Unofficial Translation

G/TBT/Notif.97.767

THAI INDUSTRIAL STANDARD

TIS 1040-2541

TWO-STROKE GASOLINE ENGINE LUBRICATING OIL

น้ำมันเครื่องสำหรับเครื่องยนต์เบนซินสองจังหวะ

THAI INDUSTRIAL STANDARDS INSTITUTE
MINISTRY OF INDUSTRY ICS 75.100 ISBN 974-

THAI INDUSTRIAL STANDARD

FOR

TWO-STROKE GASOLINE ENGINE LUBRICATING OIL

IN THE EVENT OF ANY DOUBT OR MISUNDERSTANDING ARISING FROM THIS TRANSLATION, THE STANDARD IN THAI WILL BE HELD TO BE AUTHORITATIVE

THAI INDUSTRIAL STANDARDS INSTITUTE
MINISTRY OF INDUSTRY
RAMA VI STREET, BANGKOK 10400

TEL 2023300

The Minister of Industry determined, under The provision of the Industrial product Standards Act, B.E.2511(1968), Standard for two-stroke gasoline engine lubricating oil, TIS 1040-2541(1998) on 20 May B.E.2541(1998) by the Notification of the Ministry of Industry No 2369 B.E.2541(1998).

The determination of this standard was published in the Government Gazette Voume 115, Part 48 ngor on 16 June B.E.2541(1998)

This standard supersedes TIS 1040-2534(1991)

Technical Committee 593

standard for Two-stroke Gasoline Engince Lubricating Oil

Committee Members

Representatives of

Department of Science Service

Quartermaster Division, The Royal Thai Police Department

The Office of the Consumer Protection Board

The Petroleum Authority of Thailand

Thai Standards Association

Thai Honda Manufacturing Co., Ltd.

Thai Kawasaki Motors Co., Ltd.

The Shell Company of Thailand Limited

Esso (Thailand) Public Company Limited

Caltex Oil (Thailand) Co., Ltd.

Castrol (Thailand) Co., Ltd.

Siam Yamaha Co., Ltd.

Committee Member and Secretary

Representative of

Thai Industrial Standards Institute

Thai Industrial Standard
for
Two-stroke Gasoline Engined Lubricating Oil

1. Scope

1.1 This standard covers only Two-stroke-cycle gasoline engine oil for use in road vehicles, and hereinafter referred to as “engine oil”

2. Definitions

For the purpose of this standard, the following definitions apply :

2.1 Scuffing : wear which is caused by gradual loss of material from discontinous jointing points on the surface that are rubbed and fallen apart.

2.2 Exhaust part blocking : restriction of exhaust passage blocking caused by deposits of oil and/or carbon forming by accumulative burning so that the exhaust port is blocked.

2.3 Carbon : carbon that is firmly struck and non-polish.

2.4 Varnish : a deposit, hard dry, lustrous, insoluble in oil, generally use in evaluating oil from gasoline engine rating.

2.5 base oil : oil obtained from crude oil refinery or used oil re-refining. Afterwards, the process of unwanted materials removal such as sticky residue, bad odour, corrosion materials and etc shall be applied.

2.6 Synthetic base oil : oil obtained from synthesis.

2.7 Additive : chemical added to base oil and/or synthetic base oil in an appropriate proportion to obtain engine oil of the required properties.

3. Composition and manufacture

3.1 Engine oil shall be made of base oil or synthetic base oil or mixture thereof with or wihtout additive.

4. Requirements

4.1 Physical and chemical requirements
Physical and chemical properties shall be as given in Table 1.

4.2 Performance requirements
Performance requirements shall be as given in Table 2.

Table 1 Physical and chemical requirements

(clause 4.1)

Item	Characteristic	Requirement	Test method[1)] to be in accordance with
1	Kinematic viscosity at 100 °C mm^2/sec (Centistokes)	5.6 to 16.3	ISO 3104
2	Viscosity index, not less than	95	ISO 2909
3	Flash point, °C not less than	70	ISO 2719
4	Pour point, °C not more than	-5	ISO 3016
5	Sulphate ash, % by weight, not more than	0.5	ISO 3987
6	Metal *% by weight, not less than	x	ASTM D 4628 and ASTM D 4927 or ASTM D 4951

Note [1)] Other equivalent test method may be applied. However, in the case of controversy, the test as specified in this standard shall be used.

* Only base metal is specified by the manufacturer.

X As specified by the manufacturer and shall be reported to TISI and requesting buyer.

Table 2 Performance requirements

(clause 4.2)

Item	Characteristic	Requirement	Test method to be in accordance with
1	Engine cleanliness		clause 8.1
	Total merit rating of piston, min	48	
	Top ring sticking, min	8	
	Bottom ring, sticking, min	10	
	piston cleanliness	30	
	Exhaust port blocking	no soot to be found	
2	Piston seizure and ring scuffing at fuel-oil ratio of 200 : 1	no piston seizure	clause 8.2
3	Smoke index, min	85	clause 8.3

5. Packaging

5.1 Engine oil shall be packed in dry, clean containers which shall not react with the oil, be leak proof and provided with cover.

5.2 The manufacturer shall ensure that each container is sealed by an appropriate method in such a manner that if the seal is broken or damaged before the product is delivered, the product may be considered unfit for use.

5.3 Packing size not exceeding 5 dm^3 in volume shall be packed in the same package.

5.4 Unless otherwise specified, the net volume of engine oil in each container is 0.5 dm^3, 0.7 dm^3 or 1 dm^3 and shall not be less than as specified on the label.
Compliance is checked by the test specified in clause 8.4.

6. Marking and labelling

6.1 On each container unit of engine oil shall at least bear number, letter or mark indicating legibly and clearly the following information :

(1) The words “two-stroke gasoline engine lubricating oil”

(2) Trade name

(3) Net volume in dm^3 (1)

(4) Month and year of manufacture or lot identification

(5) Name of manufacturer or factory or registered trade mark

6.2 On each package of engine oil shall at least bear number, letter or mark indicating legibly and clearly the following information :

(1) The words “two-stroke gasoline engine lubricating oil”

(2) Trade name

(3) Net volume in dm^3 (1)

(4) Number of containers

(5) Month and year or manufacture or lot identification

(6) Name of manufacturer or factory or registered trade mark

6.3 In case foreign language is used, the meaning shall correspond to that in Thai as specified above.

7. Sampling and criteria for conformity

7.1 Definitions

7.1.1 For small containers (packing size not exceeding 210 dm^3)
Lot : Engine oil of the same composition, carrying the same trade name and brand or trade mark, which is manufactured at one time or delivered or purchased at the same period of time.

