78	2.03	108	28	98	225	54	

ตารางที่ ง-22 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 22

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	105.00	14.59	14.69	14.69	14.66	2.46	105	28	95	245	50
	106.00	14.75	14.72	14.69	14.72	2.45	105	28	95	244	49.5
	107.00	14.56	14.69	14.59	14.61	2.46	107	28	94	246	49
	107.92	14.47	14.34	14.50	14.44	2.49	105	28	95	245	49.5
	108.00	15.50	15.41	15.44	15.45	2.33	103	28	94	232	51
	108.50	15.31	15.25	15.34	15.30	2.35	102	27	92	232	51
	108.92	15.18	15.40	15.25	15.28	2.36	103	27	92	232	51
	109.00	15.72	15.63	15.53	15.63	2.30	102	27	92	220	52
	109.50	16.47	16.34	16.35	16.39	2.20	100	27	91	218	52
	109.92	16.47	16.41	16.25	16.38	2.20	100	27	92	219	52
Commercial Diesel	105.00	16.12	16.41	16.44	16.32	2.21	107	29	99	226	50
	106.00	16.96	16.78	16.75	16.83	2.14	107	29	97	224	50
	107.00	16.97	16.57	16.96	16.83	2.14	107	29	97	225	50
	107.92	16.88	16.62	16.87	16.79	2.14	107	28	97	226	50
	108.00	17.47	17.72	17.66	17.62	2.04	105	28	96	213	49
	108.50	17.85	18.63	18.90	18.46	1.95	104	27	92	205	51
	108.92	18.54	19.06	18.47	18.69	1.93	105	27	92	204	51
	109.00	19.00	19.15	18.71	18.95	1.90	104	27	93	207	51
	109.50	18.88	18.48	18.37	18.58	1.94	105	28	95	207	52
109.92	18.03	18.66	18.50	18.40	1.96	104	28	95	209	52	



ตารางที่ ง-23 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 23

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	110.00	14.31	14.29	14.38	14.33	2.51	105	27	92	246	50
	111.00	14.41	14.47	14.53	14.47	2.49	106	27	94	246	48
	112.00	14.44	14.47	14.47	14.46	2.49	105	27	94	245	48
	112.92	14.66	14.63	14.50	14.60	2.47	106	27	95	246	48
	113.00	14.72	14.87	14.66	14.75	2.44	104	27	94	240	51
	113.50	14.63	14.66	14.66	14.65	2.46	105	27	93	240	51.5
	113.92	14.63	14.50	14.63	14.59	2.47	105	28	95	242	51
	114.00	16.56	16.44	16.53	16.51	2.18	101	27	92	220	51
	114.50	16.38	16.25	16.38	16.34	2.20	101	28	92	222	50.5
	114.92	16.22	16.19	16.16	16.19	2.22	102	28	91	221	50
Commercial Diesel	110.00	17.71	17.94	17.68	17.78	2.03	106	28	95	214	50
	111.00	17.56	17.88	17.91	17.78	2.02	103	28	95	217	50
	112.00	17.85	17.62	17.69	17.72	2.03	106	27	95	207	50
	112.92	17.65	17.62	17.63	17.63	2.04	107	28	96	209	50
	113.00	19.03	19.03	18.93	19.00	1.90	104	28	95	202	53
	113.50	19.56	19.65	19.63	19.61	1.84	103	27	94	198	52
	113.92	19.84	19.47	18.79	19.37	1.86	103	28	94	201	52
	114.00	19.12	18.96	19.54	19.21	1.87	102	28	93	189	51
	114.50	19.66	19.63	19.09	19.46	1.85	104	28	94	193	46
	114.92	19.62	19.69	19.63	19.65	1.83	103	28	94	192	46

ตารางที่ ง-24 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 24

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	115.00	14.59	14.53	14.53	14.55	2.47	108	32	95	250	48
	116.00	14.65	14.75	14.72	14.71	2.45	109	33	96	249	47
	117.00	14.60	14.59	14.72	14.64	2.46	109	32	98	246	48.5
	117.92	14.50	14.53	14.56	14.53	2.48	109	31	98	246	50
	118.00	14.72	14.88	14.72	14.77	2.44	107	31	97	238	54
	118.50	14.87	14.91	14.90	14.89	2.42	106	31	97	238	54
	118.92	14.75	14.78	14.78	14.77	2.44	105	31	97	239	54
	119.00	18.13	18.06	18.00	18.06	1.99	100	31	95	209	49
	119.50	17.25	17.25	17.28	17.26	2.09	100	31	92	211	51
	119.92	17.28	17.15	17.03	17.15	2.10	101	30	91	210	51
Commercial Diesel	115.00	16.10	16.12	15.94	16.05	2.24	110	34	98	232	47.5
	116.00	16.22	15.94	16.06	16.07	2.24	111	34	99	230	47
	117.00	16.78	16.91	16.75	16.81	2.14	110	33	99	226	45
	117.92	15.96	16.00	16.06	16.01	2.25	111	32	99	229	47
	118.00	18.31	18.32	18.16	18.26	1.97	107	32	99	210	48
	118.50	17.85	18.13	18.28	18.09	1.99	106	32	98	204	46
	118.92	18.16	18.12	18.12	18.13	1.99	106	32	98	202	46
	119.00	18.97	18.75	18.94	18.89	1.91	104	32	96	201	49
	119.50	17.91	17.81	17.72	17.81	2.02	104	31	96	197	48
	119.92	18.15	17.88	18.00	18.01	2.00	104	31	95	196	48

ตารางที่ ง-25 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 25

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	120.00	14.44	14.44	14.47	14.45	2.49	107	30	96	247	50
	121.00	14.34	14.37	14.37	14.36	2.51	106	30	96	248	50.5
	122.00	14.40	14.54	14.56	14.50	2.48	106	30	95	247	49
	122.92	14.60	14.56	14.56	14.57	2.47	106	29	94	245	47.5
	123.00	15.97	15.96	15.88	15.94	2.26	104	29	94	228	48
	123.50	15.90	15.72	15.81	15.81	2.28	105	30	94	227	48
	123.92	15.66	15.85	15.78	15.76	2.28	105	29	94	228	48
	124.00	16.34	16.19	16.13	16.22	2.22	98	28	92	223	52
	124.50	16.97	16.96	16.94	16.96	2.12	99	28	90	214	49.5
	124.92	16.93	17.06	16.94	16.98	2.12	99	28	90	214	49
Commercial Diesel	120.00	17.44	17.65	17.97	17.69	2.04	106	31	95	213	47.5
	121.00	17.07	17.47	17.81	17.45	2.06	104	31	95	212	46.5
	122.00	16.25	16.47	16.44	16.39	2.20	107	31	96	218	49
	122.92	16.47	16.59	16.56	16.54	2.18	106	30	95	218	49.5
	123.00	18.06	18.69	18.65	18.47	1.95	102	30	94	205	48.5
	123.50	18.62	18.16	17.97	18.25	1.97	103	30	95	205	48.5
	123.92	18.69	18.34	18.16	18.40	1.96	103	30	95	203	48
	124.00	19.53	18.78	18.69	19.00	1.89	105	29	91	206	51
	124.50	19.22	19.38	19.18	19.26	1.87	106	28	95	198	49
	124.92	19.63	19.63	19.21	19.49	1.85	105	29	95	198	50

ตารางที่ ง-26 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 26

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	125.00	14.32	14.22	14.28	14.27	2.52	107	29	88	248	48
	126.00	14.47	14.50	14.46	14.48	2.49	106	29	95	246	48
	127.00	14.65	14.59	14.66	14.63	2.46	106	28	97	246	48
	127.92	14.50	14.53	14.53	14.52	2.48	109	29	96	247	48
	128.00	15.62	15.81	15.75	15.73	2.29	105	28	95	230	48
	128.50	15.59	15.59	15.65	15.61	2.31	104	29	93	231	49
	128.92	15.59	15.72	15.53	15.61	2.31	104	28	93	231	49
	129.00	16.31	16.32	16.34	16.32	2.21	100	28	93	221	51
	129.50	16.31	16.38	16.43	16.37	2.20	102	29	93	223	51
	129.92	16.34	16.41	16.47	16.41	2.19	103	28	93	223	50.5
Commercial Diesel	125.00	16.09	16.06	16.00	16.05	2.24	112	29	92	223	48.5
	126.00	16.31	16.12	16.25	16.23	2.22	109	28	98	220	47.5
	127.00	15.96	16.18	16.34	16.16	2.23	107	28	97	218	47
	127.92	16.10	16.25	16.00	16.12	2.23	108	29	96	224	49
	128.00	17.31	17.31	17.37	17.33	2.08	104	28	96	206	45
	128.50	17.72	17.32	17.04	17.36	2.07	104	28	95	211	48
	128.92	17.78	17.72	17.69	17.73	2.03	103	28	95	212	48
	129.00	18.15	18.40	18.35	18.30	1.97	103	28	95	204	49.5
	129.50	18.47	18.25	18.19	18.30	1.97	104	29	95	209	51
	129.92	18.60	18.28	17.21	18.03	2.00	105	29	95	214	52



ตารางที่ ง-27 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 27

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	130.00	14.56	14.47	14.47	14.50	2.48	106	30	95	249	48.5
	131.00	14.38	14.50	14.53	14.47	2.49	106	31	97	248	49
	132.00	14.34	14.50	14.60	14.48	2.49	107	30	96	249	49
	132.92	14.22	14.44	14.44	14.37	2.51	107	31	97	249	49
	133.00	15.40	15.25	15.47	15.37	2.34	103	29	94	231	51
	133.50	15.31	15.25	15.22	15.26	2.36	104	30	94	232	51
	133.92	15.41	15.41	15.43	15.42	2.34	104	30	94	233	51
	134.00	16.41	16.44	16.44	16.43	2.19	103	30	93	217	53
	134.50	16.47	16.56	16.34	16.46	2.19	102	30	92	219	52.5
	134.92	16.25	16.31	16.32	16.29	2.21	101	30	91	219	52.5
Commercial Diesel	130.00	15.34	15.16	15.15	15.22	2.37	108	30	98	237	46
	131.00	15.25	15.31	15.31	15.29	2.35	108	31	99	238	46
	132.00	15.44	15.62	15.47	15.51	2.32	111	30	99	236	46
	132.92	15.28	15.29	15.59	15.39	2.34	110	30	99	237	46
	133.00	16.25	16.18	16.25	16.23	2.22	108	30	98	226	48
	133.50	15.65	15.62	15.54	15.60	2.31	108	30	99	226	48
	133.92	15.59	15.65	15.78	15.67	2.30	109	30	97	228	49.5
	134.00	17.22	17.22	17.35	17.26	2.09	105	30	98	206	46
	134.50	16.78	16.68	16.68	16.71	2.15	104	29	96	216	50
	134.92	16.44	16.59	16.65	16.56	2.17	104	30	95	215	51

ตารางที่ ง-28 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 28

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	135.00	14.16	14.28	14.35	14.26	2.52	106	29	93	251	51.5
	136.00	14.22	14.25	14.18	14.22	2.53	107	30	95	249	52
	137.00	14.15	14.19	14.16	14.17	2.54	107	29	95	250	52
	137.92	14.15	14.28	14.25	14.23	2.53	107	30	93	249	52
	138.00	15.91	16.03	15.88	15.94	2.26	103	29	93	228	51
	138.50	15.63	15.71	15.68	15.67	2.30	103	29	92	230	51
	138.92	15.75	15.87	15.69	15.77	2.28	104	29	92	230	51
	139.00	17.03	17.06	17.07	17.05	2.11	99	30	89	212	52
	139.50	16.85	16.90	16.78	16.84	2.14	101	28	87	215	52
	139.92	16.72	16.63	16.68	16.68	2.16	100	28	87	214	52
Commercial Diesel	135.00	16.28	16.13	16.54	16.32	2.21	105	29	95	220	49
	136.00	16.10	15.91	15.95	15.99	2.25	106	29	97	223	50
	137.00	15.87	15.93	15.97	15.92	2.26	106	29	96	221	50
	137.92	15.93	16.07	16.00	16.00	2.25	105	29	94	220	50
	138.00	17.53	17.41	17.84	17.59	2.05	102	29	95	209	50.5
	138.50	16.75	16.71	16.91	16.79	2.14	104	29	94	215	53
	138.92	17.53	17.78	17.91	17.74	2.03	103	29	94	204	49
	139.00	18.25	18.06	18.31	18.21	1.98	102	29	91	196	53
	139.50	18.34	19.62	19.07	19.01	1.89	99	27	89	192	52
	139.92	19.10	19.38	19.59	19.36	1.86	99	28	89	191	50

ตารางที่ ง-29 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 29

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	140.00	14.22	14.16	14.25	14.21	2.53	106	29	89	249	50.5
	141.00	14.28	14.18	14.25	14.24	2.53	108	30	91	247	51
	142.00	14.28	14.22	14.25	14.25	2.53	107	29	91	247	51
	142.92	14.28	14.25	14.22	14.25	2.53	106	29	92	246	51
	143.00	16.06	16.00	16.09	16.05	2.24	102	29	90	226	50
	143.50	15.75	15.72	15.75	15.74	2.29	102	29	89	227	50.5
	143.92	15.75	15.75	15.82	15.77	2.28	104	29	89	226	50.5
	144.00	17.50	17.47	17.53	17.50	2.06	98	29	88	210	50
	144.50	17.31	17.26	17.15	17.24	2.09	97	28	86	210	50
	144.92	17.27	17.17	17.25	17.23	2.09	99	28	86	210	50
Commercial Diesel	140.00	16.56	16.78	16.62	16.65	2.16	103	28	90	215	50
	141.00	15.75	15.90	15.94	15.86	2.27	102	29	92	216	50
	142.00	15.59	15.87	15.88	15.78	2.28	103	28	92	216	50.5
	142.92	15.81	15.87	15.97	15.88	2.27	103	28	92	217	50.5
	143.00	17.81	17.03	17.59	17.48	2.06	102	28	90	203	51
	143.50	17.04	17.81	16.96	17.27	2.08	104	27	94	224	56
	143.92	17.22	17.31	17.41	17.31	2.08	102	28	93	206	51
	144.00	17.97	18.09	18.53	18.20	1.98	99	28	91	193	50
	144.50	18.35	18.31	18.28	18.31	1.97	98	27	88	185	50
	144.92	18.35	18.31	18.28	18.31	1.97	96	27	88	184	42

ตารางที่ ง-30 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 30

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	145.00	13.94	13.90	13.87	13.90	2.59	104	28	87	251	48.5
	146.00	14.00	14.09	13.97	14.02	2.57	106	28	92	249	49
	147.00	14.25	14.22	14.10	14.19	2.54	106	27	94	247	48
	147.92	14.15	14.18	14.03	14.12	2.55	104	27	93	248	48
	148.00	15.62	15.60	15.62	15.61	2.31	102	27	91	227	49
	148.50	15.40	15.60	15.37	15.46	2.33	103	27	90	228	49
	148.92	15.41	15.44	15.37	15.41	2.34	103	27	90	227	49
	149.00	16.57	16.78	16.81	16.72	2.15	99	27	89	215	49
	149.50	16.32	16.53	16.62	16.49	2.18	99	27	84	214	49
	149.92	16.66	16.63	16.59	16.63	2.17	100	26	84	213	49
Commercial Diesel	145.00	14.94	14.85	14.71	14.83	2.43	108	28	91	238	48
	146.00	15.12	15.28	15.19	15.20	2.37	109	28	96	234	47.5
	147.00	15.10	15.38	15.32	15.27	2.36	106	27	96	234	47
	147.92	15.16	15.37	15.34	15.29	2.35	106	27	95	231	47
	148.00	16.81	16.81	16.75	16.79	2.14	103	27	93	217	48
	148.50	15.84	15.78	15.75	15.79	2.28	102	27	93	223	49.5
	148.92	15.75	15.81	15.94	15.83	2.27	102	27	93	215	46
	149.00	18.03	18.06	17.75	17.95	2.01	99	27	91	204	49
	149.50	16.84	16.85	16.72	16.80	2.14	101	27	89	212	51
	149.92	17.09	17.35	17.09	17.18	2.10	98	26	89	205	48



ตารางที่ ง-31 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 31

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	150.00	14.57	14.65	14.69	14.64	2.46	106	27	92	242	47
	151.00	14.56	14.54	14.57	14.56	2.47	104	27	92	242	48
	152.00	14.38	14.40	14.44	14.41	2.50	106	28	92	238	47
	152.92	14.47	14.34	14.50	14.44	2.49	106	28	93	238	47.5
	153.00	15.53	15.47	15.47	15.49	2.32	105	28	92	224	48.5
	153.50	15.18	15.22	15.13	15.18	2.37	104	28	91	227	49.5
	153.92	15.22	15.15	15.16	15.18	2.37	103	28	91	228	49
	154.00	16.22	16.10	16.03	16.12	2.23	102	27	92	217	50.5
	154.50	15.94	15.93	16.03	15.97	2.25	103	27	90	218	50.5
	154.92	16.10	15.94	15.91	15.98	2.25	102	28	91	218	50
Commercial Diesel	150.00	15.03	15.09	15.03	15.05	2.39	108	27	93	222	47.5
	151.00	16.41	16.22	16.44	16.36	2.20	107	27	93	221	45
	152.00	15.06	15.00	14.94	15.00	2.40	107	28	94	237	48
	152.92	15.00	15.06	15.09	15.05	2.39	106	28	94	234	48
	153.00	16.38	16.75	16.38	16.50	2.18	105	28	92	215	47
	153.50	15.47	15.25	15.47	15.40	2.34	104	27	93	222	51
	153.92	16.87	16.87	16.81	16.85	2.14	103	28	92	214	48
	154.00	17.88	18.03	17.79	17.90	2.01	101	27	92	207	48
	154.50	17.72	17.28	17.09	17.36	2.07	101	27	91	203	49
	154.92	17.13	17.12	17.19	17.15	2.10	101	27	91	203	49

