INTERNATIONAL STANDARD

ISO 4106

Third edition
2004-08-01

Motorcycles — Engine test code — Net power

Motocycles — Code d'essai des moteurs — Puissance nette

Reference number
ISO 4106:2004(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 4106 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 22, *Motorcycles*.

This third edition cancels and replaces the second edition (ISO 4106:1993), which has been technically revised.

Introduction

The third edition of ISO 4106 has been prepared in the framework of ISO engine power measurement standards. By applying this framework, the disadvantages of the existence of many similar, but different, ISO standards for the definition and determination of engine power can be avoided.

This framework uses the “Core” and “Satellite” approach. The “Core” standard contains the requirements that are common to all engine applications described in the scope and the “Satellite” standards contain those requirements that are necessary to tailor power measurement and declaration to suit a particular engine application. ISO 4106 is a “Satellite” standard and is only applicable in conjunction with the “Core” standard, in order to completely specify the requirements for the particular engine application — in this case, motorcycle engines. The “Core” standard therefore, is not a document that can stand alone but only represents addenda to the particular “Satellite” standard, used to create a complete standard together with the said “Satellite” standard.

The advantage of this approach is that the use of standards for the same or similar engines used in different applications will be rationalized and the harmonization of standards in the course of revision or development will be ensured.

ISO 15550 is the “Core” standard. It was prepared in order to serve as the “Core” standard for making engine power measurements. It was drafted in close co-operation between ISO/TC 70, *Internal combustion engines*, and ISO/TC 22, *Road vehicles,* ISO/TC 23, *Tractors and machinery for agriculture and forestry*, ISO/TC 127, *Earth-moving machinery* and ISO/TC 188, *Small craft*. The prerequisite for any future modification of ISO 15550 will be the formal approval of all the above technical committees. Together with the “Satellite” standard for each engine application, the “Core” standard serves as the basis for engine power declaration and measurement. Each technical committee is fully responsible for the administration of its own “Satellite” standard(s).

Motorcycles — Engine test code — Net power

1 Scope

This International Standard specifies methods for evaluating the performance of engines designed for motorcycles as defined in ISO 3833, in particular with a view to the presentation of power curves and specific fuel consumption at full load as a function of engine speed, for net power assessment. Used in conjunction with ISO 15550, it is applicable to reciprocating internal combustion engines (spark-ignition or compression-ignition) — excluding free-piston engines — and rotary piston engines, either naturally aspirated or pressure-charged and equipped with either mechanical pressure-charger or turbocharger.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2710-1:2000, *Reciprocating internal combustion engines — Vocabulary — Part 1: Terms for engine design and operation*

ISO 3833, *Road vehicles — Types — Terms and definitions*

ISO 15550:2002, *Internal combustion engines — Determination and method for the measurement of engine power — General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2710-1, ISO 15550 and the following apply.

3.1
net power
power obtained on a test bed at the end of the crankshaft or its equivalent at the corresponding engine speed with the equipment and auxiliaries listed in column 2 and required in column 3 (fitted for engine net power test) of ISO 15500:2002, Table 1

NOTE Adapted from ISO 15550:2002.

3.2
net torque
torque transmitted on a test bed at the end of the crankshaft or its equivalent at the corresponding engine speed with the equipment and auxiliaries listed in column 2 and required in column 3 (fitted for engine net power test) of ISO 15500:2002, Table 1

NOTE Adapted from ISO15550:2002.

3.3
specific fuel consumption
amount of fuel consumed by an engine per unit of power and time

NOTE 1 The amount of lubricants for 2-stoke cycle engines is excluded.

NOTE 2 Adapted from ISO15550:2002.

3.4
auxiliaries
equipment and devices necessary to make the engine acceptable for service in the intended application

4 Symbols

The symbols and their subscripts according to ISO 15550:2002, Tables 2 and 3, apply, except for the following:

T_y temperature of air inducted into the engine[1)].

5 Standard reference conditions

The standard reference conditions shall be according to ISO 15550:2002, Clause 5.

6 Test method

6.1 General

This test method is used for verifying the net power of an engine type with the declared values. It presents engine performance at full power/torque as a function of engine speed by generating curves of power and fuel consumption.

6.2 Measuring equipment and instrument accuracy

6.2.1 Torque

The dynamometer torque-measuring system shall have an accuracy of ± 1 % in the range of scale values required for the test.

The torque-measuring system shall be calibrated to take into account friction losses. The accuracy may be ± 2 % for measurements carried out at a power less than 50 % of maximum power.

6.2.2 Engine speed

The engine-speed measuring system shall have an accuracy according to ISO 15550:2002, 6.3.2.2.

6.2.3 Fuel flow

The fuel-flow measuring system shall have an accuracy according to ISO 15550:2002, 6.3.2.3.

1) In ISO 15550, this symbol is instead used to designate “ambient air thermodynamic temperature during test”.