7.1.2 For large containers (packing size exceeding 210 dm^3)
Lot : Engine oil in that single container.

7.2 Sampling and acceptance shall conform to the sampling plan given below or its technical equivalent.

7.2.1 Sampling and acceptance for test on packing, and marking and labelling (for small containers only)

7.2.1.1 Four samples shall be drawn at random from the same lot. Where lot contains less than 4 samples, all shall be tested.

7.2.1.2 Provided all samples meet the requirements of clauses 5 and 6, the lot shall be considered as conforming to this standard.

7.2.2 Sampling and acceptance for tests on product requirements

7.2.2.1 Take samples in accordance with TIS 1380 and carry out the test on viscosity, viscosity index and flash point. Failure to comply with any item shall constitute failure of the lot of meet the requirement, and no further tests are required. If all the samples comply with the items, the performance test on smoke index shall be carried out. Failure on this test shall constitute failure of the lot of meet the requirement, and no further tests are required.

7.2.2.2 Provided all the requirements of clause 4 are met, the lot shall be deemed to comply with the requirements.

7.3 Criteria for conformity
Provided the samples meet all the requirements of clauses 7.2.1.2 and 7.2.2.2, as applicable, the lot shall be considered as considered as conforming to this standard.

8. Testing

8.1 Engine cleanliness

8.1.1 Equipment

8.1.1.1 The test engine shall be a Kawasaki engine, model KH 125 M, with particulars on major parts as given below. Other specification including engine adjustment shall follow the manufacturer’s standard or the equivalent.

(1) Carburetor, part No.15001-1052

(2) Cylinder body, part No.11005-1355

(3) Piston, part No.13001-1001

(4) Ring, part No.13008-5060

(5) Plug gasket, part No.9207-053 or equivalent

(6) Exhaust pipe
Note Where other engine is used, particulars of the major parts shall be reported and shall be approved as equivalent by TISI.

8.1.1.2 Dynamometer with recording equipment

8.1.1.3 Heat ventilation system. The ventilation fan which give constant wind speed and volume shall be used to control the temperature of test engine according to Table 3. The air profile area shall have suitable size to ventilate the heat for both engine system and exhaust system.

8.1.2 Fuel
The premium unleaded gasoline according to the Ministerial Regulation of the Ministry of Commerce shall be used, and shall be the same lot that is used in the calibration reference oil test.

8.1.3 Calibration reference oil
Calibration reference oil with the typical properties in accordance with Appendix A shall be used. The oil shall be acceptable between the parties and shall be the oil for calibration reference to be used in sample oil testing to determine whether the engine is in normal condition.
Note Where other calibration reference oil is used, specific requirements shall be reported and shall be approved as equivalent by TISI

8.1.4 Testing engine
The calibration engine together with devices shall be installed according to clause 8.1.1. Then the calibration engine shall be tested in accordance with classed 8.1.5 and 8.1.6. This test shall be performed when new engine is used and every after 15 tests or every 45 operating days whichever comes first. However, major components of the engine in accordance with clause 8.1.1.1 (1) to 8.1.1.1 (6) for each test shall be new.

8.1.5 Procedure

8.1.5.1 Install the test engine of which all major parts are new.

8.1.5.2 Adjust the test engine and heat ventilation system given in Table 3 and operate at full throttle. Record the data as required under Table 5 at every 30 minutes intervals. For carbonmonoxide and hydrocarbon, the data at idle speed, about 1300 $\pm$ 100 rpm, no load after break-in shall be recorded.
In case of irregularities result from the engine, identify the cause, make the necessary improvement and repair and then start the test. (clause 8.1.5.1)

Table 3 Engine test operation

(clause 8.1.1.3 and 8.1.5.2)

Conditions	Engine speed rpm	Period	Fuel-oil ratio by volume	Plug seat Temperature ($^{\circ}$C)	Fuel Flow (dm^3/h)
Break-In	4 000	20 min	40 : 1	150 $\pm$ 5	depend on engine condition
Operating	7 500	5 h	40 :1	200 $\pm$ 5	6.0 to 6.3

Note 1) The engine speed and the fuel flow given in the above able apply to Kawasaki engine of clause 8.1.1.1 only. If other equivalent engine is used, the engine speed and fuel flow shall be as recommended by the manufacturer and have TISI approval.

2) At break-in and operating conditions, the accelerator shall be at the highest position (wide open throttle) and the dynamometer shall be adjusted so that the engine speed of 4,000 rpm and 7,500 rpm are obtained.

Table 4 Recorded data during operating of test engine

(clause 8.1.1.2, 8.1.5.2, 8.1.7, 8.2.6 and 8.2.9)

Item	Description	Unit	Measurement equipment
1	Engine speed	rpm	
2	Engine power	kw	dynamoneter*
3	Plug seat temperature	C	thermocouple
4	Fuel flow	dm^3/h	flow meter
5	Oil folw	dm^3/h	flow meter

6	Ratio of fuel : oil	-	Calculate from item 4 and 5
7	Room temperature	C	Thermometer
8	Atmospheric pressure	Pa (mmHg)	Barometer
9	Relative humidity of test room	%	Hydrometer
10	Carbonmonoxide	%	non-dispersive
11	Hydrocarbon	%	infrared analyser

Note * the value measured from dynamometer is used for calculation.

8.1.6 Evaluation

8.1.6.1 Evaluation of engine cleanliness

Cleanliness of piston and associated parts shall be performed within 24 h from the end of the test.

In case the condition cannot be met, the piston shall be kept in free of humidity container, using the demerit rating and subtracting from the full cleanliness score of 10.

(1) Method of evaluation

The inspecting panel shall comprise of at least 3 experts. Each expert independently evaluates according to Table 5 and assign scores after comparison with IP 247 sheet in accordance with Tables 6 and 7.

(2) the total score

(2.1) An area or circumference for calculation can be determined by either of the 2 methods : from the drawing or from directly measurement of that part.

(2.2) An example of calculating demerit rating is shown in Table 8.