ตารางที่ ง-32 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 32

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	155.00	14.34	14.25	14.28	14.29	2.52	106	28	91	238	48.5
	156.00	14.47	14.40	14.41	14.43	2.50	106	28	92	238	48
	157.00	14.53	14.44	14.41	14.46	2.49	106	28	95	238	48
	157.92	14.31	14.34	14.35	14.33	2.51	107	28	93	238	48
	158.00	15.35	15.35	15.47	15.39	2.34	104	28	93	226	49
	158.50	15.25	15.19	15.16	15.20	2.37	105	27	93	225	50
	158.92	15.16	15.09	15.09	15.11	2.38	104	27	91	229	48.5
	159.00	16.19	15.94	16.03	16.05	2.24	100	27	92	217	50
	159.50	15.97	15.97	16.06	16.00	2.25	99	25	90	218	50
	159.92	15.69	15.63	15.81	15.71	2.29	102	26	92	221	51
Commercial Diesel	155.00	15.22	15.31	15.09	15.21	2.37	104	28	91	232	46.5
	156.00	15.13	15.10	15.10	15.11	2.38	105	28	93	234	48
	157.00	15.13	15.25	15.28	15.22	2.37	104	28	94	232	48
	157.92	15.20	15.22	15.22	15.21	2.37	103	27	94	227	48
	158.00	16.78	16.65	16.66	16.70	2.16	102	28	92	214	48
	158.50	16.22	16.19	16.31	16.24	2.22	100	27	94	210	48
	158.92	15.13	15.69	15.40	15.41	2.34	103	27	92	224	50.5
	159.00	17.07	17.41	17.10	17.19	2.09	102	27	92	198	52
	159.50	18.93	19.03	19.10	19.02	1.89	97	25	89	189	46
	159.92	19.15	19.18	19.09	19.14	1.88	95	26	89	189	45

ตารางที่ ง-33 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 33

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	160.00	13.75	13.84	13.81	13.80	2.61	105	24	86	251	49.5
	161.00	14.06	14.19	14.15	14.13	2.55	108	26	92	248	49
	162.00	14.19	14.18	14.19	14.19	2.54	108	26	93	247	48.5
	162.92	14.28	14.16	14.28	14.24	2.53	111	28	92	246	48
	163.00	14.96	14.84	14.90	14.90	2.42	107	28	93	237	50
	163.50	14.78	14.81	14.93	14.84	2.43	107	27	93	237	50
	163.92	14.84	14.81	14.68	14.78	2.44	107	27	93	238	50
	164.00	16.40	16.35	16.34	16.36	2.20	104	27	92	219	50.5
	164.50	16.31	16.34	16.44	16.36	2.20	102	27	90	218	50.5
	164.92	16.53	16.50	16.44	16.49	2.18	102	27	91	217	50.5
Commercial Diesel	160.00	15.22	15.31	15.09	15.21	2.37	107	25	89	248	49
	161.00	15.13	15.10	15.10	15.11	2.38	109	26	94	245	48
	162.00	15.13	15.25	15.28	15.22	2.37	108	26	94	245	49
	162.92	15.20	15.22	15.22	15.21	2.37	108	27	93	242	49
	163.00	15.53	15.50	15.47	15.50	2.32	104	27	93	223	49.5
	163.50	15.28	15.28	15.31	15.29	2.35	103	27	92	225	50
	163.92	15.28	15.53	15.56	15.46	2.33	104	27	93	225	49
	164.00	18.69	18.91	18.68	18.76	1.92	99	27	91	192	51
	164.50	18.68	18.75	18.69	18.71	1.92	98	27	88	192	51
	164.92	18.65	18.56	18.59	18.60	1.94	99	27	88	193	51

ตารางที่ ง-34 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 34

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	165.00	14.31	14.32	14.25	14.29	2.52	108	27	92	246	48
	166.00	14.50	14.31	14.41	14.41	2.50	108	27	94	246	48
	167.00	14.34	14.22	14.34	14.30	2.52	107	26	95	246	48
	167.92	14.37	14.35	14.28	14.33	2.51	108	27	92	246	48
	168.00	14.62	14.72	14.81	14.72	2.45	107	27	94	240	50.5
	168.50	14.75	14.60	14.66	14.67	2.45	106	27	94	238	50.5
	168.92	14.60	14.75	14.62	14.66	2.46	96	19	54	191	50.5
	169.00	15.37	15.41	15.29	15.36	2.34	100	21	72	186	42
	169.50	15.37	15.41	15.29	15.36	2.34	106	22	82	229	53
	169.92	15.69	15.66	15.75	15.70	2.29	106	21	87	226	52
Commercial Diesel	165.00	15.22	15.31	15.09	15.21	2.37	105	27	90	240	48
	166.00	15.13	15.10	15.10	15.11	2.38	107	27	95	246	48
	167.00	15.13	15.25	15.28	15.22	2.37	106	27	96	245	48
	167.92	15.20	15.22	15.22	15.21	2.37	108	27	94	244	48
	168.00	15.07	15.22	15.12	15.14	2.38	104	27	94	226	49
	168.50	15.03	15.03	15.13	15.06	2.39	104	27	94	226	49
	168.92	15.02	15.12	15.20	15.11	2.38	103	20	94	232	49
	169.00	15.50	15.31	15.69	15.50	2.32	109	22	85	228	52
	169.50	15.90	15.69	19.50	17.03	2.11	108	22	92	222	51.5
	169.92	16.50	16.30	16.37	16.39	2.20	106	22	92	213	50



ตารางที่ ง-35 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 35

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	170.00	13.91	13.97	13.94	13.94	2.58	109	26	93	252	48
	171.00	14.09	14.10	14.00	14.06	2.56	112	27	95	251	49.5
	172.00	13.97	14.06	14.00	14.01	2.57	108	27	95	249	49.5
	172.92	14.06	14.03	13.94	14.01	2.57	107	26	94	248	49.5
	173.00	15.22	15.22	15.22	15.22	2.37	106	26	94	230	50.5
	173.50	15.19	15.13	15.31	15.21	2.37	105	27	91	230	50.5
	173.92	15.28	15.29	15.13	15.23	2.36	104	26	92	229	50
	174.00	15.98	16.00	15.97	15.98	2.25	104	27	92	220	52
	174.50	15.97	16.07	15.97	16.00	2.25	104	27	91	220	51
	174.92	15.91	15.91	15.84	15.89	2.27	102	27	91	221	52
Commercial Diesel	170.00	14.12	14.06	14.13	14.10	2.55	110	26	95	248	48
	171.00	14.97	14.06	14.19	14.41	2.50	110	26	95	246	48
	172.00	14.09	14.09	14.25	14.14	2.55	107	26	95	243	48
	172.92	14.19	14.22	14.06	14.16	2.54	106	25	94	243	48
	173.00	15.56	15.68	15.75	15.66	2.30	102	25	93	219	48.5
	173.50	15.44	15.60	15.47	15.50	2.32	102	27	91	220	48
	173.92	15.63	15.62	15.60	15.62	2.31	102	26	91	219	48
	174.00	16.69	16.82	16.57	16.69	2.16	100	27	91	206	49
	174.50	16.87	16.82	16.85	16.85	2.14	99	26	90	206	49
	174.92	16.90	16.94	16.90	16.91	2.13	98	26	90	205	49

ตารางที่ ง-36 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 36

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	175.00	13.97	13.93	13.97	13.96	2.58	108	26	84	247	50
	176.00	14.10	14.19	14.06	14.12	2.55	108	26	96	248	50
	177.00	14.00	14.00	13.94	13.98	2.58	107	26	96	248	50
	177.92	13.94	14.06	14.03	14.01	2.57	107	26	96	250	50
	178.00	15.47	15.47	15.44	15.46	2.33	104	26	94	234	50
	178.50	15.00	15.00	14.97	14.99	2.40	105	26	92	236	50.5
	178.92	14.94	14.85	14.91	14.90	2.42	106	27	93	238	51
	179.00	15.75	15.68	15.66	15.70	2.29	103	27	94	226	52
	179.50	15.81	15.72	15.59	15.71	2.29	104	27	94	227	52
	179.92	15.56	15.59	15.50	15.55	2.32	104	27	93	227	52
Commercial Diesel	175.00	14.62	14.69	14.60	14.64	2.46	110	26	96	243	50
	176.00	14.62	14.69	14.60	14.64	2.46	108	26	95	236	47
	177.00	14.69	14.59	14.68	14.65	2.46	103	26	94	232	47
	177.92	14.72	14.81	14.88	14.80	2.43	100	26	91	231	47
	178.00	15.50	15.81	15.71	15.67	2.30	102	26	91	222	49
	178.50	15.34	15.34	15.37	15.35	2.35	101	26	90	222	48.5
	178.92	15.22	15.28	15.13	15.21	2.37	102	27	91	224	49
	179.00	16.06	16.22	16.19	16.16	2.23	99	27	92	212	50
	179.50	16.00	15.94	16.06	16.00	2.25	99	27	91	212	50
	179.92	15.93	15.97	15.94	15.95	2.26	98	27	91	212	50

ตารางที่ ง-37 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 37

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	180.00	14.04	14.03	14.03	14.03	2.57	104	26	94	253	50.5
	181.00	14.10	13.97	14.10	14.06	2.56	109	29	95	252	50
	182.00	14.12	14.09	14.05	14.09	2.56	108	28	95	252	50
	182.92	13.25	13.22	13.25	13.24	2.72	104	24	83	255	53
	183.00	14.71	14.71	14.72	14.71	2.45	101	24	85	234	51.5
	183.50	14.85	14.82	14.91	14.86	2.42	102	23	87	234	52
	183.92	14.78	14.94	14.85	14.86	2.42	101	24	88	234	52
	184.00	16.06	16.00	15.96	16.01	2.25	99	24	87	221	52.5
	184.50	15.93	15.89	15.81	15.88	2.27	100	24	87	221	52
	184.92	15.84	16.04	16.06	15.98	2.25	99	24	88	222	52.5
Commercial Diesel	180.00	14.57	14.62	14.47	14.55	2.47	100	28	91	232	50
	181.00	14.62	14.66	14.60	14.63	2.46	103	28	91	230	50
	182.00	14.69	14.53	14.60	14.61	2.46	103	28	91	231	50
	182.92	14.03	14.03	14.13	14.06	2.56	99	24	84	227	51
	183.00	15.55	15.59	15.69	15.61	2.31	99	24	85	213	51
	183.50	15.44	15.41	15.41	15.42	2.33	100	23	88	215	51.5
	183.92	15.41	15.47	15.46	15.45	2.33	100	24	88	214	52
	184.00	17.25	17.03	17.10	17.13	2.10	98	24	87	198	52
	184.50	17.06	17.03	17.00	17.03	2.11	98	24	86	200	51.5
	184.92	17.07	16.85	16.87	16.93	2.13	99	24	86	201	51.5

ตารางที่ ง-38 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 38

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	185.00	13.87	13.94	13.87	13.89	2.59	108	25	86	250	50.5
	186.00	13.96	14.00	13.91	13.96	2.58	108	25	92	250	50
	187.00	14.00	13.82	14.00	13.94	2.58	108	25	93	249	50
	187.92	14.19	14.03	13.97	14.06	2.56	109	26	91	248	49
	188.00	14.75	14.72	14.75	14.74	2.44	105	25	92	237	52
	188.50	14.60	14.59	14.69	14.63	2.46	105	26	91	238	52
	188.92	14.72	14.63	14.65	14.67	2.45	106	25	90	239	51.5
	189.00	15.75	15.72	15.69	15.72	2.29	104	26	89	225	52.5
	189.50	15.25	15.25	15.22	15.24	2.36	104	26	91	228	54
	189.92	15.50	15.47	15.56	15.51	2.32	103	25	92	225	53
Commercial Diesel	185.00	14.57	14.44	14.57	14.53	2.48	110	24	89	237	50.5
	186.00	14.97	14.91	14.84	14.91	2.42	111	24	93	235	48
	187.00	14.72	14.78	14.72	14.74	2.44	107	24	92	233	48
	187.92	14.53	14.50	14.50	14.51	2.48	105	25	90	232	49.5
	188.00	15.41	15.47	15.37	15.42	2.34	102	24	91	222	51.5
	188.50	15.37	15.77	15.28	15.47	2.33	103	25	90	221	51.5
	188.92	15.28	15.10	15.12	15.17	2.37	101	25	89	219	51.5
	189.00	16.85	16.72	16.91	16.83	2.14	99	25	88	202	50.5
	189.50	16.78	16.65	16.87	16.77	2.15	98	25	88	204	50.5
	189.92	16.75	16.57	16.78	16.70	2.16	98	25	89	204	50.5



ตารางที่ ง-39 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 39

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	190.00	13.72	13.75	13.75	13.74	2.62	106	26	92	251	51
	191.00	13.63	13.71	13.78	13.71	2.63	104	25	93	251	51
	192.00	13.78	13.90	13.75	13.81	2.61	105	25	94	249	51
	192.92	13.81	13.97	13.97	13.92	2.59	106	25	92	250	51.5
	193.00	14.60	14.56	14.53	14.56	2.47	104	25	93	239	53
	193.50	14.53	14.40	14.41	14.45	2.49	104	25	92	239	53.5
	193.92	14.34	14.31	14.41	14.35	2.51	103	25	92	239	53
	194.00	15.60	15.62	15.65	15.62	2.30	100	91	91	222	53
	194.50	15.69	15.43	15.57	15.56	2.31	100	25	90	225	53.5
	194.92	15.50	15.44	15.53	15.49	2.32	102	25	90	225	53
Commercial Diesel	190.00	14.25	14.38	14.44	14.36	2.51	103	25	90	234	50
	191.00	14.44	14.41	14.37	14.41	2.50	102	25	93	236	51
	192.00	14.25	14.25	14.22	14.24	2.53	102	25	92	234	51
	192.92	14.25	14.34	14.28	14.29	2.52	101	25	91	234	52
	193.00	15.87	15.97	15.61	15.82	2.28	99	25	90	212	51
	193.50	15.41	15.56	15.25	15.41	2.34	98	25	89	214	51.5
	193.92	15.53	15.34	15.40	15.42	2.33	99	25	89	214	52
	194.00	16.78	16.69	16.60	16.69	2.16	95	89	89	201	52
	194.50	16.66	16.66	16.53	16.62	2.17	95	24	88	202	52
	194.92	16.44	16.43	16.56	16.48	2.18	96	24	89	203	52

ตารางที่ ง-40 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 40

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	195.00	13.90	13.88	13.84	13.87	2.59	104	25	92	250	50.5
	196.00	13.84	13.81	13.84	13.83	2.60	106	25	94	250	50.5
	197.00	13.75	13.72	13.66	13.71	2.63	106	25	93	248	51
	197.92	13.69	13.66	13.75	13.70	2.63	105	24	93	251	51
	198.00	14.87	14.81	14.78	14.82	2.43	103	24	92	236	52
	198.50	14.68	14.54	14.72	14.65	2.46	103	24	89	235	52
	198.92	14.59	14.66	14.50	14.58	2.47	103	24	89	235	52
	199.00	15.71	15.87	15.65	15.74	2.29	100	24	89	220	52
	199.50	15.85	15.65	15.69	15.73	2.29	102	24	89	219	52.5
	199.92	15.88	15.75	15.72	15.78	2.28	101	25	89	221	53
Commercial Diesel	195.00	14.18	14.13	14.25	14.19	2.54	102	24	90	234	52.5
	196.00	14.25	14.12	14.22	14.20	2.54	102	25	92	235	52.5
	197.00	14.12	14.16	14.28	14.19	2.54	100	24	92	233	52
	197.92	14.07	14.22	14.00	14.10	2.55	102	24	92	236	52.5
	198.00	15.19	15.09	15.19	15.16	2.38	98	24	91	218	52
	198.50	14.94	15.03	14.96	14.98	2.40	99	24	89	220	54
	198.92	15.34	15.44	15.31	15.36	2.34	97	24	89	214	52
	199.00	16.88	16.90	16.75	16.84	2.14	96	24	88	200	52
	199.50	16.56	16.84	16.57	16.66	2.16	97	24	88	200	52
	199.92	16.50	16.72	16.72	16.65	2.16	97	25	88	200	52

ตารางที่ ง-41 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 41

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	200.00	14.59	14.28	14.75	14.54	2.48	109	31	99	333	50
	201.00	14.65	14.62	14.53	14.60	2.47	111	35	99	336	51
	202.00	14.47	14.37	14.31	14.38	2.50	112	35	98	335	51
	202.92	14.35	14.33	14.40	14.36	2.51	109	31	99	331	52
	203.00	15.53	15.58	15.63	15.58	2.31	108	34	97	305	52
	203.50	15.41	15.59	15.41	15.47	2.33	110	36	99	309	52
	203.92	15.44	15.38	15.44	15.42	2.33	108	32	95	309	52
	204.00	17.31	17.28	17.41	17.33	2.08	105	34	98	275	52.5
	204.50	17.34	17.12	17.18	17.21	2.09	105	35	92	273	52.5
204.92	17.34	17.12	17.18	17.21	2.09	105	35	92	273	52.5	
Commercial Diesel	200.00	15.75	15.53	15.28	15.52	2.32	109	34	97	298	50
	201.00	15.68	15.72	15.78	15.73	2.29	111	36	96	302	50
	202.00	15.75	15.84	15.78	15.79	2.28	112	36	95	302	50
	202.92	15.50	14.47	15.22	15.06	2.39	109	34	96	308	50
	203.00	16.43	16.62	16.75	16.60	2.17	108	36	96	290	51
	203.50	16.66	16.37	16.56	16.53	2.18	110	37	98	289	51
	203.92	16.59	16.21	16.34	16.38	2.20	108	34	94	291	51
	204.00	17.84	17.66	17.63	17.71	2.03	105	36	98	276	51.5
	204.50	17.81	17.84	17.78	17.81	2.02	105	36	92	267	51.5
204.92	17.81	17.84	17.78	17.81	2.02	105	36	92	267	51.5	