6.2.4 Fuel temperature

The fuel-temperature measuring system shall have an accuracy according to ISO 15550:2002, 6.3.2.4.

6.2.5 Engine inlet air temperature

The air-temperature measuring system shall have an accuracy of ± 1 K.

6.2.6 Barometric pressure

The barometric-pressure measuring system shall have an accuracy of ± 70 Pa.

6.2.7 Back pressure in exhaust system

The system used to measure the back pressure in the exhaust system shall have an accuracy of ± 25 Pa.

6.2.8 Test-room humidity

The test-room-humidity measuring system shall have an accuracy of ± 11 % in relative humidity.

NOTE A relative humidity measurement accuracy of ± 11 % corresponds to a wet and dry bulb thermometer measurement accuracy of ± 1 K.

6.3 Setting and test conditions

6.3.1 Equipment and auxiliaries

During the test, the auxiliaries shall be installed on the test bench in accordance with Table 1, and according to ISO 15550:2002, Table 1, as far as possible in the same position as in the intended application.

Table 1 — Equipment and auxiliaries

No.	Equipment and auxiliaries	To be fitted during the test
1	**Inlet system** Electro-control devices	Yes, if SPE
2	**Exhaust system** Electro-control devices	Yes, if SPE
3	**Liquid-cooling equipment** Engine cowling	No
4	**Oil cooler**	Yes, if SPE

6.3.2 Setting conditions

The setting conditions shall be according to ISO 15550:2002, 6.3.3.

6.3.3 Test conditions

6.3.3.1 Test conditions shall be according to ISO 15550:2002, 6.3.4.1, 6.3.4.8 and 6.3.6.

6.3.3.2 Furthermore, the requirements of ISO 15550:2002, 6.3.4.2, 6.3.4.3, 6.3.4.7, 6.3.4.9, 6.3.4.10, 6.3.4.11, 6.3.4.12 and 6.3.4.14 shall be met, but with the following modifications.

a) ISO 15550:2002, 6.3.4.2: the stabilized operating conditions shall be obtained in accordance with the manufacturer's specifications.

b) ISO 15550:2002, 6.3.4.3: the temperature of the air inducted into the engine shall be measured within 0,15 m of the point of entry to the air cleaner, or, if no air cleaner is used, within 0,15 m of the air inlet horn.

c) ISO 15550:2002, 6.3.4.7: if the constant operating conditions (torque, engine speed and temperatures) are not specified by the manufacturer, no data shall be taken until the engine speed has been maintained within the limits specified in ISO 15550:2002, 6.3.4.8. Data shall be recorded once the time necessary to maintain the stabilized operating conditions has elapsed. The stabilized operating conditions shall be established in accordance with ISO 15550:2002, 6.3.4.8 for every measurement and the time taken shall be recorded. The time to maintain the stabilized operating conditions shall be equal for every measurement.

d) ISO 15550:2002, 6.3.4.9: data on the observed brake load, the fuel consumption and the temperature of the air inducted into the engine shall be taken virtually simultaneously and shall, in each case, be the average of two consecutive stabilized readings for which the brake load and fuel consumption do not vary by more than 2 %.

e) ISO 15550:2002, 6.3.4.10: for air-cooled spark-ignition engines, if no temperature is specified by the manufacturer, the temperature of the ignition spark-plug washer shall be 523 K or less. For multi-cylinder engines, it is permissible to measure the ignition spark-plug washer temperature at only one representative cylinder.

f) ISO 15550:2002, 6.3.4.11: for spark-ignition engines, the fuel temperature shall be measured as near as possible to the inlet of the carburettor or fuel injector manifold assembly. Fuel temperature shall be maintained within ± 5 K of the temperature specified by the manufacturer. However, the minimum test fuel temperature allowed shall be the ambient air temperature. If the test fuel temperature is not specified by the manufacturer, it shall be 298 K ± 20 K.

g) ISO 15550:2002, 6.3.4.12: the lubricating oil temperature measured in the oil sump or at the oil cooler outlet, if fitted, shall be maintained within the limits established by the engine manufacturer.

h) ISO 15550:2002, 6.3.4.14: unleaded gasoline shall be used for the engine equipped with the catalyst. Specifications for test fuels shall be informative only.

NOTE An example of the record form is given in Annex A.

6.3.4 Additional requirements

6.3.4.1 A measurement time of not less than 10 s shall be used when measuring engine speed and fuel consumption with an automatically synchronized counter-timer combination.

6.3.4.2 The exhaust temperature shall be measured at a point in the exhaust pipe(s) adjacent to the outlet flange(s) of the exhaust manifold(s) or ports.

6.3.4.3 If it is impracticable to fit the standard exhaust system, a system permitting the normal engine running characteristics in accordance with the manufacturer's specification shall be fitted for the test. In particular, in the test laboratory, the exhaust extraction system at the point where the test bench exhaust system is connected shall not create a pressure differing from the atmospheric pressure by more than

± 740 Pa at the exhaust extraction duct, with the engine in operation, unless the manufacturer has specifically prescribed the back pressure prior to the test, in which case the lower of the two pressures shall be used.