Total demerit rating = 0.50 + 0.75 + 0.75 + 0.50 + 0.50 = 3.00

Merit rating = 10 - 3.00 = 7

Table 5 Evaluation of engine cleanliness

(clause 8.1.6.1 (1))

Item	Description	Method
1	Ring sticking	Conform to Table 6
2	Expander ring sticking	Conform to Table 6
3	Deposit on ring groove	Table 7 (1) × (2)
4	Deposit on land	Table 7 (1) × (2)
5	Deposit on piston skirt	Table 7 (1) × (2)
6	Exhaust port blocking	Table 7 (3)

Table 6 Demerit rating for ring sticking[1] evaluating from the circumference

(clause 8.1.6.1 (1) and Table 5)

Item	Ring condition	Demerit rating
1	Free in groove(2)	0
2	Sluggish	0.5
3	Pinched[3]	
	not more than 75°	1
	from 75° to 150°	2
	from 150° to 225°	3
	from 225° to 300°	4
	from 300° to 360°	5
4	Stuck	
	not more than 75°	6
	from 75° to 150°	7
	from 150° to 225°	8
	from 225° to 300°	9
	from 300° to 360°	10

Note [1] Demerit rating for expander ring sticking shall be the same as for ring sticking, except that, in the case where the removal of an expander ring out of ring groove causes a deflection in the expander ring, the deflected angle corresponding to the deflection is regarded as the angle of sticking. AN expander ring can normally be removed without causing deflection.

[2] Ring can be removed easily with light pressure by finger.

[3] Ring cannot be removed by finger. However, normal operation of rings is evident with the contacting mark of an entire circumference on the sliding surface.

Table 7 Demerit rating for deposit evaluated from the area

(clause 8.1.6.1 (1) and Table 5)

Item	Description	Co-factor
1	Deposit area when divided into 100 parts	0.1
2	Lacquer color	
	Clean	0
	Slight tarnish	0.1
	Light brown or light grey	0.25
	Brown, greyish brown or grey	0.50
	Dark brown or dark grey	0.75
	Black	1.0
3	Exhaust port blocking	Calculate ratio of cross-sectional area before and after testing

Note Thick brown lacquer or grey lacquer concealing the surface of a piston is classified as black lacquer.

Table 8 Example of demerit rating based on lacquer color

(clause 8.1.6.1(2.2))

Deposit area part	Co-factor from lacquer colour	calculation
5	1.0	$5 \times 0.1 \times 1.0 = 0.50$
10	0.75	$10 \times 0.1 \times 0.75 = 0.75$
15	0.50	$15 \times 0.1 \times 0.50 = 0.75$
20	0.25	$20 \times 0.1 \times 0.25 = 0.50$
50	0.10	$50 \times 0.1 \times 0.10 = 0.50$

8.1.6.2 The evaluation of engine cleanliness shall be made according to Table 9. Afterwards, the photographs of piston and cylinder body that have been tested shall be taken. The photographs size shall be 10 cm × 15 cm according to Appendix B. Details are as follows:

(1) The front side which is subjected to side thrust and the rear side or anti-side thrust. The pictures shall be taken so that the ring groove can be clearly seen.

(2) Exhaust port of cylinder body. The pictures shall be taken so that the exhaust port at the inner side of cylinder can be clearly seen.

(3) Number of test code, test results and testing date and time shall be identified on each photograph.

Table 9 Cleanliness evaluation

(clause 8.1.6.2)

Description		Cleanliness test
Ring sticking	top	0
	bottom	0
Expander ring sticking	top	Δ
	bottom	Δ
Deposit on ring groove	top	0
	bottom	0
Deposit on land	top	0
	bottom	0
Deposit on piston skirt		0
Total rating		Sum of ratings with mark 0
Exhaust port blocking		Δ

Note Item with mark (Δ) are not used in the evaluation. They are for reporting only.

8.1.7 Report

The report shall include scores given by a rater, and the average score shall be considered as the final result. Data on recorded test conditions shall be in accordance with Table 4 with the maximum, minimum and average value recorded during testing and photograph testing shall also be reported.

8.2 Scuffing of piston and ring

8.2.1 Apparatus

The apparatus shall be the same as that specified in clause 8.1.1. Clearance between cylinder and piston shall be 0.030 to 0.035 mm at 20 °C

8.2.2 Oil supply system

A mixed fuel-oil system with the mixing ratio as given in Figure 1. The fuel and oil shall be mixed until it is homogeneous and immediately put into use.

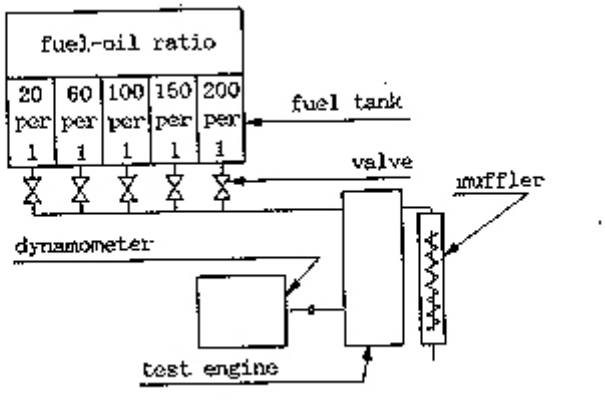


Figure 1 Oil supply system

(clause 8.2.2)

8.2.3 Fuel

Fuel shall be in accordance with clause 8.1.2

8.2.4 Calibration reference oil
Calibration reference oil as in clause 8.1.3 shall be used to determine whether the engine is in normal operation.

8.2.5 Testing engine
Testing engine shall be in accordance with clause 8.1.4

8.2.6 Procedure
Operate the engine in accordance with Table 10 at full throttle, starting from break-in condition, engine speed 4,000 rpm for 20 min, fuel-oil ratio 20 : 1, then change the speed to 8,500 rpm for 10 min. After that change fuel-oil ratio to 60 : 1 and engine speed to 8,000 rpm for 10 min. The operation shall be repeated by changing fuel-oil ratio until 200 : 1 is reached. When interruption of the piston or scuffing of the ring occurs, the fuel-oil ratio and time speed shall be checked. Interruption of piston is observed by the engine stop and scuffing of the ring by remarkable drop and then recovery of the power as indicated by the dynamometer. (Switching over the ratio causes changes in the engine power but the recovery is faster than in the case of ring scuffing). Then, the ratio of fuel-oil shall be recorded.
During the test, record shall be made as required in Table 4, from the beginning until the end of test at interval of the fuel-oil ratio changing. For carbonmonoxide and hydrocarbon, data for idle condition after bread-in shall be recorded.
In case of irregularities result from the engin, identify the cause, make the necessary improvement and repair and then start the test.

Table 10 Engine test operation

(clause 8.2.6)

Item	Description	Break-in condition[1)]			Operating condition[2)]		
1	Fuel-oil ration	20 : 1	20 : 1	60 : 1	100 : 1	150 : 1	200 : 1
2	Engine speed, rpm	4,000	8,500	8,500	8,000	8,000	8,000
3	Testing period, [3)]min	20	10	10	10	10	10
4	Plug seat temperature, °C	-	200-210	200-210	-	-	-

Note 1) Ensure that the test engine is in the specified condition and adjust the cooling fan so that the plug seat temperature is between 200-210 °C.
2) Adjust the cooling fan so that the plug seat temperature is constant and in the specified condition, after which no further adjustment shall be made.
3) At the end of each test period, the fuel-oil ratio shall be changed as given in the above table.
4) Time reckoning for each test interval shall be made when fuel-oil ratio reach the value specified in Table 10.