ตารางที่ ง-42 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 42

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	205.00	14.34	14.40	14.41	14.38	2.50	112	35	95	332	50.5
	206.00	14.47	14.44	14.50	14.47	2.49	111	35	94	333	51
	207.00	14.28	14.47	14.37	14.37	2.50	112	36	99	330	51
	207.92	14.53	14.66	14.50	14.56	2.47	111	35	99	331	51
	208.00	15.63	15.66	15.57	15.62	2.30	108	35	99	331	51
	208.50	15.63	15.60	15.62	15.62	2.31	106	31	96	299	52
	208.92	15.57	15.43	15.44	15.48	2.33	107	31	96	299	52
	209.00	17.62	17.59	17.62	17.61	2.04	104	35	95	266	51
	209.50	17.56	17.72	17.57	17.62	2.04	103	32	95	266	51
209.92	17.69	17.59	17.66	17.65	2.04	103	33	94	267	51	
Commercial Diesel	205.00	15.97	15.66	15.69	15.77	2.28	112	36	94	306	49.5
	206.00	15.03	15.16	15.09	15.09	2.39	111	36	95	315	51
	207.00	14.91	14.82	14.91	14.88	2.42	112	36	97	314	51
	207.92	15.00	14.93	15.06	15.00	2.40	111	36	99	319	51
	208.00	16.28	16.07	16.12	16.16	2.23	108	36	97	294	51.5
	208.50	16.12	16.13	16.06	16.10	2.24	106	33	94	288	52
	208.92	16.03	15.93	16.19	16.05	2.24	106	33	94	288	52
	209.00	18.03	18.00	18.06	18.03	2.00	104	36	93	259	51
	209.50	18.22	18.31	18.19	18.24	1.97	103	34	93	257	51
209.92	18.03	18.12	18.15	18.10	1.99	103	35	93	261	51	



ตารางที่ ง-43 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 43

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	210.00	14.44	14.41	14.35	14.40	2.50	111	39	95	334	50
	211.00	14.43	14.41	14.41	14.42	2.50	111	35	95	332	50
	212.00	14.47	14.47	14.77	14.57	2.47	111	39	99	326	50.5
	212.92	14.44	14.50	14.50	14.48	2.49	111	38	98	327	50.5
	213.00	15.09	15.13	15.09	15.10	2.38	109	36	98	310	52.5
	213.50	15.09	15.06	15.07	15.07	2.39	109	39	98	311	52.5
	213.92	15.03	15.09	15.03	15.05	2.39	108	39	96	311	52.5
	214.00	17.06	17.00	16.88	16.98	2.12	105	36	95	275	53
	214.50	16.88	16.94	17.00	16.94	2.13	105	39	94	276	53
	214.92	16.75	16.87	16.96	16.86	2.14	106	36	91	273	53
Commercial Diesel	210.00	15.71	15.66	15.81	15.73	2.29	111	38	94	312	49
	211.00	15.28	15.19	15.31	15.26	2.36	110	35	95	320	50
	212.00	15.37	15.47	15.37	15.40	2.34	111	38	96	313	51
	212.92	15.47	15.41	15.41	15.43	2.33	110	38	97	318	50
	213.00	16.03	16.13	16.21	16.12	2.23	109	36	96	300	51
	213.50	16.06	16.28	16.25	16.20	2.22	108	38	95	292	52
	213.92	16.41	16.15	16.09	16.22	2.22	108	28	95	296	51
	214.00	17.35	17.35	17.38	17.36	2.07	106	36	94	276	51.5
	214.50	17.50	17.44	17.43	17.46	2.06	106	38	93	273	51.5
	214.92	17.50	17.34	17.40	17.41	2.07	106	36	91	271	51.5

ตารางที่ ง-44 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 44

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	215.00	14.44	14.38	14.47	14.43	2.49	111	38	96	325	51
	216.00	14.43	14.47	14.47	14.46	2.49	111	38	98	326	52
	217.00	14.43	14.44	14.34	14.40	2.50	111	38	94	321	52
	217.92	14.41	14.38	14.47	14.42	2.50	111	38	94	322	52
	218.00	15.69	15.72	15.69	15.70	2.29	107	36	98	297	52
	218.50	15.75	15.68	15.75	15.73	2.29	107	38	93	296	52
	218.92	15.38	15.41	15.50	15.43	2.33	108	38	97	308	52
	219.00	16.78	16.75	16.62	16.72	2.15	108	38	93	275	52.5
	219.50	16.63	16.81	16.62	16.69	2.16	106	38	94	274	53
	219.92	16.72	16.62	16.65	16.66	2.16	108	38	97	281	53
Commercial Diesel	215.00	15.31	15.06	15.13	15.17	2.37	111	38	94	311	51
	216.00	15.09	15.22	15.13	15.15	2.38	110	38	96	315	51
	217.00	15.00	14.87	14.87	14.91	2.41	111	37	94	316	51
	217.92	14.85	14.88	14.91	14.88	2.42	110	37	94	317	51
	218.00	16.22	16.34	16.15	16.24	2.22	108	36	96	293	52
	218.50	16.10	16.13	16.07	16.10	2.24	108	38	93	293	52
	218.92	16.18	16.09	16.19	16.15	2.23	108	38	95	293	52
	219.00	18.03	17.79	17.91	17.91	2.01	105	38	93	265	52
	219.50	17.87	18.09	18.15	18.04	2.00	1069	38	93	266	52
	219.92	18.18	18.15	18.09	18.14	1.98	106	39	95	268	52

ตารางที่ ง-45 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 45

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	220.00	14.54	14.41	14.50	14.48	2.49	110	37	91	324	50
	221.00	14.59	14.47	14.5	14.52	2.48	112	37	92	325	50
	222.00	14.47	14.47	14.43	14.46	2.49	109	37	95	324	50
	222.92	14.56	14.59	14.66	14.60	2.47	109	38	95	333	50
	223.00	15.12	15.07	15.10	15.10	2.38	109	39	96	312	52
	223.50	15.35	15.22	15.19	15.25	2.36	109	39	95	313	52
	223.92	15.18	15.12	15.18	15.16	2.37	108	39	95	313	52
	224.00	17.06	17.06	17.06	17.06	2.11	107	38	97	281	52
	224.50	17.21	17.16	17.04	17.14	2.10	105	38	94	278	52
	224.92	17.22	17.10	17.03	17.12	2.10	107	38	93	276	52
Commercial Diesel	220.00	15.19	15.31	15.19	15.23	2.36	111	36	92	307	52
	221.00	15.47	15.28	15.37	15.37	2.34	112	36	93	304	50
	222.00	15.25	15.20	15.25	15.23	2.36	110	37	96	305	50
	222.92	15.13	15.03	15.03	15.06	2.39	111	37	96	309	51
	223.00	16.32	16.25	16.31	16.29	2.21	109	38	96	285	51
	223.50	16.13	16.12	16.03	16.09	2.24	109	38	95	289	52
	223.92	16.15	16.03	16.20	16.13	2.23	109	38	95	288	52
	224.00	17.94	17.87	17.82	17.88	2.01	107	38	96	270	52
	224.50	18.09	18.03	18.12	18.08	1.99	107	38	94	265	52
	224.92	18.34	18.25	18.19	18.26	1.97	107	38	93	265	52

ตารางที่ ง-46 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 46

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	225.00	14.28	14.38	14.40	14.35	2.51	109	38	94	329	50
	226.00	14.41	14.44	14.47	14.44	2.49	111	38	94	324	49
	227.00	14.29	14.40	14.40	14.36	2.51	111	38	95	322	50
	227.92	14.34	14.38	14.37	14.36	2.51	111	38	95	323	50
	228.00	15.10	15.07	15.12	15.10	2.38	108	37	94	312	51
	228.50	15.10	15.22	15.09	15.14	2.38	108	37	95	312	51
	228.92	15.12	15.10	15.19	15.14	2.38	108	39	95	315	50
	229.00	16.22	16.17	16.19	16.19	2.22	107	39	95	293	51
	229.50	16.22	16.18	16.13	16.18	2.23	107	39	96	294	51
	229.92	16.21	16.19	16.23	16.21	2.22	107	38	94	287	51
Commercial Diesel	225.00	15.93	15.97	15.90	15.93	2.26	111	37	96	302	50
	226.00	15.91	15.84	15.78	15.84	2.27	111	38	96	312	50
	227.00	15.75	15.63	15.69	15.69	2.29	112	38	96	306	50
	227.92	15.68	15.62	15.63	15.64	2.30	111	38	96	309	50
	228.00	16.12	16.18	16.15	16.15	2.23	109	38	95	296	52
	228.50	16.09	16.22	16.13	16.15	2.23	108	38	95	297	51.5
	228.92	16.63	16.94	16.97	16.85	2.14	108	38	95	285	50
	229.00	17.22	17.19	17.18	17.20	2.09	108	38	96	280	52
	229.50	17.25	17.28	17.22	17.25	2.09	107	38	96	280	52
	229.92	17.75	17.59	17.62	17.65	2.04	108	38	94	277	52



ตารางที่ ง-47 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 47

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	230.00	14.53	14.47	14.41	14.47	2.49	109	33	97	325	52
	231.00	14.53	14.56	14.31	14.47	2.49	109	33	98	326	52
	232.00	14.47	14.47	14.50	14.48	2.49	112	39	99	330	51
	232.92	14.34	14.38	14.43	14.38	2.50	111	36	99	302	52
	233.00	15.40	15.34	15.29	15.34	2.35	109	38	97	309	52
	233.50	15.47	15.37	15.53	15.46	2.33	109	36	95	300	52
	233.92	15.62	15.12	15.25	15.33	2.35	108	36	95	304	52
	234.00	17.03	16.97	17.03	17.01	2.12	105	36	97	272	52.5
	234.50	17.00	17.00	17.00	17.00	2.12	105	36	93	274	52
234.92	17.10	17.00	17.03	17.04	2.11	108	38	95	275	52	
Commercial Diesel	230.00	15.65	15.87	15.65	15.72	2.29	111	31	96	304	52
	231.00	15.18	15.72	15.65	15.52	2.32	112	31	97	304	52
	232.00	15.63	15.41	15.50	15.51	2.32	111	35	99	305	52
	232.92	15.53	15.63	15.50	15.55	2.31	111	36	99	302	52
	233.00	16.78	16.63	16.69	16.70	2.16	110	36	97	278	53
	233.50	16.88	16.68	16.75	16.77	2.15	108	36	96	288	53
	233.92	16.90	16.88	16.96	16.91	2.13	106	35	95	288	53
	234.00	18.56	18.75	18.50	18.60	1.94	103	35	96	262	54
	234.50	18.65	18.50	18.56	18.57	1.94	104	36	93	268	53
234.92	18.84	18.81	18.81	18.82	1.91	104	36	93	264	53	

ตารางที่ ง-48 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 48

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	235.00	14.47	14.53	14.53	14.51	2.48	112	39	97	322	52
	236.00	14.47	14.50	14.47	14.48	2.49	112	39	97	325	52
	237.00	14.47	14.41	14.41	14.43	2.49	112	40	98	327	52
	237.92	14.44	14.53	14.28	14.42	2.50	111	38	97	324	52
	238.00	15.62	15.43	15.78	15.61	2.31	108	35	99	301	52.5
	238.50	15.53	15.62	15.68	15.61	2.31	107	35	97	300	52.5
	238.92	15.65	15.75	15.63	15.68	2.30	107	35	97	300	52.5
	239.00	17.75	17.75	17.68	17.73	2.03	104	36	95	266	52
	239.50	17.59	17.54	17.46	17.53	2.05	105	36	91	265	52
239.92	17.60	17.45	17.62	17.56	2.05	105	36	95	267	52	
Commercial Diesel	235.00	15.25	15.40	15.43	15.36	2.34	109	36	94	296	50
	236.00	15.38	15.63	15.69	15.57	2.31	108	37	93	296	49
	237.00	15.28	15.28	15.41	15.32	2.35	109	37	94	304	51
	237.92	15.28	15.37	15.31	15.32	2.35	108	37	96	311	51
	238.00	16.28	16.22	16.15	16.22	2.22	106	36	98	294	52
	238.50	16.18	16.09	16.13	16.13	2.23	106	36	96	290	52
	238.92	16.00	16.00	16.12	16.04	2.24	105	36	96	289	52
	239.00	18.16	17.94	18.03	18.04	2.00	104	36	93	260	51
	239.50	17.59	17.47	17.59	17.55	2.05	105	36	91	267	52.5
239.92	18.16	18.15	18.10	18.14	1.98	103	36	94	264	51	

ตารางที่ ง-49 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 49

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	240.00	14.44	14.44	14.44	14.44	2.49	112	37	100	326	52
	241.00	14.50	14.44	14.50	14.48	2.49	111	37	101	328	51
	242.00	14.34	14.53	14.35	14.41	0.00	111	38	100	331	52
	242.92	14.35	14.35	14.34	14.35	2.51	111	38	100	330	52
	243.00	15.66	15.54	15.50	15.57	2.31	110	38	96	306	52.5
	243.50	15.56	15.40	15.44	15.47	2.33	107	34	95	302	52.5
	243.92	15.41	15.50	15.56	15.49	2.32	108	36	97	302	52.5
	244.00	16.88	16.69	16.69	16.75	2.15	107	38	99	281	52.5
	244.50	16.69	16.50	16.69	16.63	2.17	108	38	98	284	53
	244.92	16.75	16.56	16.59	16.63	2.16	108	38	97	282	52.5
Commercial Diesel	240.00	15.15	15.28	15.19	15.21	2.37	113	38	99	311	50.5
	241.00	15.35	15.37	15.40	15.37	2.34	112	38	99	305	51
	242.00	15.28	15.38	15.28	15.31	2.35	112	38	99	311	51
	242.92	15.40	15.25	15.35	15.33	2.35	113	38	99	309	51
	243.00	16.00	16.10	16.07	16.06	2.24	112	39	96	295	52
	243.50	16.12	16.15	16.15	16.14	2.23	111	35	96	288	52
	243.92	16.15	16.10	16.19	16.15	2.23	111	36	97	290	52
	244.00	17.84	17.85	17.81	17.83	2.02	108	38	100	269	52
	244.50	18.00	18.00	17.49	17.83	2.02	108	39	98	270	51
	244.92	17.97	17.91	19.93	18.60	1.94	108	38	97	271	51

ตารางที่ ง-50 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 50

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	245.00	14.53	14.50	14.44	14.49	2.48	113	37	98	327	52
	246.00	14.56	14.56	14.62	14.58	2.47	111	37	100	329	53
	247.00	14.53	14.56	14.40	14.50	2.48	108	32	97	325	52
	247.92	14.56	14.47	14.60	14.54	2.48	110	36	97	327	52
	248.00	15.25	15.37	15.13	15.25	2.36	109	36	100	310	54
	248.50	15.22	15.19	15.28	15.23	2.36	108	37	96	305	54
	248.92	15.16	15.22	15.21	15.20	2.37	109	327	96	304	54
	249.00	16.69	16.72	16.84	16.75	2.15	107	36	96	279	54
	249.50	16.84	16.72	16.69	16.75	2.15	106	33	94	279	54
	249.92	16.69	16.72	16.84	16.75	2.15	107	32	95	279	53.5
Commercial Diesel	245.00	15.41	15.35	15.35	15.37	2.34	113	38	98	311	52
	246.00	15.41	15.32	15.25	15.33	2.35	112	38	102	312	52
	247.00	15.22	15.12	15.06	15.13	2.38	113	35	100	314	52
	247.92	15.10	15.03	15.03	15.05	2.39	112	37	100	312	52
	248.00	16.36	16.38	16.25	16.33	2.20	109	38	102	292	52
	248.50	12.19	16.07	16.16	14.81	2.43	111	38	98	291	52
	248.92	16.22	16.16	16.15	16.18	2.23	110	38	98	289	52
	249.00	17.85	17.72	17.62	17.73	2.03	107	38	98	269	52
	249.50	17.87	17.84	17.94	17.88	2.01	108	34	96	267	52
	249.92	17.76	17.81	17.87	17.81	2.02	108	35	96	268	52



ตารางที่ ง-51 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 51

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	250.00	14.53	14.50	14.53	14.52	2.48	111	32	94	324	52
	251.00	14.60	14.63	14.56	14.60	2.47	111	32	95	324	51
	252.00	14.55	14.57	14.60	14.57	2.47	112	33	95	325	51
	252.92	14.63	14.56	14.57	14.59	2.47	111	32	95	325	51
	253.00	15.80	15.82	15.72	15.78	2.28	107	32	95	306	52.5
	253.50	15.75	15.72	15.82	15.76	2.28	106	32	95	306	52.5
	253.92	15.73	15.69	15.70	15.71	2.29	107	32	95	307	52.5
	254.00	16.94	16.91	16.82	16.89	2.13	105	33	93	272	53
	254.50	16.69	16.65	16.69	16.68	2.16	106	30	92	281	54
	254.92	16.84	16.87	16.77	16.83	2.14	106	31	92	281	54
Commercial Diesel	250.00	15.63	15.55	15.52	15.57	2.31	112	35	98	314	50
	251.00	15.78	15.94	15.88	15.87	2.27	111	35	97	310	50
	252.00	15.94	15.88	15.88	15.90	2.26	111	35	96	313	50
	252.92	15.74	15.75	15.78	15.76	2.28	111	35	97	313	50
	253.00	16.35	16.28	16.32	16.32	2.21	111	35	99	296	52
	253.50	16.28	16.25	16.35	16.29	2.21	110	34	99	297	52
	253.92	16.23	16.15	16.28	16.22	2.22	111	35	98	297	52
	254.00	17.47	17.44	17.45	17.45	2.06	106	35	94	270	52
	254.50	17.40	17.16	17.22	17.26	2.09	107	32	96	280	52.5
	254.92	17.27	17.28	17.37	17.31	2.08	107	33	95	279	52.5