6.4 Test procedure

The test procedure shall be according to ISO 15550:2002, 6.3.5, with the following modifications.

Data shall be taken incrementally from the lowest to the highest engine speeds recommended by the manufacturer. When the temperature exceeds the specified value, the measurements shall be made intermittently.

7 Method of power correction

7.1 Definition of factors a_m, a_a and a_c

These factors are those by which the observed power shall be multiplied to determine the engine power, taking into account the efficiency of the transmission (a_m factor) used during the test and the standard reference conditions given in Clause 5 (a_a and a_c factors).

The corrected power, P_o (i.e. power under the standard reference conditions and at the end of the crankshaft) is given by either Equation (1) or (2), depending on the type of engine.

For spark-ignition engines:

$$P_o = \alpha_m \alpha_a P \tag{1}$$

For compression-ignition (diesel) engines:

$$P_o = \alpha_m \alpha_c P \tag{2}$$

where

a_m is the correction factor for efficiency of the transmission;

a_a is the correction factor for the standard reference conditions for spark-ignition engines;

a_c is the correction factor for the standard reference conditions for compression-ignition engines;

P is the measured power.

7.2 Atmospheric test conditions

For the test, the atmospheric conditions shall be according to ISO 15550:2002, 7.2.

7.3 Determination of power correction factors

7.3.1 Determination of a_m factor

Where the measurement point is at the crankshaft, this factor is equal to 1.

Where the measurement point is not at the crankshaft, this factor is calculated using Equation (3):

$$\alpha_m = \frac{1}{\eta_t} \tag{3}$$

where η_t is the efficiency of the transmission which is located between the crankshaft and the measurement point.

This efficiency of the transmission, η_t, is determined from the product of efficiency η_i of each element constituting the transmission:

$$\eta_t = \eta_1 \times \eta_2 \times \ldots \times \eta_i \quad (4)$$

The efficiency η_i of each element constituting the transmission shall be in accordance with Table 2.

Table 2 — Transmission component efficiencies

Component	Type	Efficiency η_i
Gear	Spur gear	0,98
	Helical gear	0,98
	Bevel gear	0,98
Chain	Roller	0,95
	Silent	0,98
Belt	Toothed	0,95
	V-belt	0,94
Hydraulic coupler or converter	Hydraulic coupler	0,92
	Non-locked hydraulic converter	0,92

7.3.2 Correction factor a_a for naturally aspirated and pressure-charged spark-ignition engines (with or without charge air cooling)

The correction factor a_a for naturally aspirated and pressure-charged spark-ignition engines, with or without charge air cooling, shall be according to ISO 15550:2002, 7.3.

7.3.3 Correction factor a_c for compression-ignition (diesel) engines

The correction factor a_c for compression-ignition (diesel) engines shall be according to ISO 15550:2002, 7.4.

8 Measurement and correction of smoke value for compression-ignition (diesel) engines

The measurement and correction of the smoke value for a compression-ignition (diesel) engine shall be made in accordance with ISO 15550:2002, Clause 8.

9 Test report

9.1 General

The test report shall be according to ISO 15550:2002, 9.2, with the following additions/modifications:

Results

Maximum net power: .....kW at ..... min^{-1}

Maximum net torque: .....N·m at..... min^{-1}

Specific fuel consumption

— at maximum net power:..... g/kW·h

— at maximum net torque: ..... g/kW·h

Description of engine

Identification No.: .....

Rotary trochoidal engines

Make:.....Type: .....Identification No.:.....

Epitrochoidal/hypotrochoidal (strike out the one that does not apply)

Envelope: internal/external (strike out the one that does not apply)

Number of gas-tight chambers between the rotor and the stator, i.e. number of peripheral sealing devices per rotor or stator:

Eccentricity: ..... mm Generating radius: .....mm

Operating width: ..... mm Swept volume of one gas-tight chamber: .....cm^3

Number of rotors: ..... Firing order: .....

Compression ratio:..... Cycle: two-stroke/four-stroke (strike out the one that does not apply)

Transmission gear ratio

$$r_g = \frac{n_c}{n_p}$$

where

r_g is the reduction gear ratio;

n_c is the crankshaft rotation speed (min^{-1});

n_p is the power take-off shaft rotation speed (min^{-1}).

Crankcase emission control system

Brief description:.....

Make:.....Type: ..... Identification No.:.....

Natural air cooling

Air ducting (standard production): yes/no (strike out the one that does not apply)

9.2 Statement of results as a function of engine speed

The characteristic curves of the corrected torque and power and of the specific fuel consumption shall be drawn as a function of the engine speed.

The statement of results shall be presented in the format given in Table 1.