8.2.7 Evaluation
The evaluation of scuffing at piston and ring shall be made by observing pistion sticking, and the phatograph, 10 cm × 15 cm in size, at side thrust and anti-side thrust shall be taken. On each photograph, the number of test, code, test results and testing time shall be identified.

8.2.8 Criteria for conformity
In case where the test fails to satisfy the requirement, retest shall be conducted using new sample and new major engine parts. The result of this retest shall be the referee.

8.2.9 Report
The results of “Past” or “Fail” of the samples shall be reported together with data on test condition according to Table 4 and photographs.

8.3 Smoke index
The purpose of this clause is to measure smoke created from sample oil and compare to reference oil when used with specified engine and under the specified conditions.

8.3.1 Equipment

8.3.1.1 The test engine shall be Suzuki generator SX-800R with details as follows:

(1) Type of engine	Two-stroke gasoline engine
(2) Number of cylinder and cooling system	Single cylinder forced air-cooled
(3) Bore x stroke	46.0 × 42.0 mm
(4) Displacement	69 CC

(5) Compression ratio 5.6

8.3.1.2 Details of engine modification

(1) Remove fuel tank from the engine main body and replace the fuel pressure adjuster. Details of suitable fuel pressure adjuster are as in Figure 2.

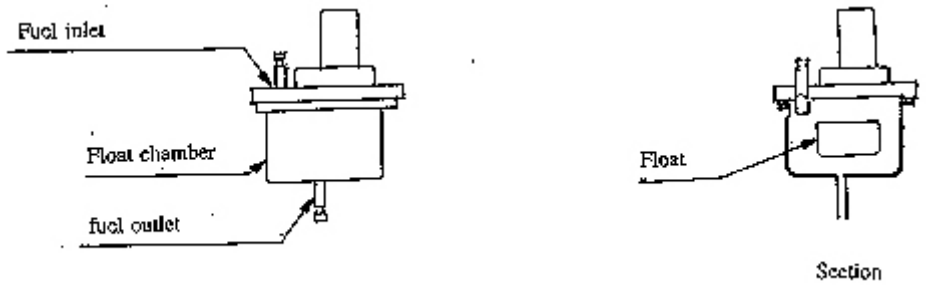


Figure 2 Fuel pressure adjuster

(clause 8.3.1.2 (1))

(2) The muffler shall be modified as follows:

(2.1) Remove the heat insulator plate from the muffler. See Figure 3.

(2.2) Chip off exhaust pipe and tail pipe at the weldings. Drill 6 holes at the spot welding that weld cover to the internal plate on one side only according to Figure 4.

(2.3) Cut the fold around the muffler and clip off welding between the rest of exhaust pipe and muffler half round as shown in Figure 5. The muffler shall then be separated into 2 parts and glass wool shall be fully pulled out. The muffler shall then be the same as shown in Figure 6. Finally, the separated muffler shall be reassembled by reversing the direction of the exhaust pipe as shown in Figure 8. The muffler shall then be repaired to be in the perfect condition without glass wool and heat insulator plate.

(2.4) Connect the submuffler, see Figure 7, to the rear end of the muffler using flange joint as shown in Figure 8 to ease the inspection and cleaning.

(3) Prepare glass wool insulator, approximately 300 mm $\times$ 500 mm $\times$ 20 mm in size, and wrap around main and submuffler as shown in Figure 9 to remove oil remaining before est according in clause 8.3.8.1

(4) Remove the control panel of the generator and connect and extension code with the generator.

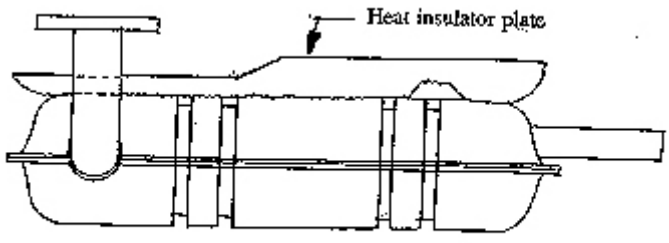


Figure 3 Heat insulator plate

(clause 8.3.1.2 (2.1))

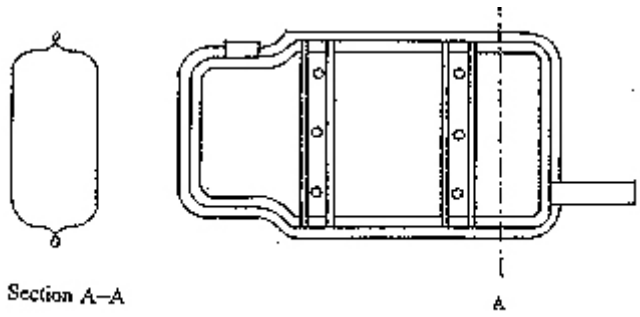


Figure 4 Bore holes at 6 welded point on muffler
(clause 8.3.1.2 (2.2))

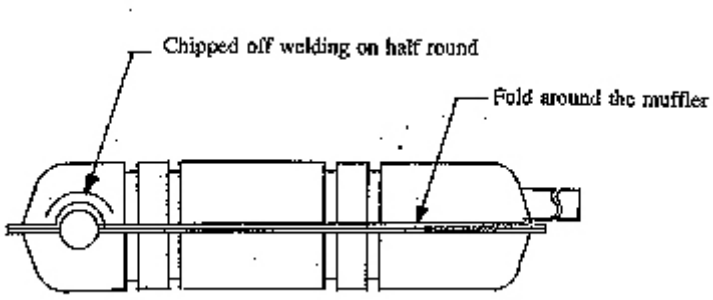


Figure 5 Clip off welding between the rest of exhaust pipe and muffler
(clause 8.3.1.2 (2.3))

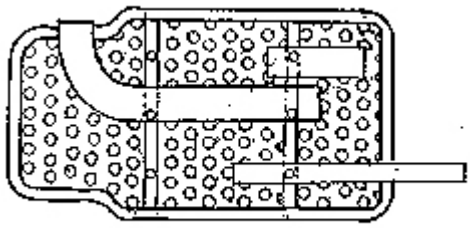


Figure 6 Removal of glass wool
(clause 8.3.1.2 (2.3))