ตารางที่ ง-52 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 52

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	255.00	14.53	14.28	14.35	14.39	2.50	108	30	94	325	52
	256.00	14.53	14.31	14.34	14.39	2.50	109	30	95	326	52
	257.00	14.37	14.35	14.31	14.34	2.51	110	34	93	326	52
	257.92	14.28	14.31	14.41	14.33	2.51	111	33	94	327	52
	258.00	15.25	15.31	15.25	15.27	2.36	110	35	92	306	53
	258.50	15.15	15.19	15.15	15.16	2.37	108	35	91	305	52
	258.92	15.31	15.19	15.22	15.24	2.36	108	35	91	305	53
	259.00	16.58	16.88	16.85	16.77	2.15	106	32	94	282	52
	259.50	16.65	16.59	16.69	16.64	2.16	107	32	95	283	52
	259.92	16.75	16.72	16.78	16.75	2.15	107	33	95	282	52
Commercial Diesel	255.00	15.57	15.59	15.40	15.52	2.32	109	32	95	306	50.5
	256.00	15.78	15.78	15.78	15.78	2.28	109	32	95	308	50
	257.00	15.29	15.12	15.16	15.19	2.37	110	34	93	307	52
	257.92	15.19	15.12	15.17	15.16	2.37	110	34	94	307	52
	258.00	16.31	16.32	16.16	16.26	2.21	109	35	93	292	52
	258.50	16.15	16.28	16.31	16.25	2.22	108	36	92	287	52
	258.92	16.25	16.15	16.34	16.25	2.22	108	36	92	287	52
	259.00	17.28	17.22	17.25	17.25	2.09	106	34	96	279	51.5
	259.50	17.38	17.31	17.33	17.34	2.08	106	34	97	279	51.5
259.92	17.18	17.55	17.35	17.36	2.07	107	34	96	278	51.5	

ตารางที่ ง-53 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 53

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	260.00	14.37	14.34	14.47	14.39	2.50	111	34	102	336	52
	261.00	14.50	14.43	14.38	14.44	2.49	111	35	97	333	50
	262.00	14.43	14.44	14.44	14.44	2.49	112	35	97	332	50
	262.92	14.50	14.31	14.31	14.37	2.50	112	36	101	336	50
	263.00	15.28	15.28	15.22	15.26	2.36	110	37	98	314	52
	263.50	15.18	15.29	15.22	15.23	2.36	109	35	98	314	52
	263.92	15.25	15.15	15.21	15.20	2.37	110	33	96	312	52
	264.00	16.44	16.44	16.34	16.41	2.19	108	33	99	286	52.5
	264.50	16.31	16.44	16.44	16.40	2.20	110	38	96	285	52.5
	264.92	16.44	16.40	16.34	16.39	2.20	110	38	95	286	52.5
Commercial Diesel	260.00	15.37	15.69	15.72	15.59	2.31	111	36	102	336	50
	261.00	15.81	15.75	15.72	15.76	2.28	111	34	100	309	49
	262.00	15.75	15.72	15.82	15.76	2.28	112	37	100	308	49
	262.92	15.41	15.31	15.63	15.45	2.33	112	38	102	313	49
	263.00	16.25	16.22	16.16	16.21	2.22	112	38	101	299	51
	263.50	16.16	16.07	16.07	16.10	2.24	112	36	100	293	52
	263.92	16.40	16.46	16.31	16.39	2.20	112	35	97	290	51
	264.00	17.32	17.19	17.22	17.24	2.09	110	36	101	278	52
	264.50	17.54	17.44	17.44	17.47	2.06	111	39	99	275	52
	264.92	17.34	17.34	17.25	17.31	2.08	112	39	98	273	53

ตารางที่ ง-54 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 54

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	265.00	14.46	14.53	14.57	14.52	2.48	112	38	97	326	51
	266.00	14.46	14.40	14.47	14.44	2.49	111	39	99	330	51
	267.00	14.50	14.62	14.53	14.55	2.47	112	38	99	331	51
	267.92	14.50	14.46	14.47	14.48	2.49	112	34	99	326	51
	268.00	15.25	15.19	15.31	15.25	2.36	110	38	101	314	53
	268.50	15.25	15.31	15.22	15.26	2.36	110	39	96	311	53
	268.92	15.31	15.22	15.28	15.27	2.36	109	39	95	310	53
	269.00	16.75	16.69	16.62	16.69	2.16	106	39	97	282	52.5
	269.50	16.56	16.78	16.56	16.63	2.16	106	35	93	283	53
	269.92	16.62	16.62	16.71	16.65	2.16	106	34	94	283	53
Commercial Diesel	265.00	15.60	15.81	15.72	15.71	2.29	114	39	100	311	51
	266.00	15.75	15.75	15.78	15.76	2.28	111	40	102	313	50
	267.00	15.37	15.44	15.38	15.40	2.34	112	40	102	315	51
	267.92	15.46	15.66	15.57	15.56	2.31	113	37	98	311	50
	268.00	16.25	16.22	16.22	16.23	2.22	110	40	101	297	52
	268.50	16.25	16.22	16.31	16.26	2.21	110	40	97	294	51.5
	268.92	16.25	16.25	16.22	16.24	2.22	112	40	97	294	51.5
	269.00	17.65	17.78	17.81	17.75	2.03	109	40	98	272	51
	269.50	17.65	17.62	17.75	17.67	2.04	110	38	96	270	52
	269.92	17.81	17.65	17.59	17.68	2.04	110	37	96	270	52



ตารางที่ ง-55 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 55

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	270.00	14.29	14.28	14.31	14.29	2.52	110	28	91	336	52
	271.00	14.34	14.35	14.38	14.36	2.51	108	28	98	325	52
	272.00	14.44	14.41	14.47	14.44	2.49	110	33	99	329	51
	272.92	14.53	14.41	14.34	14.43	2.50	109	29	96	330	51
	273.00	15.22	15.18	15.19	15.20	2.37	109	33	99	308	52
	273.50	15.21	15.22	15.28	15.24	2.36	106	30	95	307	52
	273.92	15.28	15.25	15.22	15.25	2.36	107	30	95	307	52
	274.00	16.81	16.81	16.75	16.79	2.14	104	33	96	276	52.5
	274.50	16.88	16.81	16.81	16.83	2.14	103	29	92	275	52.5
	274.92	16.87	16.75	16.72	16.78	2.15	103	30	92	275	52.5
Commercial Diesel	270.00	15.62	15.25	15.19	15.35	2.34	110	29	96	316	50
	271.00	15.22	15.13	15.16	15.17	2.37	11	31	101	314	50
	272.00	15.22	15.19	15.16	15.19	2.37	112	34	102	316	50
	272.92	15.12	15.15	15.10	15.12	2.38	112	32	100	313	51
	273.00	16.09	16.10	16.09	16.09	2.24	110	35	101	297	52
	273.50	16.19	16.12	16.15	16.15	2.23	109	32	99	299	51
	273.92	16.12	16.19	16.10	16.14	2.23	109	32	99	298	51.5
	274.00	17.84	17.87	17.72	17.81	2.02	108	35	98	271	52
	274.50	17.81	17.59	17.69	17.70	2.03	107	33	95	269	52
	274.92	17.66	17.56	17.63	17.62	2.04	106	33	95	270	52

ตารางที่ ง-56 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 56

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	275.00	14.43	14.38	14.41	14.41	2.50	111	34	102	327	52
	276.00	14.41	14.44	14.38	14.41	2.50	112	34	100	328	51
	277.00	14.46	14.22	14.28	14.32	2.51	112	34	100	329	51
	277.92	14.41	14.40	14.43	14.41	2.50	109	29	99	326	51.5
	278.00	15.50	15.53	15.56	15.53	2.32	107	33	99	303	52
	278.50	15.44	15.40	15.41	15.42	2.34	105	30	90	294	52
	278.92	15.44	15.53	15.50	15.49	2.32	106	30	90	294	52
	279.00	16.78	16.75	16.78	16.77	2.15	104	33	92	271	53
	279.50	16.81	16.68	16.72	16.74	2.15	103	31	91	274	53
	279.92	16.85	16.81	16.72	16.79	2.14	103	32	94	277	53
Commercial Diesel	275.00	15.13	15.22	15.25	15.20	2.37	113	35	102	314	50.1
	276.00	15.15	15.10	15.11	15.12	2.38	113	35	102	317	50
	277.00	15.63	15.53	15.34	15.50	2.32	113	35	102	318	50
	277.92	15.19	15.22	15.16	15.19	2.37	109	32	100	316	51
	278.00	16.19	16.22	16.16	16.19	2.22	107	34	99	296	51.5
	278.50	16.16	16.32	16.25	16.24	2.22	105	32	91	284	52
	278.92	16.22	16.12	16.13	16.16	2.23	107	32	91	284	52
	279.00	17.75	17.85	17.79	17.80	2.02	103	34	91	260	52
	279.50	17.78	17.72	17.72	17.74	2.03	104	33	91	262	52
	279.92	17.47	17.81	17.87	17.72	2.03	103	34	93	264	52

ตารางที่ ง-57 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 57

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	280.00	14.31	14.41	14.28	14.33	2.51	111	35	99	325	52
	281.00	14.47	14.41	14.40	14.43	2.50	111	36	99	327	51
	282.00	14.47	14.44	14.41	14.44	2.49	112	36	100	327	51
	282.92	14.41	14.41	14.44	14.42	2.50	112	36	100	330	51
	283.00	15.34	15.32	15.38	15.35	2.35	106	32	96	300	53
	283.50	15.25	15.21	15.35	15.27	2.36	109	36	94	303	53
	283.92	15.33	15.22	15.32	15.29	2.35	109	36	98	306	53
	284.00	16.88	16.84	16.75	16.82	2.14	106	37	92	274	54
	284.50	16.72	16.59	16.68	16.66	2.16	106	36	95	274	54
	284.92	16.68	16.69	16.72	16.70	2.16	102	32	93	275	51
Commercial Diesel	280.00	15.25	15.19	15.15	15.20	2.37	112	36	99	325	52
	281.00	15.19	15.25	15.25	15.23	2.36	113	37	99	313	51
	282.00	15.25	15.16	15.38	15.26	2.36	113	37	99	316	51
	282.92	15.16	15.19	15.22	15.19	2.37	113	37	100	317	51
	283.00	16.12	16.18	16.19	16.16	2.23	109	34	95	291	51
	283.50	16.18	16.35	16.25	16.26	2.21	109	37	94	292	51
	283.92	16.41	16.22	16.34	16.32	2.21	108	37	97	296	51
	284.00	17.59	17.75	17.56	17.63	2.04	105	37	90	268	51
	284.50	17.69	17.56	17.44	17.56	2.05	104	37	93	269	51
	284.92	17.41	17.59	17.56	17.52	2.05	104	35	92	270	54

ตารางที่ ง-58 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 58

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	285.00	14.37	14.43	14.47	14.42	2.50	108	32	96	322	52
	286.00	14.47	14.47	14.31	14.42	2.50	110	37	98	325	51.5
	287.00	14.50	14.44	14.38	14.44	2.49	109	37	98	322	51.5
	287.92	14.41	14.47	14.41	14.43	2.49	109	32	94	320	51
	288.00	15.31	15.34	15.34	15.33	2.35	109	36	96	297	52
	288.50	15.43	15.35	15.35	15.38	2.34	108	36	96	297	52
	288.92	15.50	15.53	15.50	15.51	2.32	109	37	96	295	52
	289.00	16.53	16.59	16.63	16.58	2.17	104	37	96	278	54
	289.50	16.53	16.50	16.54	16.52	2.18	106	37	95	276	53.5
	289.92	16.62	16.62	16.62	16.62	2.17	104	32	93	278	53.5
Commercial Diesel	285.00	15.34	15.56	15.53	15.48	2.33	108	34	95	312	50
	286.00	15.53	15.53	15.78	15.61	2.31	109	38	96	308	49
	287.00	15.50	15.47	15.56	15.51	2.32	109	37	95	307	50
	287.92	15.63	15.41	15.47	15.50	2.32	109	34	93	313	50
	288.00	16.34	16.72	16.56	16.54	2.18	106	37	93	288	51
	288.50	16.60	16.40	16.43	16.48	2.18	105	37	93	287	51
	288.92	16.56	16.54	16.60	16.57	2.17	105	38	94	290	51
	289.00	17.81	17.78	17.75	17.78	2.02	104	38	94	274	50
	289.50	17.69	17.75	17.59	17.68	2.04	102	38	91	267	50
	289.92	17.62	17.50	17.56	17.56	2.05	102	35	92	275	50



ตารางที่ ง-59 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 59

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	290.00	14.56	14.50	14.57	14.54	2.48	110	33	96	326	50.5
	291.00	14.69	14.59	14.56	14.61	2.46	108	30	97	322	50
	292.00	14.35	14.44	14.43	14.41	2.50	110	35	99	326	53
	292.92	14.41	14.37	14.34	14.37	2.50	111	31	100	327	51
	293.00	15.31	15.28	15.32	15.30	2.35	106	31	95	302	53
	293.50	15.28	15.38	15.23	15.30	2.35	108	36	94	302	53
	293.92	15.37	15.22	15.28	15.29	2.35	106	35	94	302	52.5
	294.00	16.69	16.87	16.78	16.78	2.15	104	35	93	277	53
	294.50	16.84	16.87	16.78	16.83	2.14	103	32	90	268	52.5
	294.92	16.81	16.79	16.84	16.81	2.14	103	32	90	269	53
Commercial Diesel	290.00	15.60	15.69	15.53	15.61	2.31	112	34	99	309	48
	291.00	15.49	15.47	15.41	15.46	2.33	110	33	100	318	49
	292.00	15.36	15.38	15.25	15.33	2.35	111	36	102	320	50
	292.92	15.28	15.16	15.19	15.21	2.37	111	34	102	315	50
	293.00	16.12	16.19	16.12	16.14	2.23	108	34	98	299	51.5
	293.50	16.16	16.12	16.12	16.13	2.23	105	34	96	297	51.5
	293.92	16.15	16.17	16.19	16.17	2.23	106	36	96	297	51.5
	294.00	17.75	17.64	17.68	17.69	2.04	102	36	94	273	51
	294.50	17.60	17.65	17.75	17.67	2.04	103	34	89	267	52
	294.92	17.78	17.74	17.65	17.72	2.03	103	34	90	266	52

ตารางที่ ง-60 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 60

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	295.00	14.34	14.34	14.29	14.32	2.51	108	32	97	324	52
	296.00	14.40	14.34	14.45	14.40	2.50	111	35	96	325	52
	297.00	14.40	14.41	14.34	14.38	2.50	108	32	96	321	52
	297.92	14.34	14.38	14.31	14.34	2.51	109	31	96	323	52
	298.00	15.66	15.85	15.82	15.78	2.28	106	31	98	298	53
	298.50	15.75	15.82	15.74	15.77	2.28	106	32	94	299	53
	298.92	15.63	15.44	15.63	15.57	2.31	105	32	94	299	53
	299.00	16.75	16.75	16.75	16.75	2.15	104	31	93	284	54
	299.50	16.91	16.81	16.90	16.87	2.13	103	31	93	280	54
	299.92	16.79	16.91	16.85	16.85	2.14	103	32	93	275	54
Commercial Diesel	295.00	15.16	15.19	15.21	15.19	2.37	107	34	94	307	50
	296.00	15.28	15.34	15.22	15.28	2.36	107	36	95	316	51
	297.00	15.44	15.62	15.51	15.52	2.32	105	34	95	319	49
	297.92	15.25	15.22	15.36	15.28	2.36	106	34	95	320	50.5
	298.00	16.16	16.19	16.16	16.17	2.23	104	34	96	292	52
	298.50	16.18	16.19	16.16	16.18	2.23	103	34	95	290	53
	298.92	16.21	16.24	16.19	16.21	2.22	103	34	94	292	52
	299.00	17.60	17.78	17.72	17.70	2.03	100	34	94	274	52
	299.50	17.69	17.62	17.59	17.63	2.04	100	34	92	273	52
	299.92	17.75	17.62	17.54	17.64	2.04	100	34	92	273	52

ตารางที่ ง-61 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 61

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	300.00	14.29	14.34	14.32	14.32	2.51	110	34	99	328	52
	301.00	14.34	14.22	14.32	14.29	2.52	108	31	97	325	52
	302.00	14.31	14.35	14.38	14.35	2.51	109	31	97	325	52
	302.92	14.31	14.25	14.29	14.28	2.52	110	32	97	326	41
	303.00	15.31	15.41	15.34	15.35	2.34	108	32	96	307	52
	303.50	15.25	15.40	15.47	15.37	2.34	107	32	94	303	52
	303.92	15.37	15.41	15.34	15.37	2.34	107	32	94	303	52
	304.00	16.81	16.78	16.88	16.82	2.14	106	35	97	280	52.5
	304.50	16.81	16.75	16.75	16.77	2.15	105	35	96	297	52.5
	304.92	16.87	16.85	16.75	16.82	2.14	105	36	96	278	42.5
Commercial Diesel	300.00	15.21	15.25	15.13	15.20	2.37	112	35	102	320	51
	301.00	15.18	15.28	15.25	15.24	2.36	113	33	102	318	50
	302.00	15.19	15.15	15.28	15.21	2.37	112	33	102	317	50
	302.92	15.53	15.50	15.44	15.49	2.32	111	35	100	311	48
	303.00	16.59	16.59	16.22	16.47	2.19	109	35	99	297	49.5
	303.50	15.78	15.84	15.72	15.78	2.28	106	34	97	300	50.5
	303.92	16.72	16.72	16.59	16.68	2.16	106	34	96	289	48.5
	304.00	17.56	17.53	17.53	17.54	2.05	104	37	97	276	49.5
	304.50	17.50	17.53	17.56	17.53	2.05	105	37	97	274	49.5
	304.92	17.47	17.47	17.66	17.53	2.05	103	37	96	273	50

