INTERNATIONAL STANDARD

ISO 14396

First edition
2002-06-01

Reciprocating internal combustion engines — Determination and method for the measurement of engine power — Additional requirements for exhaust emission tests in accordance with ISO 8178

Moteurs alternatifs à combustion interne — Détermination et méthode de mesurage de la puissance — Exigences supplémentaires pour les essais d'émissions de gaz d'échappement suivant l'ISO 8178

Reference number
ISO 14396:2002(E)

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Printed in Switzerland

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14396 was prepared by Technical Committee ISO/TC 70, *Internal combustion engines*.

This first edition of ISO 14396 cancels and replaces ISO/TR 14396:1996 which has been technically revised.

Introduction

This International Standard establishes one “Satellite” standard of the ISO engine power measurement standards, the use of which enables one to avoid the disadvantages due to the existance of many similar, but different, ISO standards for the definition and determination of engine power. It uses the “Core” and “Satellite” approach.

The “Core” standard, ISO 15550 contains the requirements that are common to all engine applications whereas this International Standard contains as a “Satellite” standard those requirements that are necessary to tailor power measurement and declaration to suit the particular engine application as defined in clause 1.

This International Standard is intended to be applied only in conjunction with the “Core” standard ISO 15550 in order to completely specify the requirements for the particular engine application. The “Satellite” standard therefore is not a document that can stand alone but is intended to be accomplished by the requirements laid down in the “Core” standard ISO 15550 to become a complete standard.

The structure of both, the “Core” and the “Satellite” standard have been drafted in a very similar way to ensure easy use.

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.

In comparison with engines for on-road applications, engines for off-road use are made in a much wider range of power outputs and configurations as they are used in a large number of different applications.

The objective of ISO 8178 is to rationalize the gaseous and particulate emission test procedures for off-road engines in order to simplify and make more cost effective the drafting of legislation, the development of engine specifications and engine certification.

One of the concepts that has been adopted to achieve this objective is to calculate the specific emissions (g/kWh) on the basis of the engine power when only the essential dependent auxiliaries are fitted.

ISO 8178 has been used in legislation and the authorities have set limit values that vary according to the power of the engine. This International Standard defines the procedure to be used to determine the power of the engine for testing in accordance with the requirements of ISO 8178.

The calculation of specific emissions in accordance with ISO 8178 is based upon uncorrected power measurement values, since the emissions vary with ambient conditions but cannot be corrected at the time of measurement. The permissible range of ambient conditions in this International Standard is therefore very small in order to minimize this effect.

This International Standard, which uses power correction procedures so that a wide range of ambient test conditions can be met, is intended to be used to determine the engine power prior to performing an emission test.

Reciprocating internal combustion engines — Determination and method for the measurement of engine power — Additional requirements for exhaust emission tests in accordance with ISO 8178

1 Scope

This International Standard specifies the additional and method requirements for determining the power of reciprocating internal combustion (RIC) engines when presented for an exhaust emission test in accordance with ISO 8178, to the basic requirements defined in the "Core" standard ISO 15550.

It also specifies the power correction method for the confirmation of engine power for pre-set engines under variable atmospheric conditions. These corrections do not apply to the definition of the exhaust emission values which are in all cases only related to the uncorrected engine power.

This International Standard applies to RIC engines for land, rail traction and marine use excluding engines for motor vehicles primarily designed for on-road use. It may be applied to engines used to propel e.g. road construction and earth-moving machines, industrial trucks and for other applications.

This International Standard is a "Satellite" standard and shall be applied in conjunction with the "Core" standard ISO 15550 only, in order to completely specify the requirements for the particular engine application.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3104:1994, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 3675:1998, *Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method*

ISO 5164:1990, *Motor fuels — Determination of knock characteristics — Research method*

ISO 5165:1998, *Petroleum products — Determination of the ignition quality of diesel fuels — Cetane engine method*

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

ASTM D240-00, *Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter*

ASTM D3338-00, *Standard Test Method for Estimation of Net Heat of Combustion of Aviation Fuels*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 15550 listed in Table 1 apply.

Table 1 — Terms and definitions

Term (listed alphabetically)	Definition see ISO 15550 Subclause No.
declared engine speed	3.2.4
declared intermediate engine speed	3.2.5
declared power	3.3.1
engine adjustment	3.2.1
engine power for ISO 8178	3.3.3.3
engine speed	3.2.3
engine speed at maximum torque	3.2.7
fuel delivery	3.4.2
load	3.3.11
power correction	3.3.10
production conformity test	3.5.4
special test	3.5.3

For the declaration of the intermediate engine speed the following requirements shall be taken into account:

— for engines which are designed to operate over a specific speed range of the full load torque curve, the intermediate engine speed shall be the declared engine speed at maximum torque if it occurs between 60 % and 75 % of the declared speed.

If the declared engine speed at maximum torque is less than 60 % of the declared speed, then the intermediate engine speed shall be 60 % of the declared speed.

If the declared engine speed at maximum torque is greater than 75 % of the declared speed, then the intermediate engine speed shall be 75 % of the declared speed.

— for engines which are not designed to operate over a speed range of the full load torque curve at steady conditions, the intermediate engine speed will typically be between 60 % and 70 % of the declared speed.

4 Symbols

For the symbols used in this International Standard see Table 2 of ISO 15550:2002; for the meanings of subscripts see Table 3 of ISO 15550:2002.

5 Standard reference conditions

The requirements of ISO 15550:2002 clause 5 apply.

6 Tests

6.1 Test method

Test method 2 in accordance with 6.3 of ISO 15550:2002 applies.