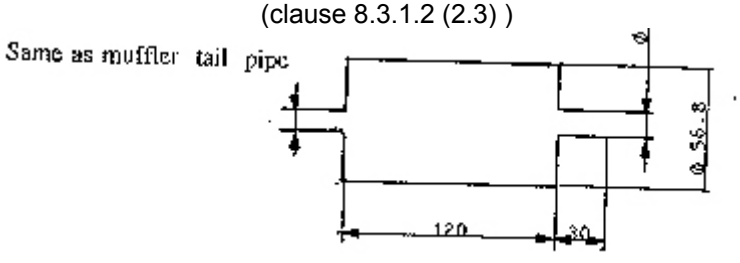


Figure 7 Structure of submuffler
(clause 8.3.1.2 (2.4))

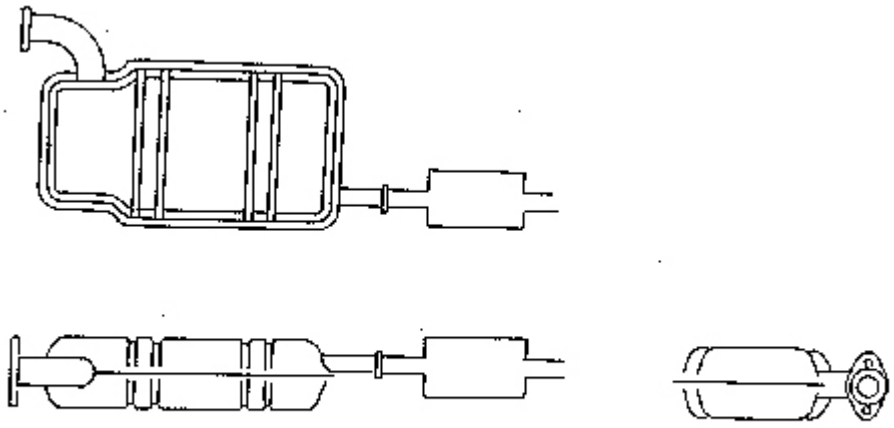


Figure 8 After resetting of exhaust pipe

(clause 8.3.1.2 (2.3) and clause 8.3.1.2 (2.4))

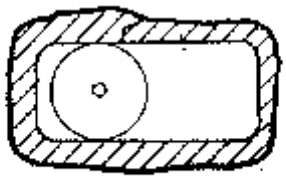


Figure 9 Heat insulation for the muffler

(clause 8.3.1.2 (3))

8.3.1.3 Electrical load absorber consists of lamps connected in circuit as shown in Figure 10. Electrical load absorber in practical use shall be as required by the test. However, heaters may be used in place of lamps.

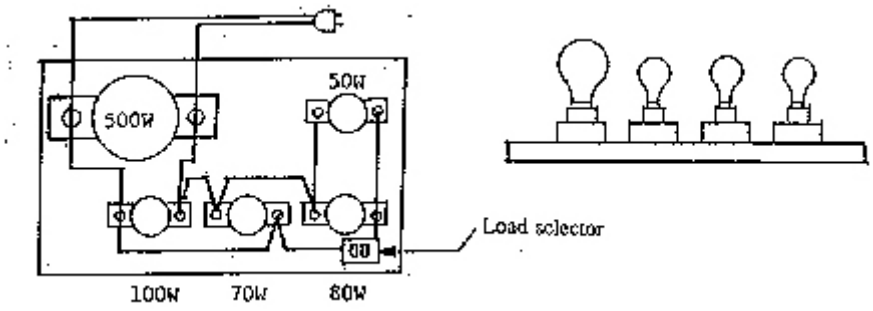


Figure 10 An example of electrical load absorber

(clause 8.3.1.3)

8.3.1.4 Measurement equipment to be used shall cover measuring items as shown in Table 16 and shall be as follows:

(1) Smoke meter
A light absorbing type smoke detector should be used. Output signals from the smoke detector shall be smoothed through 1,000 MF electrolytic capacitors connected in parallel and then transmitted to recorder.

(2) Thermometer with accuracy within $\pm 1^{\circ}C$ to be connected to the measurement recorder.

(3) Recorder which is capable of graphic recording.

(4) Tachometer with accuracy within ± 10 rpm to be connected to recorder

(5) Fuel flow meter which is capable of measuring fuel flow rate in the range of 0 to 1 L/h

(6) Psychrometer which is the wet and dry bulb thermometer type for the measurement of relative humidity shall be within $\pm 1^{\circ}C$ in accuracy.

(7) Barometer which is capable of measuring pressure within ± 0.1 kPa.

(8) Ammeter with accuracy within ± 0.01 A to be connected to measurement recorder.

8.3.1.5 External cooling equipment which is capable of cooling the generator main body and muffler shall be is shown in Figure 11.

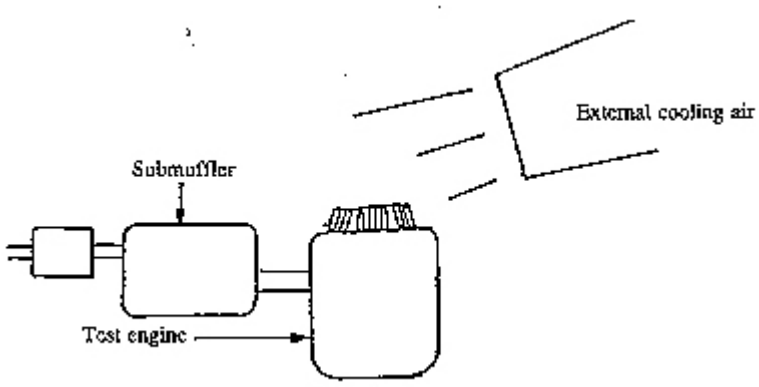


Figure 11 External cooling equipment (Top view)

(clause 8.3.1.5)

8.3.1.6 Location for measuring temparature

(1) To measure the plug seat temperature, set the thermocouple on the downstream side of cooling air at plug seat position as shown in Figure 12.

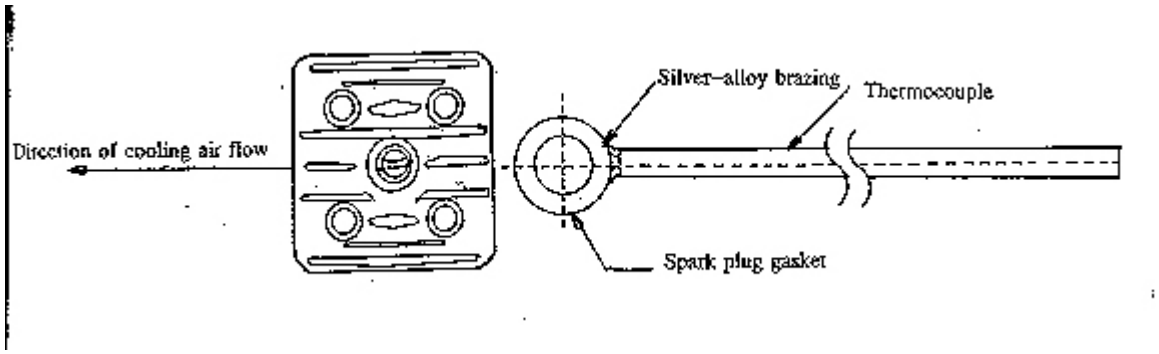


Figure 12 Thermocouple installation position and example of thermocouple for spark plug gasket.