ตารางที่ ง-62 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 62

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	305.00	14.25	14.25	14.23	14.24	2.53	108	32	97	323	53
	306.00	14.47	14.35	14.35	14.39	2.50	107	32	96	328	51
	307.00	14.38	14.25	14.41	14.35	2.51	108	32	96	328	51
	307.92	14.34	14.25	14.26	14.28	2.52	112	36	100	327	52
	308.00	15.18	15.28	15.19	15.22	2.37	107	34	97	305	52.5
	308.50	15.47	15.38	15.28	15.38	2.34	106	37	98	302	52
	308.92	15.35	15.38	15.38	15.37	2.34	107	37	98	300	52
	309.00	16.72	16.57	16.75	16.68	2.16	104	37	93	275	52.5
	309.50	16.85	16.72	16.81	16.79	2.14	103	37	93	275	52.5
	309.92	16.75	16.75	16.72	16.74	2.15	103	37	93	275	52.5
Commercial Diesel	305.00	15.56	15.62	15.53	15.57	2.31	106	34	96	311	48.5
	306.00	15.81	15.81	15.59	15.74	2.29	107	35	97	314	48
	307.00	15.69	15.72	15.59	15.67	2.30	107	35	96	314	48.5
	307.92	15.42	15.31	15.40	15.38	2.34	108	37	99	320	48.5
	308.00	16.25	16.28	16.44	16.32	2.21	103	34	95	287	49.5
	308.50	16.59	16.44	16.50	16.51	2.18	102	36	96	290	49
	308.92	16.40	16.41	16.32	16.38	2.20	102	36	96	292	49
	309.00	17.56	17.69	17.63	17.63	2.04	101	37	93	269	49.5
	309.50	17.59	17.54	17.53	17.55	2.05	100	37	93	270	50
	309.92	17.57	17.56	17.56	17.56	2.05	99	37	93	272	50



ตารางที่ ง-63 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 63

	ชั่วโมงรวม	Time1	Time	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	310.00	14.53	14.28	14.35	14.39	2.50	108	30	94	325	52
	311.00	14.53	14.31	14.34	14.39	2.50	109	30	95	326	52
	312.00	14.37	14.35	14.31	14.34	2.51	110	34	93	326	52
	312.92	14.28	14.31	14.41	14.33	2.51	111	33	94	327	52
	313.00	15.25	15.31	15.25	15.27	2.36	110	35	92	306	53
	313.50	15.15	15.19	15.15	15.16	2.37	108	35	91	305	52
	313.92	15.31	15.19	15.22	15.24	2.36	108	35	91	305	53
	314.00	16.58	16.88	16.85	16.77	2.15	106	32	94	282	52
	314.50	16.65	16.59	16.69	16.64	2.16	107	32	95	283	52
	314.92	16.75	16.72	16.78	16.75	2.15	107	33	95	282	52
Commercial Diesel	310.00	15.25	15.40	15.43	15.36	2.34	109	36	94	296	50
	311.00	15.38	15.63	15.69	15.57	2.31	108	37	93	296	49
	312.00	15.28	15.28	15.41	15.32	2.35	109	37	94	304	51
	312.92	15.28	15.37	15.31	15.32	2.35	108	37	96	311	51
	313.00	16.28	16.22	16.15	16.22	2.22	106	36	98	294	52
	313.50	16.18	16.09	16.13	16.13	2.23	106	36	96	290	52
	313.92	16.00	16.00	16.12	16.04	2.24	105	36	96	289	52
	314.00	18.16	17.94	18.03	18.04	2.00	104	36	93	260	51
	314.50	17.59	17.47	17.59	17.55	2.05	105	36	91	267	52.5
	314.92	18.16	18.15	18.10	18.14	1.98	103	36	94	264	51

ตารางที่ ง-64 แสดงข้อมูลระหว่างการทดสอบความทนทานของวัฏจักรที่ 64

	ชั่วโมงรวม	Time1	Time2	Time3	T. Av	L/hr	Water	Fuel	Oil	Exhaust	P Disc.
Palm Diesel	315.00	14.37	14.34	14.47	14.39	2.50	111	34	102	336	52
	316.00	14.50	14.43	14.38	14.44	2.49	111	35	97	333	50
	317.00	14.43	14.44	14.44	14.44	2.49	112	35	97	332	50
	317.92	14.50	14.31	14.31	14.37	2.50	112	36	101	336	50
	318.00	15.28	15.28	15.22	15.26	2.36	110	37	98	314	52
	318.50	15.18	15.29	15.22	15.23	2.36	109	35	98	314	52
	318.92	15.25	15.15	15.21	15.20	2.37	110	33	96	312	52
	319.00	16.44	16.44	16.34	16.41	2.19	108	33	99	286	52.5
	319.50	16.31	16.44	16.44	16.40	2.20	110	38	96	285	52.5
	319.92	16.44	16.40	16.34	16.39	2.20	110	38	95	286	52.5
Commercial Diesel	315.00	15.15	15.28	15.19	15.21	2.37	113	38	99	311	50.5
	316.00	15.35	15.37	15.40	15.37	2.34	112	38	99	305	51
	317.00	15.28	15.38	15.28	15.31	2.35	112	38	99	311	51
	317.92	15.40	15.25	15.35	15.33	2.35	113	38	99	309	51
	318.00	16.00	16.10	16.07	16.06	2.24	112	39	96	295	52
	318.50	16.12	16.15	16.15	16.14	2.23	111	35	96	288	52
	318.92	16.15	16.10	16.19	16.15	2.23	111	36	97	290	52
	319.00	17.84	17.85	17.81	17.83	2.02	108	38	100	269	52
	319.50	18.00	18.00	17.49	17.83	2.02	108	39	98	270	51
	319.92	17.97	17.91	19.93	18.60	1.94	108	38	97	271	51




ภาคผนวก จ

ข้อมูลผลการวิเคราะห์น้ำมันหล่อลื่น

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย



รูปที่ จ-1 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นใหม่ ยี่ห้อ ช้าง มาตรฐาน SAE 40 API CC (19277)


FOCUS		LubeCheck™ - Oil Analysis for Predictive Maintenance		Page 1 of 1	
Customer #	: 18004	Site Name	:	Condition	
Invoice To	: ICE R&D LAB	Location	:	of	
Address	: Faculty of Engineering Chulalongkorn University Bangkok	Unit Number	: New Oil CHANG SAE30 API CC	Oil	Wear
Tel.	: 02.2522889	Test code	: 803 904	 Normal	
Fax.	:	Unit type	: NEW OIL		
		Unit make	:		
		Unit model	:		
		Oil grade	: CHANG SAE30 API CC		
Recommendations					
All tests appear normal for this type of new oil.					
Sample	19277			Alarm Limit Range	
Date sampled	11-Jul-03			Limit Name :	
Hours on Oil	Not Available			New Oil for Baseline Purposes	
Hours on Unit	Not Available				
Cust. Ref #	814377				
Spectro Test	RDE RFS				
Iron(Fe)	0.5				
Chromium(Cr)	0.0				
Lead(Pb)	0.0				
Copper(Cu)	0.0				
Tin(Sn)	0.0				
Aluminium(Al)	0.1				
Nickel(Ni)	0.0				
Silver(Ag)	0.0				
Molybdenum(Mo)	0.0				
Titanium(Ti)	0.0				
Vanadium(V)	0.0				
Silicon(Si)	9.0				
	Additive				
Boron(B)	0			A-Low C-Low N.O. C-High A-High	
Sodium(Na)	1				
Magnesium(Mg)	8				
Calcium(Ca)	1990				
Barium(Ba)	0				
Phosphorus(P)	233				
Zinc(Zn)	378				
	Viscosity				
Visc @40	97.50			A-Low C-Low N.O. C-High A-High	
Visc @100	11.23				
Vis. Index					
	FTIR				
Oxidation(Abs)	4			A-Low C-Low N.O. C-High A-High	
Nitration(Abs)	5				
Sulfation(Abs)	15				
Fuel %	0.00				
Water %	0.083				
Glycol %	0				
Soot %	0.00				
ZDDP(Abs)	15				
	Other Test				
TAN				A-Low C-Low N.O. C-High A-High	
TBN	5.2				
Flash Point	>205				

จุฬาลงกรณ์มหาวิทยาลัย



Office : 9 Fl., Thooapoi Land 4 Bldg., 947/99 Bangna-Trad Rd., KM.3, Bangna, Bangkok 10260, Thailand  
Tel. : (662) 361 8600-3 Fax : (662) 361 8567 Email : focus@toxininfo.co.th

Lab : 523 Bangpoo Industrial Estate, Soi 8, Sukhuvit Rd., Prakasa, Muang, Samutprakan 10280, Thailand  
Tel : (02) 709 2933-36 Fax (02) 709 2937 E-mail : focuslab@toxininfo.co.th

รูปที่ จ-2 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้น้ำมันดีเซลหลังผ่านการรันอินครบ 20 ชั่วโมง (19274)



**LubeCheck™ - Oil Analysis for Predictive Maintenance**

<b>Customer #</b> : 18004	<b>Site Name</b> :	<b>Condition</b>
<b>Invoice To</b> : ICE R&D LAB	<b>Location</b> :	of
<b>Address</b> : Faculty of Engineering Chulalongkorn University Bangkok	<b>Unit Number</b> : KUBOTA ET 115 DIESEL	<b>Oil</b> 
	<b>Test code</b> : 803 904 911	<b>Wear</b> 
<b>Tel.</b> : 02.2522889	<b>Unit type</b> : Engine Diesel	
<b>Fax.</b> :	<b>Unit make</b> : KUBOTA	
	<b>Unit model</b> : ET 115	
	<b>Oil grade</b> : CHANG SAE30 API CC	

**Recommendations**

Moderate amount of dirt and abrasive wear probably from leak in air filter system.  
All other wear tests and oil condition tests appear satisfactory, and the oil was still serviceable at the time of sampling.

Sample	19274	Alarm Limit Range
Date sampled	14-Jul-03	<i>Limit Name :</i>
Hours on Oil	20	Engine Diesel General, Kubota Chang
Hours on Unit	Not Available	Sae 30
Cust. Ref #	814395	
Spectro Test	RDE RFS	
Iron(Fe)	65.5 A	N.O. C-High A-High C-High A-High
Chromium(Cr)	7.4 A	1.0 24.0 38.0 33.0 53.0
Lead(Pb)	2.5	0.0 1.0 1.7 1.6 2.4
Copper(Cu)	3.6	0.0 8.0 13.0 9.0 15.0
Tin(Sn)	0.0	0.0 15.0 25.0 20.0 34.0
Aluminium(Al)	12.9 A	0.0 3.2 5.8 6.6 11.7
Nickel(Ni)	0.0	0.0 4.0 6.0 6.0 9.0
Silver(Ag)	0.0	0.0 0.6 1.1 2.6 4.1
Molybdenum(Mo)	0.0	0.0
Titanium(Ti)	0.0	0.0
Vanadium(V)	0.0	0.0
Silicon(Si)	16.1 C	9.0 13.0 21.0 16.0 21.0
	Additive	A-Low C-Low N.O. C-High A-High
Boron(B)	0	0
Sodium(Na)	3	1
Magnesium(Mg)	6	8
Calcium(Ca)	2075	1991
Barium(Ba)	0	0
Phosphorus(P)	251	233
Zinc(Zn)	382	378
	Viscosity	A-Low C-Low N.O. C-High A-High
Visc @40	97.31	97.50
Visc @100	11.50	9.54 10.10 11.23 12.35 12.91
Vis. Index		
	FTIR	A-Low C-Low N.O. C-High A-High
Oxidation(Abs)	4	4 14 19
Nitration(Abs)	6	5 11 14
Sulfation(Abs)	16	15 25 34
Fuel %	0.00	0.00 3.00 5.00
Water %	0.038	0.083 0.100 0.300
Glycol %	0	
Soot %	0.28	0.00 2.10 5.10
ZDDP(Abs)	16	
	Other Test	A-Low C-Low N.O. C-High A-High
TAN		
TBN	4.0	2.0 2.6 5.2
Flash Point	>205	

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รูปที่ จ-3 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้น้ำมันปาล์มดิบผสม  
ดีเซลหลังผ่านการรันอินครบ 20 ชั่วโมง (19271)

FOCUS		LubeCheck™ - Oil Analysis for Predictive Maintenance				
Customer # : 18004	Site Name :	Condition				
Invoice To : ICE R&D LAB	Location :	of				
Address : Faculty of Engineering Chulalongkorn University Bangkok	Unit Number : KUBOTA ET 115 CPO+DIESEL	Oil	Wear			
Tel. : 02.2522889	Test code : 803 904 911	Normal	Normal			
Fax. :	Unit type : Engine Diesel					
	Unit make : KUBOTA					
	Unit model : ET 115					
	Oil grade : CHANG SAE30 API CC					
Recommendations						
Moderate amount of dirt and abrasive wear probably from leak in air filter system.						
All other wear tests and oil condition tests appear satisfactory, and the oil was still serviceable at the time of sampling.						
Sample	19271	Alarm Limit Range				
Date sampled	14-Jul-03	Limit Name :				
Hours on Oil	20	Engine Diesel General, Kubota Chang				
Hours on Unit	Not Available	Sae 30				
Cust. Ref #	814394					
Spectro Test	RDE RFS					
Iron(Fe)	53.6 A	N.O.	C-High	A-High	C-High	A-High
Chromium(Cr)	4.9 A	1.0	24.0	38.0	13.0	53.0
Lead(Pb)	5.0	0.0	1.0	1.7	1.6	2.4
Copper(Cu)	3.3	0.0	9.0	13.0	9.0	15.0
Tin(Sn)	0.0	0.0	15.0	25.0	20.0	34.0
Aluminium(Al)	15.0 A	0.0	3.2	5.8	6.6	11.7
Nickel(Ni)	0.0	0.0	4.0	6.0	6.0	9.0
Silver(Ag)	0.0	0.0	0.6	1.1	2.6	4.1
Molybdenum(Mo)	0.0	0.0				
Titanium(Ti)	0.0	0.0				
Vanadium(V)	0.3	0.0				
Silicon(Si)	13.6 C	9.0	13.0	21.0	16.0	21.0
	Additive	A-Low	C-Low	N.O.	C-High	A-High
Boron(B)	0			0		
Sodium(Na)	3			1		
Magnesium(Mg)	8			8		
Calcium(Ca)	2042			1991		
Barium(Ba)	0			0		
Phosphorus(P)	250			233		
Zinc(Zn)	376			378		
	Viscosity	A-Low	C-Low	N.O.	C-High	A-High
Visc @40	98.48			97.50		
Visc @100	11.53	9.54	10.10	11.23	12.35	12.91
Vis. Index						
	FTIR	A-Low	C-Low	N.O.	C-High	A-High
Oxidation(Abs)	4			4	14	19
Nitration(Abs)	6			5	11	14
Sulfation(Abs)	17			15	25	34
Fuel %	0.00			0.00	3.00	5.00
Water %	0.039			0.083	0.100	0.300
Glycol %	0					
Soot %	0.34			0.00	2.10	5.10
ZDDP(Abs)	16					
	Other Test	A-Low	C-Low	N.O.	C-High	A-High
TAN						
TBN	5.1	2.0	2.6	5.2		
Flash Point	>205					
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Tel : (662) 361 8600-3 Fax : (662) 361 8567 Email : focus@loxinfo.co.th						
Tel (02) 709 2933-36 Fax (02) 7092937 E-mail : focuslab@loxinfo.co.th						

รูปที่ จ-4 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้น้ำมันดีเซลหลังจากผ่าน  
การทดสอบความทนทาน 10 (19275) ชั่วโมง

FOCUS		LubeCheck™ - Oil Analysis for Predictive Maintenance				
Customer # : 18004	Site Name :	Condition				
Invoice To : ICE R&D LAB	Location :	of				
Address : Faculty of Engineering Chulalongkorn University Bangkok	Unit Number : KUBOTA ET 115 DIESEL	Oil	Wear			
Tel. : 02.2522889	Test code : 803 904 911	Normal	Normal			
Fax. :	Unit type : Engine Diesel					
	Unit make : KUBOTA					
	Unit model : ET 115					
	Oil grade : CHANG SAE30 API CC					
Recommendations						
Note some test values are near to the Alarm Limits, or slightly over the Alarm Limits, but are not considered serious at this time. All other wear tests and oil condition tests appear satisfactory, and the oil was still serviceable at the time of sampling.						
Sample	19275	Alarm Limit Range				
Date sampled	15-Jul-03	Limit Name :				
Hours on Oil	10	Engine Diesel General, Kubota Chang				
Hours on Unit	Not Available	Sae 30				
Cust. Ref #	814397					
Spectro Test	RDE RFS					
Iron(Fe)	23.4	N.O.	C-High	A-High	C-High	A-High
Chromium(Cr)	2.0 A	1.0	24.0	38.0	23.0	53.0
Lead(Pb)	0.4	0.0	3.0	1.7	1.6	2.4
Copper(Cu)	1.1	0.0	8.0	13.0	9.0	15.0
Tin(Sn)	0.0	0.0	15.0	25.0	20.0	34.0
Aluminium(Al)	3.8	0.0	3.2	5.8	6.6	11.7
Nickel(Ni)	0.0	0.0	4.0	6.0	6.0	9.0
Silver(Ag)	0.0	0.0	0.6	1.1	2.6	4.1
Molybdenum(Mo)	0.0	0.0				
Titanium(Ti)	0.0	0.0				
Vanadium(V)	0.0	0.0				
Silicon(Si)	10.3	9.0	13.0	21.0	16.0	21.0
	Additive	A-Low	C-Low	N.O.	C-High	A-High
Boron(B)	0			0		
Sodium(Na)	1			1		
Magnesium(Mg)	5			8		
Calcium(Ca)	2049			1991		
Barium(Ba)	0			0		
Phosphorus(P)	255			233		
Zinc(Zn)	378			378		
	Viscosity	A-Low	C-Low	N.O.	C-High	A-High
Visc @40	99.01			97.50		
Visc @100	11.28	9.54	10.10	11.23	12.35	12.91
Vis. Index						
	FTIR	A-Low	C-Low	N.O.	C-High	A-High
Oxidation(Abs)	4			4	14	19
Nitration(Abs)	6			5	11	14
Sulfation(Abs)	16			15	25	34
Fuel %	0.00			0.00	3.60	5.00
Water %	0.039			0.063	0.100	0.300
Glycol %	0					
Soot %	0.09			0.00	2.10	5.10
ZDDP(Abs)	16					
	Other Test	A-Low	C-Low	N.O.	C-High	A-High
TAN						
TBN	5.1	2.0	2.6	5.2		
Flash Point	>205					
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รูปที่ ๑-5 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้ น้ำมันปาล์มดิบผสม  
ดีเซลหลังผ่านการทดสอบความหนืด 10 (19272) ชั่วโมง