6.2 Test conditions

The requirements of ISO 15550:2002 sublauses 6.3.4.1 to 6.3.4.14 apply with the following additions:

a) The settings for the engine power test depend upon whether the engine is 'pre-set' and will run at full fuel delivery under all conditions, or if the engine is adjustable and will be adjusted to produce a specified power output.

For adjustable compression-ignition (diesel) engines the engine power test shall consist of a run at the required fuel system settings to produce the manufacturer's specified power, the engine being equipped as specified in ISO 15550:2002, Table 1, column 5.

All equipment and auxiliaries not required by ISO 15550:2002, Table 1, column 5, should be removed before the test.

Certain accessories, necessary only for the operation of the machine to which the engine will be connected and which may be mounted on the engine, should be removed for the test. The following non-exhaustive list is given as an example:

— air compressors for brakes;

— power-steering pump;

— suspension compressor;

— air-conditioning system compressor;

— mounted gearbox.

Where accessories cannot be removed, the power absorbed by them in the unloaded condition shall be determined and added to the measured engine power. If this value is greater than 3 % of the maximum power at the test speed it may be verified by the test authority.

b) The fuel selected for the ISO 8178 power test shall be the same as that for the ISO 8178 emission test. Unless otherwise agreed by the parties involved the fuel shall be selected in accordance with the requirements of Table 12 of ISO 15550:2002.

For compression ignition (diesel) engines operating on distillate fuel, the fuel temperature values given in ISO 15550:2002, subclause 6.3.4.11 b) do not apply. For these engines the fuel temperature shall be 313 K^{+3}_{-7} K [1) 2)].

1) The tolerances shown are in conformity with the non-road engine emission legislative requirements.

2) If other than diesel fuels are used, the fuel temperature may vary.

6.3 Test procedure

The requirements of ISO 15550:2002, subclause 6.3.5 do not apply and shall be replaced by the following.

For variable speed engines, measurements shall be taken at a sufficient number of engine speeds to completely define the power curve between the lowest and the highest engine speeds recommended by the manufacturer. At each point, the average of at least two stabilized measurements shall be taken.

For constant speed engines and those driving equipment which determines the speed-dependent torque characteristics, e.g. a propeller, measurements shall be made at the declared speed and declared power.

7 Method of power correction

7.1 For the purposes of this International Standard the method of power correction in accordance with clause 7 of ISO 15550, applies.

7.2 The test may be carried out in an air-conditioned test room where the atmospheric conditions are controlled in order to maintain the correction factor as close to unity (1) as possible. In the case of engines fitted with an automatic air temperature control, if the device is such that at full load at 298 K (25 °C) no heated air is added to the inlet air, the test shall be carried out with the device operating normally and the exponent of the temperature term in the correction factor in ISO 15550:2002, subclause 7.3 or 7.4.2 shall be taken as zero (no temperature correction).

8 Measurement of exhaust emission

The requirements of clause 8 of ISO 15550:2002 , do not apply and shall be replaced by the following.

For the measurement of the gaseous and particulate exhaust emissions after the measurement of engine power has been completed, the measurement methods shown in ISO 8178 apply.

9 Test report

9.1 General

In addition to the requirements of the test report shown in ISO 15550:2002 subclauses 9.2.2.1 and 9.2.2.2, those shown in 9.2 and 9.3 apply.

Test conditions for measuring engine power:

General		
Trade-name or marque of engine:		
Type and identification number of engine:		
Engine family:		
Test conditions		
Pressures measured at declared speed of:		
a) total barometric pressure;		kPa
b) water vapour pressure;		kPa
c) exhaust back-pressure		kPa
Location of exhaust back-pressure measurement point:		
Inlet depression:		Pa
Absolute pressure in the inlet ductwork:		Pa
Temperatures measured at declared speed of the:		
a) inlet air;		K
b) engine charge air cooler outlet;		K
c) cooling fluid at the:		K
— engine cooling fluid outlet [3)]		K
— reference point in the air cooling case [3)]		K
d) lubricating oil:		
— measurement point		K
e) fuel:		
— at the carburettor inlet/fuel injection system inlet [3)]		K
— in the fuel flow measuring device		K
Characteristics of the dynamometer		
Make:		
Model:		
Type:		
Rating:		

3) Strike out which does not apply.

Fuel details for spark-ignition engines operating on liquid fuel		
Make and type:		
Specification:		
Research Octane Number (RON) in accordacne with ISO 5164 [4]:		
Motor Octane Number (MON) in accordance with ISO 5164 [4]:		
Percentage and type of oxygenates:		%
Density at 288 K (in accordance with ISO 3675) [4]:		g cm^{-3}
Low calorific value, measured (in accordance with ASTM D240-00) [3] or lower calorific value, estimated (in accordance with ASTM D3338-00) [3]:		kJ/kg
Fuel details for spark-ignition engines operating on gaseous fuel		
Make:		
Specification:		
Storage pressure:		kPa
Utilization pressure:		kPa
Lower calorific value:		kJ/kg
Fuel details for compression-ignition engines operating on liquid fuel		
Make:		
Specification of fuel used:		
Cetane number (in accordance with ISO 5165) [4]:		
Viscosity at 40 °C (in accordance with ISO 3104):		$mm^2\ s^{-1}$
Density (at 288 K in accordance with ISO 3675):		g cm^{-3}
Lower calorific value, measured (in accordance with ASTM D240-00) [3] or lower calorific value estimated (in accordance with ASTM D3338-00) [3]:		kJ/kg
Fuel details for compression-ignition engines operating on gaseous fuel		
Feed system gas:		
Specification of gas used:		
Fuel/oil gas proportion:		
Lower calorific value:		kJ/kg
Lubricant		
Make:		
Specification:		
SAE viscosity:		

4) ASTM standards also exist.