(clause 8.3.1.6 (1))

(2) To meaure exhaust gas temperature, insert the end of the thermocouple into the submuffler as shown in Figure 13.

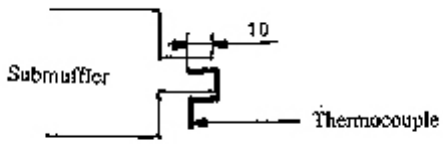


Figure 13 Exhaust gas temparature sensor installation position

(clause 8.3.1.6 (2))

8.3.2 Fuel supply system, shown in Figure 14, shall supply the fuel by gravity system.

8.3.2.1 Fuel pipe construction which minimizes the head pressure loss of the fuel should preferably be adopted. It shall be such that no bubble stays in the piping.

8.3.2.2 The fuel tank shall have a capacity of approximately 1 L.

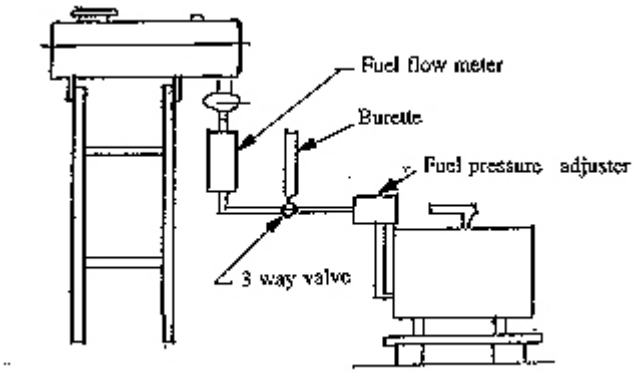


Figure 14 Fuel supply system

(clause 8.3.2)

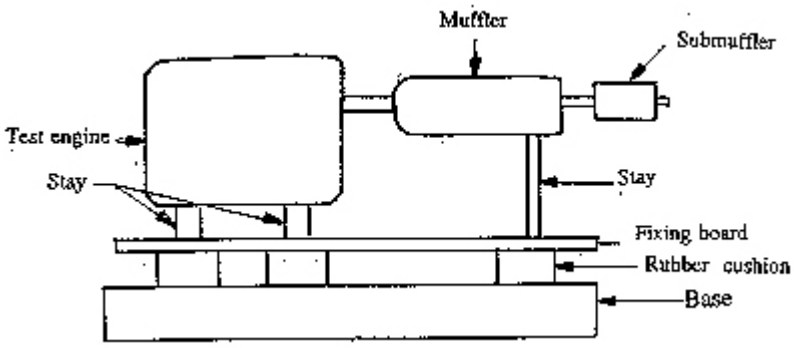
8.3.3 Test site

The test site shall be free of wind except for ventilation and without effect to testing is desired.

8.3.4 Installation of test engine and measurement equipments

8.3.4.1 Test engine

Prepare an engine bed as shown in Figure 15



Note Fasten the engine body and submuffler to the base plate with stays and fasten the base plate to the fixing board through rubber cushion

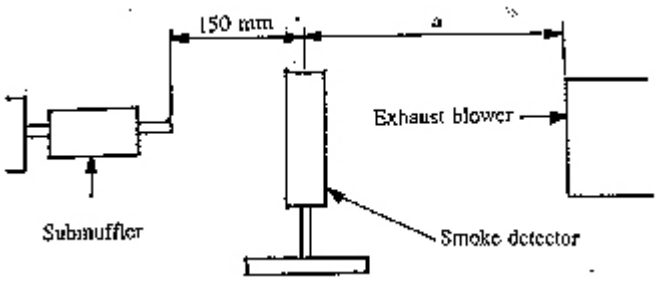
Figure 15 Engine bed preparation

(clause 8.3.4.1)

8.3.4.2 Location for smoke measurement

Installed smoke meter in accordance with Table 16. Distance between center light of smoke meter and end of submuffler shall be 150 mm.

Light center line shall be perpendicular to smoke axis.



a: apart enough not to disturb smoke

Figure 16 Location of smoke meter and submuffler

8.3.5 Fuel

The regular unleaded gasoline according to the Ministry of Commerce Act which has octane number between 92 to 94 when checked by the tests specified in TIS1182 part 14 shall be used. (In case the standard has not been promulgated, method specified in ASTM D 2699 shall apply). The same lot of fuel shall be used for the same series of test so that the candidate oil and reference oil can be relatively compared.

8.3.6 The standard reference oil for smoke test and engine test

8.3.6.1 Engine test

The test engine shall be run using calibration oil when it is used for the first time or has not been used for a long time, or mufflers are renewed.

8.3.6.2 Types and characteristic properties of the standard reference oil for smoke test and the calibration oil

Types of the standard reference oil for smoke test (JATRE-1) and the calibration reference oil (JATRE-3) are shown in Table 11, and the typical properties are shown in Table 12.

Table 11 Type of standard reference oil for smoke test and Calibration reference oil

(clause 8.3.6.2)

Type	Description
JATRE-1	Standard reference oil for smoke test
JATRE-3	Calibration reference oil

Table 12 Typical properties of standard reference oil for smoke test and calibration reference oil

(clause 8.3.6.2)

Item	Description	Requirement		Test method
		JATRE-1	JATRE-3	
1	Kinematic viscosity, mm2/sec			ISO 3104
	at 40°C	58.14	60.90	
	at 100°C	8.580	8.548	
2	Viscosity index	121	121	ISO 2909
3	Total acid number, mg KOH/g	0.17	0.15	ISO 6619
4	Total base number, mg KOH/g	1.45	1.58	ISO 3771
5	Sulfate ash, mass%	0.12	0.12	ISO 3987
6	Carbon residue, mass%	0.35	0.19	ISO 6615

Note Other test methods which are specified by reference oil manufacturer for smoke test and calibration reference oil may be used.

8.3.7 Preparation for test

8.3.7.1 Preparation of engine

(1) Break in

Break in is a part of test engine preparation to be used for new engine or which is rebuilt with new parts (piston, cylinder, ring, etc.) according to Table 13.