FOCUS		LubeCheck™ - Oil Analysis for Predictive Maintenance				
Customer # : 18004	Site Name :	Condition				
Invoice To : ICE R&D LAB	Location :	of				
Address : Faculty of Engineering Chulalongkorn University Bangkok	Unit Number : KUBOTA ET 115 CPO+DIESEL	Oil	Wear			
Tel. : 02.2522889	Test code : 803 904 911	Normal	Normal			
Fax. :	Unit type : Engine Diesel					
	Unit make : KUBOTA					
	Unit model : ET 115					
	Oil grade : CHANG SAE30 API CC					
Recommendations						
Note some test values are near to the Alarm Limits, or slightly over the Alarm Limits, but are not considered serious at this time. All other wear tests and oil condition tests appear satisfactory, and the oil was still serviceable at the time of sampling.						
Sample	19272	Alarm Limit Range				
Date sampled	15-Jul-03	Limit Name :				
Hours on Oil	10	Engine Diesel General, Kubota Chang				
Hours on Unit	Not Available	Sae 30				
Cust. Ref #	814396	RDE RFS				
Spectro Test	RDE RFS	N.O.	C-High	A-High	C-High	A-High
Iron(Fe)	19.6	1.0	24.0	38.0	33.0	53.0
Chromium(Cr)	1.7 A	0.0	1.0	1.7	1.6	2.4
Lead(Pb)	0.9	0.0	9.0	13.0	9.0	15.0
Copper(Cu)	1.0	0.0	15.0	25.0	20.0	34.0
Tin(Sn)	0.0	0.0	3.7	5.8	6.6	11.7
Aluminium(Al)	5.0 C	0.0	4.0	6.0	6.0	9.0
Nickel(Ni)	0.0	0.0	0.6	1.1	2.6	4.1
Silver(Ag)	0.0					0.0
Molybdenum(Mo)	0.0					0.0
Titanium(Ti)	0.0					0.0
Vanadium(V)	0.0					0.0
Silicon(Si)	10.4	9.0	13.0	21.0	16.0	21.0
	Additive	A-Low	C-Low	N.O.	C-High	A-High
Boron(B)	0					0
Sodium(Na)	1					1
Magnesium(Mg)	9					8
Calcium(Ca)	2082					1991
Barium(Ba)	0					0
Phosphorus(P)	248					233
Zinc(Zn)	378					378
	Viscosity	A-Low	C-Low	N.O.	C-High	A-High
Visc @40	98.68					97.50
Visc @100	11.42	9.54	10.10	11.23	12.35	12.91
Vis. Index						
	FTIR	A-Low	C-Low	N.O.	C-High	A-High
Oxidation(Abs)	4					4
Nitration(Abs)	6					5
Sulfation(Abs)	16					15
Fuel %	0.00					0.00
Water %	0.038					0.083
Glycol %	0					0.100
Soot %	0.14					0.00
ZDDP(Abs)	16					2.10
	Other Test	A-Low	C-Low	N.O.	C-High	A-High
TAN						2.0
TBN	4.8					5.2
Flash Point	>205					
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Tel : (662) 361 8600-3 Fax : (662) 361 8567 Email : focus@loxinfo.co.th		Tel (02) 709 2933-36 Fax (02) 7092937 E-mail : focuslab@loxinfo.co.th				

รูปที่ ๑-6 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้น้ำมันดีเซลหลังผ่านการทดสอบความทนทาน 25 (19276) ชั่วโมง

FOCUS		LubeCheck™ - Oil Analysis for Predictive Maintenance				
Customer # : 18004	Site Name :	Condition				
Invoice To : ICE R&D LAB	Location :	of				
Address : Faculty of Engineering Chulalongkorn University Bangkok	Unit Number : KUBOTA ET 115 DIESEL	Oil	Wear			
Tel. : 02.2522889	Test code : 803 904 911	Normal	Normal			
Fax. :	Unit type : Engine Diesel					
	Unit make : KUBOTA					
	Unit model : ET 115					
	Oil grade : CHANG SAE30 API CC					
Recommendations						
Note some test values are near to the Alarm Limits, or slightly over the Alarm Limits, but are not considered serious at this time.						
All other wear tests and oil condition tests appear satisfactory, and the oil was still serviceable at the time of sampling.						
Sample	19276	Alarm Limit Range				
Date sampled	16-Jul-03	Limit Name :				
Hours on Oil	25	Engine Diesel General, Kubota Chang				
Hours on Unit	Not Available	Sae 30				
Cust. Ref #	814399	RDE RFS				
Spectro Test	RDE RFS	N.O.	C-High	A-High	C-High	A-High
Iron(Fe)	28.1 C	1.0	24.0	38.0	33.0	53.0
Chromium(Cr)	2.5 A	0.0	1.0	1.7	1.6	2.4
Lead(Pb)	1.0	0.0	8.0	13.0	9.0	15.0
Copper(Cu)	1.5	0.0	15.0	25.0	20.0	34.0
Tin(Sn)	0.0	0.0	3.2	5.8	6.6	11.7
Aluminium(Al)	5.5 C	0.0	4.0	6.0	6.0	9.0
Nickel(Ni)	0.0	0.0	0.6	1.1	2.6	4.1
Silver(Ag)	0.0	0.0				
Molybdenum(Mo)	0.0	0.0				
Titanium(Ti)	0.0	0.0				
Vanadium(V)	0.2	0.0				
Silicon(Si)	10.1	9.0	13.0	21.0	16.0	21.0
	Additive	A-Low	C-Low	N.O.	C-High	A-High
Boron(B)	0			0		
Sodium(Na)	1			1		
Magnesium(Mg)	8			8		
Calcium(Ca)	1988			1991		
Barium(Ba)	0			0		
Phosphorus(P)	237			233		
Zinc(Zn)	386			378		
	Viscosity	A-Low	C-Low	N.O.	C-High	A-High
Visc @40	96.83			97.50		
Visc @100	11.35	9.54	10.10	11.23	12.35	12.91
Vis. Index		A-Low	C-Low	N.O.	C-High	A-High
	FTIR					
Oxidation(Abs)	4			4	14	19
Nitration(Abs)	6			5	11	14
Sulfation(Abs)	16			15	25	34
Fuel %	0.00			0.00	3.00	5.00
Water %	0.041			0.083	0.100	0.300
Glycol %	0					
Soot %	0.21			0.00	2.10	5.10
ZDDP(Abs)	16					
	Other Test	A-Low	C-Low	N.O.	C-High	A-High
TAN						
TBN	4.8	2.0	3.6	5.2		
Flash Point	>205					
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Tel : (662) 361 8600-3 Fax : (662) 361 8567 Email : focus@loxinfo.co.th		Tel (02) 709 2933-36 Fax (02) 7092937 E-mail : focuslab@loxinfo.co.th				



รูปที่ ๖-7 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้น้ำมันปาล์มดิบผสม  
ดีเซลหลังผ่านการทดสอบความหนืด 25 (19273) ชั่วโมง


FOCUS		LubeCheck™ - Oil Analysis for Predictive Maintenance			
Customer # : 18004	Site Name :	Condition		of	
Invoice To : ICE R&D LAB	Location :	Oil		Wear	
Address : Faculty of Engineering Chulalongkorn University Bangkok	Unit Number : KUBOTA ET 115 CPO+DIESEL	Normal		Normal	
Tel. : 02.2522889	Test code : 803 904 911	Normal		Normal	
Fax. :	Unit type : Engine Diesel	Normal		Normal	
	Unit make : KUBOTA	Normal		Normal	
	Unit model : ET 115	Normal		Normal	
	Oil grade : CHANG SAE30 API CC	Normal		Normal	
Recommendations					
Note some test values are near to the Alarm Limits, or slightly over the Alarm Limits, but are not considered serious at this time. All other wear tests and oil condition tests appear satisfactory, and the oil was still serviceable at the time of sampling.					
Sample	19273	Alarm Limit Range			
Date sampled	16-Jul-03	Limit Name :			
Hours on Oil	25	Engine Diesel General, Kubota Chang			
Hours on Unit	Not Available	Sae 30			
Cust. Ref #	814398				
Spectro Test	RDE RFS				
Iron(Fe)	27.7 C	N.O.	C-High	A-High	RFS
Chromium(Cr)	2.8 A	1.0	24.0	38.0	33.0 53.0
Lead(Pb)	2.4	0.0	1.0	1.7	1.6 2.4
Copper(Cu)	1.5	0.0	8.0	13.0	9.0 15.0
Tin(Sn)	0.0	0.0	15.0	25.0	20.0 34.0
Aluminum(Al)	7.4 A	0.0	3.2	5.8	6.6 11.7
Nickel(Ni)	0.2	0.0	4.0	6.0	6.0 9.0
Silver(Ag)	0.0	0.0	0.6	1.1	2.6 4.1
Molybdenum(Mo)	0.0	0.0			
Titanium(Ti)	0.0	0.0			
Vanadium(V)	0.2	0.0			
Silicon(Si)	11.4	9.0	13.0	21.0	16.0 21.0
	Additive	A-Low	C-Low	N.O.	C-High A-High
Boron(B)	0				0
Sodium(Na)	2				1
Magnesium(Mg)	10				8
Calcium(Ca)	2038				1991
Barium(Ba)	0				0
Phosphorus(P)	247				233
Zinc(Zn)	390				378
	Viscosity	A-Low	C-Low	N.O.	C-High A-High
Visc @40	99.91				97.50
Visc @100	11.86	9.54	10.10	11.23	12.35 12.91
Vis. Index		A-Low	C-Low	N.O.	C-High A-High
	FTIR				
Oxidation(Abs)	4				4 14 19
Nitration(Abs)	6				5 11 14
Sulfation(Abs)	17				15 25 34
Fuel %	0.10				0.00 3.00 5.00
Water %	0.040				0.083 3.000 0.300
Glycol %	0				
Soot %	0.34				0.00 2.10 5.10
ZDDP(Abs)	16				
	Other Test	A-Low	C-Low	N.O.	C-High A-High
TAN					
TBN	4.6	2.0	2.0	5.2	
Flash Point	>205				
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รูปที่ จ-10 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้น้ำมันดีเซลหลังผ่าน  
การทดสอบความหนืด 75(19472) ,100(19473) ,125(19474) ชั่วโมง



**LubeCheck™ - Oil Analysis for Predictive Maintenance**

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**Customer #** : 18004  
**Invoice To** : ICE R&D LAB  
**Address** : Faculty of Engineering  
Chulalongkorn University  
Bangkok  
**Tel.** : 02.2522889  
**Fax.** :


**Site Name** :  
**Location** :  
**Unit Number** : KUBOTA ET 115 DIESEL  
**Test code** : 803 904 911  
**Unit type** : Engine Diesel  
**Unit make** : KUBOTA  
**Unit model** : ET 115  
**Oil grade** : CHANG SAE30 API CC

Condition  
of  
Oil Wear

Normal



Normal



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**Recommendations**

Note some test values are near to the Alarm Limits, or slightly over the Alarm Limits, but are not considered serious at this time.  
All other wear tests and oil condition tests appear satisfactory, and the oil was still serviceable at the time of sampling.


Sample	19474		19473		19472		Alarm Limit Range				
	22-Jul-03		20-Jul-03		19-Jul-03		Limit Name :				
	25		100		75		Engine Diesel General, Kubota Chang Sae 30				
Hours on Oil	Not Available		Not Available		Not Available						
Hours on Unit	814391		814405		814403						
Cust. Ref #	RDE RFS		RDE RFS		RDE RFS						
Spectro Test							RDE RFS				
Iron(Fe)	23.0		56.2 A		44.2 A		N.O.	C-High	A-High	C-High	A-High
Chromium(Cr)	1.5 C		4.9 A		3.9 A		0.0	1.0	1.7	1.6	2.4
Lead(Pb)	0.0		2.3		1.7		0.0	8.0	13.0	9.0	15.0
Copper(Cu)	0.8		2.9		2.5		0.0	15.0	25.0	20.0	34.0
Tin(Sn)	0.0		0.0		0.0		0.0	3.2	5.8	6.6	11.7
Aluminium(Al)	3.2		10.5 A		8.4 A		0.0	4.0	6.0	6.0	9.0
Nickel(Ni)	0.0		0.2		0.0		0.0	0.6	1.1	2.5	4.1
Silver(Ag)	0.0		0.0		0.0		0.0				
Molybdenum(Mo)	0.0		0.0		0.0		0.0				
Titanium(Ti)	0.0		0.0		0.0		0.0				
Vanadium(V)	0.0		0.4		0.0		0.0				
Silicon(Si)	10.2		11.5		10.6		9.0	13.0	21.0	16.0	21.0
	Additive		Additive		Additive		A-Low C-Low N.O. C-High A-High				
Boron(B)	0		0		0						
Sodium(Na)	1		2		2				1		
Magnesium(Mg)	9		12		8				8		
Calcium(Ca)	2088		2085		2034				1991		
Barium(Ba)	0		0		0				0		
Phosphorus(P)	239		231		240				233		
Zinc(Zn)	371		371		359				378		
	Viscosity		Viscosity		Viscosity		A-Low C-Low N.O. C-High A-High				
Visc @40	96.83		99.01		97.31				97.50		
Visc @100	11.43		11.68		11.45		9.54	10.10	11.23	12.35	12.91
	FTIR		FTIR		FTIR		A-Low C-Low N.O. C-High A-High				
Oxidation(Abs)	3		4		3				4	14	19
Nitration(Abs)	4		5		5				5	11	14
Sulfation(Abs)	12		14		13				15	25	34
Fuel %	0.40		0.80		0.40				0.00	3.00	5.00
Water %	0.023		0.027		0.025				0.083	0.100	0.300
Glycol %	0		0		0						
Soot %	0.17		0.50		0.40				0.00	2.10	5.10
ZDDP(Abs)	12		12		12						
	Other Test		Other Test		Other Test		A-Low C-Low N.O. C-High A-High				
TAN											
TBN	4.2		4.2		4.3		2.0	2.6	5.2		
Flash Point	>205		>205		>205						

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รูปที่ จ-11 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้น้ำมันปาล์มดิบผสม  
ดีเซลหลังจากการทดสอบความทนทาน 75(19469) ,100 (19470) ,125 (19471) ชั่วโมง



**LubeCheck™ - Oil Analysis for Predictive Maintenance**

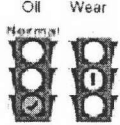
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Customer # : 18004  
 Invoice To : ICE R&D LAB  
 Address : Faculty of Engineering  
 Chulalongkorn University  
 Bangkok  
 Tel. : 02.2522889  
 Fax. :

Site Name :  
 Location :  
 Unit Number : KUBOTA ET 115 CPO+DIESEL  
 Test code : 803 904 911  
 Unit type : Engine Diesel  
 Unit make : KUBOTA  
 Unit model : ET 115  
 Oil grade : CHANG SAE30 API CC

Condition  
 of  
 Oil Wear



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**Recommendations**


Note slight amount of dirt contamination and associated abrasive wear, probably from leak in air filtration system.  
 All other wear tests and oil condition tests appear satisfactory, and the oil was still serviceable at the time of sampling.

Sample	19471		19470		19469		Alarm Limit Range				
	22-Jul-03		20-Jul-03		19-Jul-03		Limit Name :				
	25		100		75		Engine Diesel General, Kubota Chang Sae 30				
Hours on Oil	Not Available		Not Available		Not Available		RDE RFS				
Hours on Unit	814390		814404		814402						
Cust. Ref #											
Spectro Test	RDE	RFS	RDE	RFS	RDE	RFS	N.O.	C-High	A-High	C-High	A-High
Iron(Fe)	29.2 C		58.0 A		55.8 A		1.0	24.0	38.0	33.0	53.0
Chromium(Cr)	3.1 A		5.9 A		5.7 A		0.0	1.0	1.7	1.6	2.4
Lead(Pb)	0.4		2.3		2.9		0.0	8.0	13.0	9.0	15.0
Copper(Cu)	1.1		3.0		3.1		0.0	15.0	25.0	20.0	34.0
Tin(Sn)	0.0		0.0		0.0		0.0	1.2	5.8	6.6	11.7
Aluminium(Al)	6.2 A		16.2 A		15.7 A		0.0	4.3	6.0	6.0	9.0
Nickel(Ni)	0.0		0.0		0.2		0.0	0.5	1.1	2.6	4.1
Silver(Ag)	0.0		0.0		0.0		0.0				
Molybdenum(Mo)	0.0		0.0		2.6		0.0				
Titanium(Ti)	0.0		0.0		0.0		0.0				
Vanadium(V)	0.0		0.2		0.2		0.0				
Silicon(Si)	12.2		15.5 C		15.3 C		9.0	13.0	21.0	16.0	21.0
	Additive		Additive		Additive		A-Low	C-Low	N.O.	C-High	A-High
Boron(B)	0		0		0				0		
Sodium(Na)	1		2		2				1		
Magnesium(Mg)	11		9		15				8		
Calcium(Ca)	2070		2076		2194				1991		
Barium(Ba)	0		0		0				0		
Phosphorus(P)	252		258		258				233		
Zinc(Zn)	368		376		380				378		
	Viscosity		Viscosity		Viscosity		A-Low	C-Low	N.O.	C-High	A-High
Visc @40	100.88		103.56		102.38				97.50		
Visc @100	11.86		12.37 C		12.46 C		9.54	10.10	11.23	12.35	12.91
Vis. Index							A-Low	C-Low	N.O.	C-High	A-High
	FTIR		FTIR		FTIR						
Oxidation(Abs)	3		4		4				4	1.4	19
Nitration(Abs)	5		5		5				5	1.1	14
Sulfation(Abs)	13		14		14				15	2.5	34
Fuel %	0.60		0.90		0.60				0.00	3.00	5.00
Water %	0.024		0.023		0.027				0.083	0.100	0.300
Glycol %	0		0		0						
Soot %	0.37		0.81		0.66				0.00	2.10	5.10
ZDDP(Abs)	12		12		12						
	Other Test		Other Test		Other Test		A-Low	C-Low	N.O.	C-High	A-High
TAN											
TBN	5.5		4.0		5.0		2.0	2.6	5.2		
Flash Point	>205		>205		>205						

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รูปที่ ๑-12 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้น้ำมันดีเซลหลังผ่าน  
การทดสอบความทนทาน 150(19603) , 175(19632) , 200(19633) ชั่วโมง



**LubeCheck™ - Oil Analysis for Predictive Maintenance**

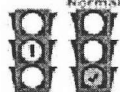
Page 1 of 3

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**Customer #** : 18004  
**Invoice To** : ICE R&D LAB  
**Address** : Faculty of Engineering  
Chulalongkorn University  
Bangkok  
**Tel.** : 02.2522889  
**Fax.** :

**Site Name** :  
**Location** :  
**Unit Number** : KUBOTA ET 115 DIESEL  
**Test code** : 803 904 911  
**Unit type** : Engine Diesel  
**Unit make** : KUBOTA  
**Unit model** : ET 115  
**Oil grade** : CHANG SAE30 API CC

Condition  
of  
Oil Wear



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**Recommendations**

Note slight amount of dirt contamination and associated abrasive wear, probably from leak in air filtration system.  
All other wear tests and oil condition tests appear satisfactory, and the oil was still serviceable at the time of sampling.  
Continue routine sampling interval.

Sample	19632			19632			19603			Alarm Limit Range				
	27-Jul-03			26-Jul-03			23-Jul-03			Limit Name :				
	100			75			50			Engine Diesel General, Kubota Chang Sae 30				
Date sampled	Not Available			Not Available			Not Available							
Hours on Oil	814977			814975			814393							
Hours on Unit	814977			814975			814393							
Cust. Ref #	814977			814975			814393							
Spectro Test	RDE	RFS		RDE	RFS		RDE	RFS		RDE		RFS		
Iron(Fe)	52.6 A			44.9 A			30.6 C			1.0	24.0	38.0	33.0	53.0
Chromium(Cr)	3.5 A			3.2 A			2.2 A			0.0	4.0	1.7	1.6	2.4
Lead(Pb)	0.8			0.6			0.9			0.0	8.0	13.0	9.0	15.0
Copper(Cu)	1.8			1.6			1.1			0.0	15.0	25.0	20.0	34.0
Tin(Sn)	0.0			0.0			0.0			0.0	3.1	5.8	6.6	11.7
Aluminium(Al)	9.1 A			7.4 A			5.4 C			0.0	4.0	6.0	6.0	9.0
Nickel(Ni)	0.1			0.0			0.0			0.0	0.0	1.1	2.6	4.1
Silver(Ag)	0.0			0.0			0.0			0.0				
Molybdenum(Mo)	0.0			2.0			2.5			0.0				
Titanium(Ti)	0.0			0.0			0.0			0.0				
Vanadium(V)	0.3			0.3			0.2			0.0				
Silicon(Si)	13.1 C			12.9			11.4			9.0	15.0	21.0	16.0	21.0
	Additive			Additive			Additive			A-Low	C-Low	N.O.	C-High	A-High
Boron(B)	0			0			0					0		
Sodium(Na)	2			2			1					1		
Magnesium(Mg)	9			7			9					8		
Calcium(Ca)	2199			2208			2114					1991		
Barium(Ba)	0			0			2					0		
Phosphorus(P)	258			269			273					233		
Zinc(Zn)	378			382			377					378		
	Viscosity			Viscosity			Viscosity			A-Low	C-Low	N.O.	C-High	A-High
Visc @40	101.29			100.88			100.63					97.50		
Visc @100	12.16			11.71			11.42			9.54	10.10	11.23	12.35	12.91
Vis. Index														
	FTIR			FTIR			FTIR			A-Low	C-Low	N.O.	C-High	A-High
Oxidation(Abs)	4			4			3					4	14	19
Nitration(Abs)	6			5			5					5	11	14
Sulfation(Abs)	15			14			13					15	25	34
Fuel %	0.30			0.30			0.60					0.00	3.00	5.00
Water %	0.032			0.031			0.029					0.083	0.100	0.300
Glycol %	0			0			0							
Soot %	0.71			0.50			0.28					0.00	2.50	5.10
ZDDP(Abs)	13			12			12							
	Other Test			Other Test			Other Test			A-Low	C-Low	N.O.	C-High	A-High
TAN														
TBN	4.1			4.0			4.8			2.0	3.0	5.2		
Flash Point	>205			>205			>205							

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รูปที่ จ-13 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้น้ำมันปาล์มดิบผสม  
ดีเซลหลังผ่านการทดสอบความทนทาน 150(19602) ,175 (19630) ,200 (19631) ชั่วโมง

FOCUS		LubeCheck™ - Oil Analysis for Predictive Maintenance				Page 1 of 3		
Customer # : 18004	Site Name :	Condition						
Invoice To : ICE R&D LAB	Location :	of						
Address : Faculty of Engineering Chulalongkorn University Bangkok	Unit Number : KUBOTA ET 115 CPO+DIESEL	Oil		Wear				
Tel. : 02.2522889	Test code : 803 904 911							
Fax. :	Unit type : Engine Diesel							
	Unit make : KUBOTA							
	Unit model : ET 115							
	Oil grade : CHANG SAE30 API CC							
Recommendations								
Note increase in viscosity, soot iron and dirt (silicon).								
Recommend check to determine how dirt is entering the system and correct the problem to prevent further dirt entry.								
Continue routine sampling interval.								
Sample	19631	19630	19602	Alarm Limit Range				
Date sampled	27-Jul-03	26-Jul-03	23-Jul-03	Limit Name :				
Hours on Oil	100	75	50	Engine Diesel General, Kubota Chang				
Hours on Unit	Not Available	Not Available	Not Available	Sae 30				
Cust. Ref #	814976	814974	814392					
Spectro Test	RDE RFS	RDE RFS	RDE RFS	RDE RFS				
Iron(Fe)	74.3 A	54.4 A	44.5 A	N.O.	C-High	A-High	C-High	A-High
Chromium(Cr)	7.2 A	5.7 A	4.6 A	0.0	1.0	1.7	1.6	2.4
Lead(Pb)	1.6	1.3	1.2	0.0	8.0	13.0	9.0	15.0
Copper(Cu)	2.5	2.0	1.6	0.0	18.0	25.0	20.0	34.0
Tin(Sn)	0.0	0.0	0.0	0.0	3.2	5.8	6.6	11.7
Aluminium(Al)	13.5 A	11.0 A	9.2 A	0.0	4.0	6.0	6.0	9.0
Nickel(Ni)	0.3	0.2	0.0	0.0	0.6	1.1	2.6	4.1
Silver(Ag)	0.0	0.0	0.0					
Molybdenum(Mo)	0.0	0.1	2.2					
Titanium(Ti)	0.0	0.0	0.0					
Vanadium(V)	0.0	0.5	0.0					
Silicon(Si)	16.0 C	14.1 C	14.0 C	9.0	13.0	21.0	16.0	21.0
Boron(B)	0	0	0	A-Low	C-Low	N.O.	C-High	A-High
Sodium(Na)	2	2	2					
Magnesium(Mg)	13	8	8					
Calcium(Ca)	2175	2079	2024	1991				
Barium(Ba)	0	1	2	0				
Phosphorus(P)	279	279	275	233				
Zinc(Zn)	373	367	373	378				
Viscosity				A-Low	C-Low	N.O.	C-High	A-High
Visc @40	107.47	104.32	103.35	97.50				
Visc @100	13.05 A	12.28	12.08	9.54	10.10	11.23	12.35	12.91
Vis. Index				A-Low	C-Low	N.O.	C-High	A-High
Oxidation(Abs)	5	4	4	4 18 19				
Nitration(Abs)	6	5	5	5 11 14				
Sulfation(Abs)	16	14	13	15 25 34				
Fuel %	0.30	0.60	0.50	0.00 3.00 5.00				
Water %	0.023	0.030	0.028	0.083 0.100 0.300				
Glycol %	0	0	0					
Soot %	1.00	0.75	0.59	0.00 2.10 5.10				
ZDDP(Abs)	13	12	12					
Other Test				A-Low	C-Low	N.O.	C-High	A-High
TAN								
TBN	4.1	3.8	4.5	2.0 2.5 5.2				
Flash Point	>205	>205	>205					

จุฬาลงกรณ์มหาวิทยาลัย

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Samutprakan 10280, Thailand.  
Tel:(02) 709 2933-36 Fax:(02) 7092937 E-mail : focusbb@toxinfo.co.th

รูปที่ จ-14 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้น้ำมันดีเซลหลังผ่านการทดสอบความทนทาน 210(19730) , 235(20415) , 260(20488) ชั่วโมง

FOCUS		LubeCheck™ - Oil Analysis for Predictive Maintenance				Page 1 of 3	
Customer #	: 18004	Site Name	:	Condition			
Invoice To	: ICE R&D LAB	Location	:	Oil	Normal		
Address	: Faculty of Engineering Chulalongkorn University Bangkok	Unit Number	: KUBOTA ET 115 DIESEL	Wear	Normal		
Tel.	: 02.2522889	Test code	: 803 904 911				
Fax.	:	Unit type	: Engine Diesel				
		Unit make	: KUBOTA				
		Unit model	: ET 115				
		Oil grade	: CHANG SAE30 API CC				
Recommendations							
Note slight amount of dirt contamination and associated abrasive wear, probably from leak in air filtration system.							
All other wear tests and oil condition tests appear satisfactory, and the oil was still serviceable at the time of sampling.							
Sample	20448	20415	19730	Alarm Limit Range			
Date sampled	23-Aug-03	21-Aug-03	31-Jul-03	Limit Name :			
Hours on Oil	50	25	110	Engine Diesel General, Kubota Chang Sae 30			
Hours on Unit	Not Available	Not Available	Not Available				
Cust. Ref #	814985	814983	814981				
Spectro Test	RDE RFS	RDE RFS	RDE RFS	RDE RFS			
Iron(Fe)	33.7	28.6 C	58.9 A	N.O.	C-High	A-High	
Chromium(Cr)	2.3	2.1 A	4.0 A	1.0	3.0	3.0	
Lead(Pb)	1.6	0.6	1.6	0.0	1.0	1.7	
Copper(Cu)	1.7	1.4	2.0	0.0	13.0	13.0	
Tin(Sn)	0.0	0.0	0.0	0.0	25.0	25.0	
Aluminium(Al)	8.0	7.3 A	9.4 A	0.0	3.2	5.8	
Nickel(Ni)	0.0	0.0	0.4	0.0	6.0	6.0	
Nilver(Ag)	0.0	0.0	0.0	0.0	1.1	2.6	
Molybdenum(Mo)	0.0	0.0	5.3	0.0	0.0	4.1	
Titanium(Ti)	0.0	0.0	0.0	0.0	0.0	0.0	
Vanadium(V)	0.0	0.0	0.4	0.0	0.0	0.0	
Silicon(Si)	14.1	14.0 C	13.6 C	9.0	13.0	21.0	
	Additive	Additive	Additive	A-Low	C-Low	N.O.	
Boron(B)	0	0	0				
Sodium(Na)	2	2	2				
Magnesium(Mg)	13	6	11				
Calcium(Ca)	2189	2069	2214			1991	
Barium(Ba)	0	0	0			0	
Phosphorus(P)	262	249	247			233	
Zinc(Zn)	389	402	368			378	
	Viscosity	Viscosity	Viscosity	A-Low	C-Low	N.O.	
Visc @40	100.20	95.91	101.61				
Visc @100	10.97	11.48	12.00	9.54	10.10	11.23	
Vis. Index				12.35	12.35	12.91	
	FTIR	FTIR	FTIR	A-Low	C-Low	N.O.	
Oxidation(Abs)	3	3	4				
Nitration(Abs)	5	5	6			4	
Sulfation(Abs)	13	12	15			14	
Fuel %	0.30	0.50	0.70			15	
Water %	0.024	0.023	0.030			25	
Glycol %	0	0	0			34	
Soot %	0.23	0.18	0.71			0.00	
ZDDP(Abs)	12	12	12			3.00	
	Other Test	Other Test	Other Test	A-Low	C-Low	N.O.	
TAN							
TBN	5.5	5.6	4.3	2.0	2.6	5.2	
Flash Point	>205	>205	>205				

จุฬาลงกรณ์มหาวิทยาลัย

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Tel.(02) 709 2833-36 Fax (02) 7992937 E-mail : focuslab@focusinfo.co.th



รูปที่ จ-15 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้น้ำมันปาล์มดิบผสม  
ดีเซลหลังผ่านการทดสอบความหนืด 210(19729) ,235 (20414) ,260(20447) ชั่วโมง

FOCUS LABORATORIES LTD		LubeCheck™ - Oil Analysis for Predictive Maintenance				Page 1 of 3		
Customer # : 18004	Site Name :	Condition						
Invoice To : ICE R&D LAB	Location :	Oil		Wear				
Address : Faculty of Engineering Chulalongkorn University Bangkok	Unit Number : KUBOTA ET 115 CPO+DIESEL	Normal						
Tel. : 02.2522889	Test code : 803 904 911							
Fax. :	Unit type : Engine Diesel							
	Unit make : KUBOTA							
	Unit model : ET 115							
	Oil grade : CHANG SAE30 API CC							
Recommendations								
Note slight amount of dirt contamination and associated abrasive wear, probably from leak in air filtration system.								
All other wear tests and oil condition tests appear satisfactory, and the oil was still serviceable at the time of sampling.								
Sample	20447	20414	19729	Alarm Limit Range				
Date sampled	23-Aug-03	21-Aug-03	31-Jul-03	Limit Name :				
Hours on Oil	50	25	110	Engine Diesel General, Kubota Chang				
Hours on Unit	Not Available	Not Available	Not Available	Sae 30				
Cust. Ref #	814984	814982	814980	RDE		RFS		
Spectro Test	RDE RFS	RDE RFS	RDE RFS	N.O.	C-High	A-High	C-High	A-High
Iron(Fe)	42.9 A	44.5 A	287.8 A	1.0	24.0	38.0	33.0	53.0
Chromium(Cr)	2.8 A	2.4 A	7.7 A	0.0	1.0	1.7	1.6	2.4
Lead(Pb)	1.9	1.8	13.5 A	0.0	8.0	13.0	9.0	15.0
Copper(Cu)	1.9	1.6	2.6	0.0	15.0	25.0	20.0	34.0
Tin(Sn)	0.0	0.0	0.0	0.0	3.0	5.8	6.6	11.7
Aluminium(Al)	8.9 A	8.4 A	14.4 A	0.0	4.0	6.0	6.0	9.0
Nickel(Ni)	0.1	0.0	0.0	0.0	0.0	1.1	2.6	4.1
Silver(Ag)	0.0	0.0	0.0	0.0				
Molybdenum(Mo)	0.5	0.0	0.3	0.0				
Titanium(Ti)	0.0	0.0	0.0	0.0				
Vanadium(V)	0.3	0.0	0.0	0.0				
Silicon(Si)	14.6 C	16.1 C	17.9 C	9.0	13.0	21.0	16.0	21.0
	Additive	Additive	Additive	A-Low	C-Low	N.O.	C-High	A-High
Boron(B)	0	0	0					
Sodium(Na)	2	2	3			1		
Magnesium(Mg)	5	8	10			8		
Calcium(Ca)	2202	2166	2206			1991		
Barium(Ba)	0	0	1			0		
Phosphorus(P)	259	276	269			233		
Zinc(Zn)	385	406	359			378		
	Viscosity	Viscosity	Viscosity	A-Low	C-Low	N.O.	C-High	A-High
Visc @40	102.86	94.98	106.28			97.50		
Visc @100	11.28	11.60	13.02 A	9.54	10.10	11.23	12.35	12.91
Vis. Index				A-Low	C-Low	N.O.	C-High	A-High
	FTIR	FTIR	FTIR					
Oxidation(Abs)	3	3	4			4	14	19
Nitration(Abs)	5	5	5			5	11	14
Sulfation(Abs)	14	13	14			15	25	34
Fuel %	0.70	0.60	0.80			0.00	3.00	5.00
Water %	0.024	0.024	0.027			0.083	0.100	0.300
Glycol %	0	0	0					
Soot %	0.47	0.32	1.03			0.00	0.10	5.10
ZDDP(Abs)	13	13	12					
	Other Test	Other Test	Other Test	A-Low	C-Low	N.O.	C-High	A-High
TAN								
TBN	5.4	5.5	4.1	2.0	2.5	5.2		
Flash Point	>205	>205	>205					

จุฬาลงกรณ์มหาวิทยาลัย

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Tel : (662) 381 8600-3 Fax : (662) 361 8567 E-mail : focus@toxin.co.th

Lab : 523 Bangpoo Industrial Estate, Soi 8, Sukhumvit Rd., Prakasa Muang, Samutprakarn 10280, Thailand  
Tel (02) 709 2833-36 Fax (02) 7092937 E-mail : focuslab@toxin.co.th

รูปที่ จ-16 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้น้ำมันดีเซลหลังจากผ่าน  
การทดสอบความหนืด 285(20500) , 310(20502) , 320(21043) ชั่วโมง