Table 13 Break in condition

(clause 8.3.7.1 (1))

Description	Requirement
1. fuel-oil ratio	50 :1
2. oil	An oil equivalent to the standard

	reference oil for smoke test
3. Load, W	0 200 400 600 and 800
4. Frequency, Hz	60
5. Duration for each load, h	2

(2) Adjustment of engine speed
The engine speed is adjusted to 3,000±50 rpm at 50 Hz/670 W and 3,600±5 rpm at 60 Hz/750 W by adjusting the engine speed control screw on the frequency control lever.

(3) Confirmation of fuel flow rate
During break in operation and at an interval of once a week confirm the fuel flow rate as follow:
- at 50 Hz no load, 350 ± 20 mL/h
- at 50 Hz 670 W, 630 to 670 mL/h

(4) Adjustment of fuel flow under no load
In case that the load fuel flow under no load is out of the specified value in clause 8.3.7.1 (3) adjustment shall be made as follows; turn the pilot screw to left to increase flow rate, and if turning to left does not increase the flow, replace the pilot jet (standard ≠ 32.5) with that of a larger number (≠35) (refer to the service guide of the test engine for detail) Figure 17 indicates the locations of the pilot screw and pilot jet.

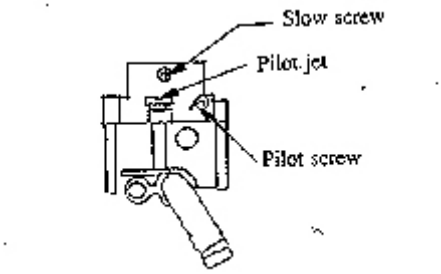


Figure 17 Pilot screw and pilot jet

(clause 8.3.7.1 (4))

(5) Confirmation of engine condition
The smoke density of reference oils shall be within the range shown in Table 14. If it fails to meet the range, the fuel flow rate shall be adjusted using the method indicated in clause 8.3.7.1 (4)

Table 14 Smoke density of standard reference oil for smoke test and calibration reference oil

(clause 8.3.7.1 (5))

standard reference oil for smoke test and calibration reference oil	smoke density %
JATRE - 1	20 ± 3
JATRE - 3	40 ± 3

(6) Replacement of engine parts
Engine parts, listed in Table 15, shall be replaced with new ones in accordance with time period specified in the engine's manufacturer service guide.

Table 15 Replacement parts

(clause 8.3.7.1 (6))

Part name	Part number	Time to replace
Piston	12110-87601	
Piston ring set	12140-87600	
Cylinder	11211-87600	
Gasket, cylinder head	11141-91A00	Each time cylinder head is assembled
Gasket, cylinder	11241-87600	Each time cylinder is assembled
Small end bearing	09263-10010	As required
Pin, piston	12151-87600	

Circlip	09381-10006	
Gasket, exhaust	14140-87600	When exhaust gas leadage occurs
Sperk plug	09482-00316	Once a day at commencement of the test

(7) Removal of carbon deposits in combustion chamber and exhaust port.
Every 75 times of testing according to clause 8.3.8.1 to 8.3.8.4 carbon deposits from the piston head, cylinder head and exhaust ports shall be eliminated by removing the cylinder head, check and clear up the carbon deposits. The piston ring sticking shall also be checked up. In case that piston ring sticking occurred, the piston and piston ring shall be replaced.

(8) Removal of carbon deposits in the muffler
Periodically remove carbon deposits in the muffler (every 50 hours of operation) by following method.
Method 1 Soak the whole of the muffler in carbon cleaner for about 24 hours, then flush the inside with tap water.
Method 2 Burn out the muffler until the muffler gets redhot.

In case that method 2 or both of the above methods are not effective in enabling the engine to recover its output, the muffler shall be replaced.
In case that the engine output does not recover even with the replacement of the muffler, then overhaul the engine or replace it with a new one.

8.3.7.2 Preparation of mixed fuel
Mixed fuels, each about 1 dm^3 at the ratio of 10:1, shall be prepared by using fuel and standard reference oil for smoke test, and fuel and candidate oil.

In case that the separation of the fuel and candidate oil is found after mixing, the test should not be conducted and it should be recorded in the report as a special matter. In this case candidate oil is deemed not to comply with this.

8.3.7.3 Preparation of fuel supply system
Whenever the lot of test fuel is replaced, (see clause 8.3.5), mixed fuel in the fuel tank, fuel piping and carburetor float chamber should be drain off. After the premixed fuel to be tested next has been poured into the fuel tank, then drain off the premixed fuel from the carburetor float chamer by drain screw to eliminate the influence of the premixed fuel used in preceding test.

8.3.8 Procedure

8.3.8.1 To remove unburned oil out of the muffler cover the muffler and submuffler with heat insulator, and switch the frequency selector to 60 Hz, start the engine and run at load of 750 W. Stop the engine when the exhaust gas temparature reaches at 320°C. The engine should be run for about 15 min, then measure the smoke. The value of smoke should be 0.5% or below.

8.3.8.2 Stop the engine and remove the heat insulator and cool the engine with a cooling blower.

(1) Cooling condition
Cooling shall be continued until the plug seat temperature becomes 60±5°C by cooling fan. At this time the exhaust gas temperature generally indicates 50°C or below, but the priority shall be given to the plug seat temperature.

(2) Adjustment and calibration
Adjust the recorder for zero point during the cooling period in clause 8.3.8.2(1). Calibrate the smoke meter with calibration glass each time the test oil is replaced.

8.3.8.3 Switch the frequency selector to 50 Hz, start the engine and run at a load of 0 W for 20 minutes. At this time, record the smoke density as reference data. (see Appendix C)

8.3.8.4 Change the load to 670+10 W, read the peak value of smoke density (see Figure 18) and continue the engine running until the value of smoke density decreases, then stop the engine operation

8.3.8.5 Report the operation from clause 8.3.8.1 to clause 8.3.8.4 for 3 times for each type of oil testing on the same day as follow:

Start the test with standard reference oil for smoke test (JATRE-1) 3 times, followed by 2 to 3 samples of candidate oil in the same way, and ended with standard reference oil for smoke test (JATRE-1)

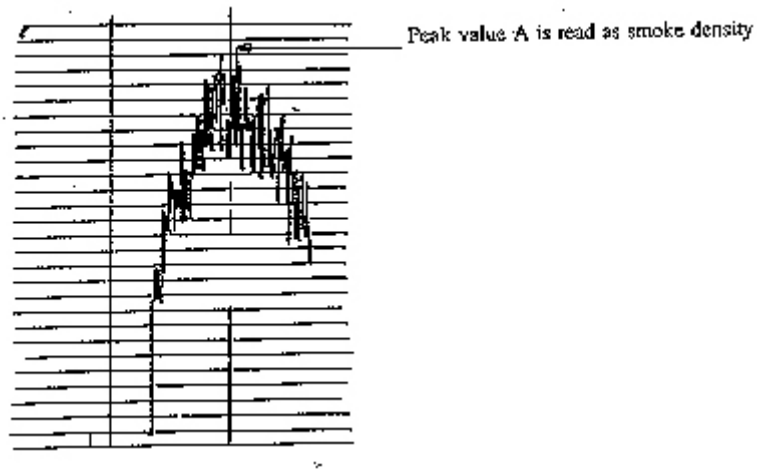


Fig 18 An example peak of smoke density

(clause 8.3.8.4)

8.3.8.6 Measuring items are shown in Table 16

Table 16 Measuring items

(clause 8.3.1.4 and clause 8.3.8.6)

Item	Description		Condition and timing of measurement
1	Engine speed	r/min	At 60 Hz 760 W operation
2	Current	A	At 50 Hz 670 W operation
3	Spark plug gasket temperature	°C	At 50 Hz no load operation (just before changing load)
4	Exhaust gas temperature	°C	At 50 Hz no load operation (just before changing load), and at the time when smoke density is peak in 50 Hz 670 W operation.
5	Smoke density	%	At 50 Hz noload operation (just before changing load), and at the time when smoke density is peak in 50 Hz 670 W operation (50 Hz no load value is for reference)
6	Dry-bulb temperature	°C	Before and after testing (beginning and end of each day's operation)
7	Wet-bulb temperature	°C	
8	Humidity	%	
9	Atmospheric pressure	kPa	

8.3.8.7 Result on average value of smoke of standard reference oil for smoke test from the first measurement and the end on the same day with the difference of not more than 15 percent is deemed to comply with the standard. (see clause C.1 of Appendix C)

8.3.9 Calculation

Calculated smoke index by equation

$$S = (S_R/S_C) \times 100$$

When

S : smoke index

S_R : Average smoke density of the first and the last measurement of a tisting day on the standard reference oil for smoke test.

S_C : Average smoke density of a candidate oil (B or C in Annex C)

8.3.10 Report

The smoke index shall be reported as an integral numbers using round up method.

8.4 Net volume

Weigh the sample with the container. The weight obtained substracted by the weight of empty container shall be the net weight. The net volume shall be calculated from the density of the sample in accordance with TIS 1182 part 3.

APPENDIX A

Calibration reference oil

(clause 8.1.3)

A.1 composition of calibration reference oil

	volume %
Bright stock	12.0
500 Neutral	73.0
Solvent	5.0
Additives	10.0

A.2 Typical properties of calibration reference oil

Table A.1 Typical properties of calibration reference oil
(clause A.1)

Item	Description	Requirement	Test Method
1	Kinematic viscosity, mm^2/sec		ISO 3104
	at 40 °C	95.0 to 97.0	
	at 100 °C	95.1 11.0 to 13.0	
2	Viscosity index	95.2 110	ISO 2909
3	Density g/cm^3	95.3 0.875	TIS 1182 part 3
4	Total acid number, mg KOH/g	95.4 4.5	ISO 3771
5	Sulfate ash mass%	95.5 0.18	ISO 3987
6	Nitrogen mass%	95.6 0.13	ASTM D 3228

A.3 Test result

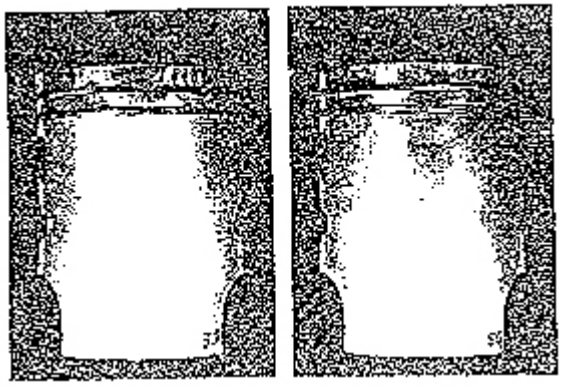
A.3.1 Engine cleanliness
Total merit rating of piston 49.5±2

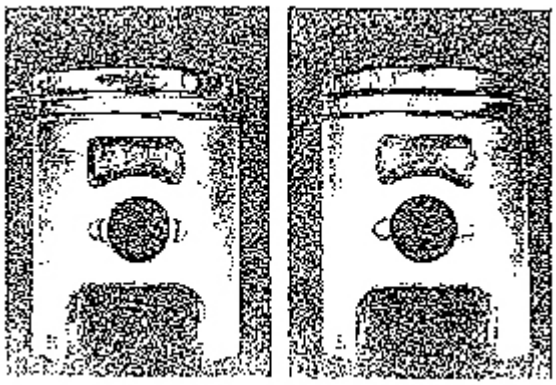
A.3.2 Piston seizure and ring scuffing at fuel-oil ratio 200:1, there shall be no piston seizure
Note Calibration reference oil is available from Castrol (Thailand) Co.,Ltd.

APPENDIX B

Photographs attached for the cleanliness evaluation test result

(clause 8.1.6.2)





APPENDIX C

Form report on smoke test

(clause 8.3.8.3 and clause 8.3.9)

Test date													
Test oil			JATRE-1									JATRE-1	
Test No.		1	2	3	1	2	3	1	2	3	4	5	6
Smoke density %	At 50 Hz no load (reference)												
	At 50 Hz 670 W												
Spark plug gasket temperature °C	At 50 Hz no load												
	At 50 Hz 670 W												
Exhaust gas temperature °C	At 50 Hz no load												
	At 50 Hz 670 W												
Engine speed r/min	At 50 Hz 670 W												
	At 60 Hz 750 W												
Dry-bulb temperature °C													
Wet-bulb temperature °C													
Atmospheric pressure kPa													
Humidity %													
Average smoke density %		A			B			C			D		
Remarks		A			B			C			D		

C.1 Find it the average smoke density of the reference oil is wihtin+15%

$$\frac{A - D}{A} \times 100 = X\ \%$$

X is $\pm$ 15% or more : The test is invalid
X is within $\pm$ 15% : Proceed to C.2 and C.3

C.2 Calculate the average smoke density of the standard reference oil

$$\frac{A + D}{2} = \qquad (1)$$

C.3 Calculate the smoke index of the candidate oil

$$\frac{(I)}{B} \times 10 =$$

$$\frac{(I)}{C} \times 100 =$$