FOCUS LABORATORIES LTD		LubeCheck™ - Oil Analysis for Predictive Maintenance				Page 1 of 3	
Customer #	: 18004	Site Name	:	Condition			
Invoice To	: ICE R&D LAB	Location	:				
Address	: Faculty of Engineering Chulalongkorn University Bangkok	Unit Number	: KUBOTA ET 115 DIESEL	Oil	Wear		
Tel.	: 02.2522889	Test code	: 803 904 911				
Fax.	:	Unit type	: Engine Diesel				
		Unit make	: KUBOTA				
		Unit model	: ET 115				
		Oil grade	: CHANG SAE30 API CC				
Recommendations							
(Last Refilled 100 mL+125mL)							
Note some test values are near to the Alarm Limits, or slightly over the Alarm Limits, but are not considered serious at this time.							
All other wear tests and oil condition tests appear satisfactory, and the oil was still serviceable at the time of sampling.							
Sample	21043	20502	20500	Alarm Limit Range			
Date sampled	28-Aug-03	27-Aug-03	24-Aug-03	Limit Name :			
Hours on Oil	110	100	75	Engine Diesel General, Kubota Chang			
Hours on Unit	Not Available	Not Available	Not Available	Sae 30			
Cust. Ref #	814993	814989	814987				
Spectro Test	RDE RFS	RDE RFS	RDE RFS	RDE RFS			
Iron(Fe)	41.0 A	43.2 A	36.6 C	1.0	3.0	53.0	
Chromium(Cr)	3.1 A	2.8 A	2.8 A	0.0	1.7	2.4	
Lead(Pb)	1.7	1.2	2.0	0.0	13.0	15.0	
Copper(Cu)	1.9	1.8	1.7	0.0	25.0	34.0	
Tin(Sn)	0.0	0.0	0.0	0.0	5.8	11.7	
Aluminium(Al)	9.1 A	9.2 A	8.4 A	0.0	6.0	9.0	
Nickel(Ni)	0.0	0.0	0.1	0.0	1.1	4.1	
Silver(Ag)	0.0	0.0	0.0	0.0			
Molybdenum(Mo)	0.0	0.0	1.6	0.0			
Titanium(Ti)	0.0	0.0	0.0	0.0			
Vanadium(V)	0.5	0.1	0.7	0.0			
Silicon(Si)	14.1 C	14.1 C	13.4 C	9.0	21.0	21.0	
Boron(B)	Additive	Additive	Additive	A-Low	C-Low	A-High	
Sodium(Na)	0	0	0				
Magnesium(Mg)	116	123	119				
Calcium(Ca)	9	11	6				
Barium(Ba)	2266	2245	2089				
Phosphorus(P)	0	0	0				
Zinc(Zn)	263	264	247				
	388	375	376				
Viscosity	Viscosity	Viscosity	Viscosity	A-Low	C-Low	A-High	
Visc @40	104.48	105.20	101.85				
Visc @100	11.27	11.24	11.58	9.54	10.10	12.91	
Vis. Index							
Oxidation(Abs)	FTIR	FTIR	FTIR	A-Low	C-Low	A-High	
Nitration(Abs)	4	4	4				
Sulfation(Abs)	5	5	5				
Fuel %	14	14	14				
Water %	0.70	0.10	0.10				
Glycol %	0.032	0.028	0.027				
Soot %	0	0	0				
ZDDP(Abs)	0.48	0.45	0.33				
	12	12	13				
TAN	Other Test	Other Test	Other Test	A-Low	C-Low	A-High	
TBN	5.4	5.2	5.4				
Flash Point	>205	>205		2.0	2.6	5.2	

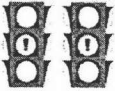
จุฬาลงกรณ์มหาวิทยาลัย

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รูปที่ ๑-17 แสดงใบรายงานผลการทดสอบน้ำมันหล่อลื่นจากเครื่องยนต์ที่ใช้น้ำมันปาล์มดิบผสม  
ดีเซลหลังผ่านการทดสอบความหนืด 285(20499) ,310(20501) ,320(21042) ชั่วโมง

FUS LABORATORIES LTD		LubeCheck™ - Oil Analysis for Predictive Maintenance				Page 1 of 3					
Customer # : 18004	Site Name :					Condition					
Invoice To : ICE R&D LAB	Location :					of					
Address : Faculty of Engineering Chulalongkorn University Bangkok	Unit Number : KUBOTA ET 115 CPO+DIESEL					Oil Wear					
Tel. : 02.2522889	Test code : 803 904 911										
Fax. :	Unit type : Engine Diesel										
	Unit make : KUBOTA										
	Unit model : ET 115										
	Oil grade : CHANG SAE30 API CC										
Recommendations											
(Last Refilled 100 mL+175mL)											
Note some test values are near to the Alarm Limits, or slightly over the Alarm Limits, but are not considered serious at this time.											
All other wear tests and oil condition tests appear satisfactory, and the oil was still serviceable at the time of sampling.											
Sample	21042		20501		20499		Alarm Limit Range				
Date sampled	28-Aug-03		27-Aug-03		24-Aug-03		Limit Name :				
Hours on Oil	110		100		75		Engine Diesel General, Kubota Chang				
Hours on Unit	Not Available		Not Available		Not Available		Sae 30				
Cust. Ref #	814992		814988		814986		RDE RFS				
Spectro Test	RDE	RFS	RDE	RFS	RDE	RFS	N.O.	C-High	A-High	C-High	A-High
Iron(Fe)	53.8 A		56.5 A		47.1 A		1.0	24.0	38.0	33.0	53.0
Chromium(Cr)	4.6 A		4.6 A		4.0 A		0.0	1.0	1.7	1.6	2.4
Lead(Pb)	1.9		1.8		2.2		0.0	8.0	13.0	9.0	15.0
Copper(Cu)	2.0		2.1		2.0		0.0	15.0	25.0	20.0	34.0
Tin(Sn)	0.0		0.0		0.0		0.0	1.0	5.8	6.6	11.7
Aluminium(Al)	10.0 A		10.7 A		9.6 A		0.0	4.0	6.0	6.0	9.0
Nickel(Ni)	0.0		0.0		0.0		0.0	0.0	1.1	2.6	4.1
Silver(Ag)	0.0		0.0		0.0		0.0				
Molybdenum(Mo)	2.7		0.5		1.0		0.0				
Titanium(Ti)	0.0		0.0		0.0		0.0				
Vanadium(V)	0.3		0.0		0.5		0.0				
Silicon(Si)	16.3 C		16.8 C		15.8 C		9.0	13.0	21.0	16.0	21.0
	Additive		Additive		Additive		A-Low	C-Low	N.O.	C-High	A-High
Boron(B)	0		1		0					0	
Sodium(Na)	126		126		112					1	
Magnesium(Mg)	5		9		10					8	
Calcium(Ca)	2163		2274		2204					1991	
Barium(Ba)	0		0		3					0	
Phosphorus(P)	267		272		285					233	
Zinc(Zn)	397		399		364					378	
	Viscosity		Viscosity		Viscosity		A-Low	C-Low	N.O.	C-High	A-High
Visc @40	107.67		107.64		103.14					97.50	
Visc @100	13.01 A		13.33 A		11.79		9.54	10.10	11.23	12.35	12.91
Vis. Index							A-Low	C-Low	N.O.	C-High	A-High
	FTIR		FTIR		FTIR						
Oxidation(Abs)	4		4		4					4	14
Nitration(Abs)	6		6		5					5	11
Sulfation(Abs)	15		15		14					15	25
Fuel %	0.80		0.10		0.10					0.00	3.00
Water %	0.032		0.027		0.027					0.083	0.100
Glycol %	0		0		0						
Soot %	1.17		1.12		0.63					0.00	2.10
ZDDP(Abs)	13		13		13						5.10
	Other Test		Other Test		Other Test		A-Low	C-Low	N.O.	C-High	A-High
TAN											
TBN	6.0		5.1		5.3		2.0	2.6	5.2		
Flash Point	>205		>205								

จุฬาลงกรณ์มหาวิทยาลัย

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รูปที่ ๑-18 แสดงใบรายงานผลการทดสอบด้วยกระบวนการเฟอร์โรกราฟฟีของน้ำมันหล่อจาก  
เครื่องยนต์ที่ใช้น้ำมันดีเซลหลังผ่านการทดสอบความทนทาน 200 ชั่วโมง

F CUS		LubeCheck™ - Oil Analysis for Predictive Maintenance		Page 1 of 1	
Customer #	: 18004	Site Name	:	Condition	
Invoice To	: ICE R&D LAB	Location	:	of	
Address	: Faculty of Engineering Chulalongkorn University Bangkok	Unit Number	: KUBOTA ET 115 DIESEL	Oil	Wear
Tel.	: 02.2522889	Test code	: 803 904 911		
Fax.	:	Unit type	: Engine Diesel		
		Unit make	: KUBOTA		
		Unit model	: ET 115		
		Oil grade	: CHANG SAE30 API CC		
Sample	19633	Hours on Oil	Not Available		
Date sampled	27/07/03	Hours on Unit	100		
Cust. Ref #	814977				
<b>Analytical Ferrography</b>					
Rating					
Wear Particles	0 1 2 3 4 5 6 7 8 9 10	Ferrous	Non-Ferrous	Contaminants	Size
Rubbing Wear		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3-5
Sliding Wear		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Cutting Wear		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Rolling Fatigue Wear		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Spheres		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Black Oxides		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Red Oxides		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Corrosion		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Dirt / Dust		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Others		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0 1 2 3 4 5 6 7 8 9 10				
<b>Sample # 19633</b>					
<b>Quantity of Sample Used</b>					
Photo @ 100X Scale 500 microns		Photo @ 400X Scale 100 microns		Photo @ 400X Scale 100 microns	
<p><b>Recommendations</b>          Ferrogram was clean enough to be inconclusive.          Normal rubbing wear detected in ferrogram.</p>					
Office : 9 Fl., Thosapol Land 4 Bldg., 947/39 Bangna-Trad Rd., KM.3, Bangna, Bangkok 10280, Thailand Tel : (662) 361 8606-3 Fax : (062) 361 8567 Email : focus@lxinfo.co.th			Lab : 523 Bangpoo Industrial Estate, Soi 8, Sukhumvit Rd., Prakasa, Muang, Samutprakarn 10280, Thailand Tel (02) 709 2933-36 Fax (02) 709 2937 E-mail : focusbb@lxinfo.co.th		



รูปที่ จ-19 แสดงใบรายงานผลการทดสอบด้วยกระบวนการเฟอร์โรกราฟีของน้ำมันหล่อจากเครื่องยนต์ที่ใช้น้ำมันปาล์มดิบผสมดีเซลหลังจากการทดสอบความทนทาน 200 ชั่วโมง

FOCUS		LubeCheck™ - Oil Analysis for Predictive Maintenance		Page 1 of 1	
Customer # : 18004	Site Name :	Condition :			
Invoice To : ICE R&D LAB	Location :	of :			
Address : Faculty of Engineering Chulalongkorn University Bangkok	Unit Number : KUBOTA ET 115 CPO+DIESEL	Oil :		Wear :	
Tel. : 02.2522889	Test code : 803 904 911				
Fax. :	Unit type : Engine Diesel				
	Unit make : KUBOTA				
	Unit model : ET 115				
	Oil grade : CHANG SAE30 API CC				
Sample : 19631	Date sampled : 27/07/03	Hours on Oil : Not Available			
Cust. Ref # : 814976	Hours on Unit : 100				
Analytical Ferrography					
	Rating				
Wear Particles	0 1 2 3 4 5 6 7 8 9 10	Ferrous	Non-Ferrous	Contaminants	Size
Rubbing Wear		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3-5
Sliding Wear		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Cutting Wear		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Rolling Fatigue Wear		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Spheres		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	15
Black Oxides		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Red Oxides		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Corrosion		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	20
Dirt / Dust		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Others		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0 1 2 3 4 5 6 7 8 9 10				
Sample # 19631 Quantity of Sample Used					
	Normal rubbing wear		Corrosion particle		Fatigue sphere
Photo @ 100X Scale 100 microns		Photo @ 400X Scale 100 microns		Photo @ 400X Scale 100 microns	
<p><b>Recommendations</b>                      Ferrogram was clean enough to be inconclusive.                      Concentration of normal rubbing wear present in ferrogram, is not normally found in this high amount (see large dark areas in low magnification photos).</p>					
Office : 9 Fl., Thosapol Land 4 Bldg. 947/39 Bangna-Trad Rd., KM.3, Bangna, Bangkok 10280, Thailand Tel : (662) 361 8600-3 Fax : (662) 361 8567 Email : focus@foxinfo.co.th			Lab : 523 Bangpoo Industrial Estate, Soi 8, Sukhumvit Rd., Prakasa, Muang, Samutprakan 10280, Thailand. Tel (02) 709 2933-36 Fax (02) 7092937 E-mail : focuslab@foxinfo.co.th		

รูปที่ จ-20 แสดงใบรายงานผลการทดสอบด้วยกระบวนการเฟอร์โรกราฟฟีของน้ำมันหล่อจาก  
เครื่องยนต์ที่ใช้น้ำมันดีเซลหลังผ่านการทดสอบความทนทาน 210 ชั่วโมง

CUS		LubeCheck™ - Oil Analysis for Predictive Maintenance		Page 1 of 1	
Customer #	: 18004	Site Name	:	Condition	
Invoice To	: ICE R&D LAB	Location	:	of	
Address	: Faculty of Engineering Chulalongkorn University Bangkok	Unit Number	: KUBOTA ET 115 DIESEL	Oil	Wear
Tel.	: 02.2522889	Test code	: 803 904 911		
Fax.	:	Unit type	: Engine Diesel		Normal
		Unit make	: KUBOTA		
		Unit model	: ET 115		
		Oil grade	: CHANG SAE30 API CC		
Sample	19730	Hours on Oil	Not Available		
Date sampled	31/07/03	Hours on Unit	110		
Cust. Ref #	814981				
Analytical Ferrography					
Rating					
Wear Particles	0 1 2 3 4 5 6 7 8 9 10	Ferrous	Non-Ferrous	Contaminants	Size
Rubbing Wear		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3-5
Sliding Wear		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Cutting Wear		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Rolling Fatigue Wear		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Spheres		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Black Oxides		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Red Oxides		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Corrosion		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Dirt / Dust		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	10-100
Others		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	0 1 2 3 4 5 6 7 8 9 10				
Sample # 19730					
Quantity of Sample Used					
	Normal rubbing wear		Photo polarized for viewing effect	Dirt particles	
Photo @ 400X Scale 500 microns	Photo @ 400X Scale 100 microns	Photo @ 400X Scale 100 microns			
<b>Recommendations</b> Normal rubbing wear detected in ferrogram. Note the dirt particles detected in ferrogram.					
Office : 9 Fl., Thosapol Land 4 Bldg., 947/99 Bangna-Trad Rd., KM.3, Bangna, Bangkok 10260, Thailand Tel : (662) 361 8600-3 Fax : (662) 361 8567 Email : focus@loxinfo.co.th			Lab : 523 Bangpoo Industrial Estate, Soi 8, Sukhewit Rd., Prakasa, Muang, Samutprakarn 10230, Thailand Tel (02) 709 2933-36 Fax (02) 709 2937 E-mail : focuslab@loxinfo.co.th		



รูปที่ จ-21 แสดงใบรายงานผลการทดสอบด้วยกระบวนการเฟอร์โรกราฟีของน้ำมันหล่อจาก เครื่องยนต์ที่ใช้น้ำมันปาล์มดิบผสมดีเซลหลังผ่านการทดสอบความทนทาน 210 ชั่วโมง

<b>FOCUS</b>		<b>LubeCheck™ - Oil Analysis for Predictive Maintenance</b>		Page 1 of 1
<b>Customer #</b> : 18004	<b>Site Name</b> :	<b>Condition</b>		
<b>Invoice To</b> : ICER&D LAB	<b>Location</b> :	<b>of</b>		
<b>Address</b> : Faculty of Engineering Chulalongkorn University Bangkok	<b>Unit Number</b> : KUBOTA ET 115 CRO+DIESEL	<b>Oil</b>	<b>Wear</b>	
<b>Tel.</b> : 02.2522889	<b>Test code</b> : 803 904 911			
<b>Fax.</b> :	<b>Unit type</b> : Engine Diesel			
	<b>Unit make</b> : KUBOTA			
	<b>Unit model</b> : ET 115			
	<b>Oil grade</b> : CHANG SAE30 API CC			
<b>Sample</b> : 19729	<b>Date sampled</b> : 31/07/03	<b>Hours on Oil</b> : Not Available		
<b>Cust. Ref #</b> : 814980	<b>Hours on Unit</b> : 110			
<b>Analytical Ferrography</b>				
Rating				
0 1 2 3 4 5 6 7 8 9 10	Ferrous	Non-Ferrous	Contaminants	Size
<b>Wear Particles</b>				
<b>Rubbing Wear</b>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3-5
<b>Sliding Wear</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Cutting Wear</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Rolling Fatigue Wear</b>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	20-70
<b>Spheres</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Black Oxides</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Red Oxides</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Corrosion</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Dirt / Dust</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Others</b>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	10-40
0 1 2 3 4 5 6 7 8 9 10				
<b>Sample # 19729</b>				
<b>Quantity of Sample Used</b>				
Photo @ 100X Scale 500 microns	Photo @ 400X Scale 100 microns	Photo @ 400X Scale 100 microns		
<b>Recommendations</b>				
Concentration of normal rubbing wear present in ferrogram, is not normally found in this high amount (see large dark areas in low magnification photos).				
Non-ferrous fatigue particles with heat tempering colors are found in a moderate amount.				
Office : 9 Fl., Thosapoi Land 4 Bldg., 947/29 Bangna-Trad Rd., KM.3, Bangna. Bangkok 10260, Thailand Tel : (662) 361 8600-3 Fax : (662) 361 8567 Email : focus@loxinfo.co.th		Lab : 523 Bangpoo Industrial Estate, Soi 8, Sukhumvit Rd., Prakasa, Muang. Samutprakarn 10280, Thailand. Tel (02) 709 2933-36 Fax (02) 7092937 E-mail : focuslab@loxinfo.co.th		

## ประวัติผู้เขียนวิทยานิพนธ์

นายพิชญ์ ปริญาจารย์ เกิดเมื่อวันที่ 12 เดือน มิถุนายน พุทธศักราช 2522 ที่ เขตพระโขนง จังหวัดกรุงเทพมหานคร สำเร็จการศึกษาปริญญาวิศวกรรมศาสตรบัณฑิต ภาควิชาวิศวกรรมเครื่องกล คณะวิศวกรรมศาสตร์ มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรีเมื่อปีการศึกษา 2544 เข้าศึกษาต่อในหลักสูตรวิศวกรรมศาสตรมหาบัณฑิต ภาควิชาวิศวกรรมเครื่องกล คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัยเมื่อปีการศึกษา 2544



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย