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Measurement methods of net power for automotive engines and drive motor

汽车发动机及驱动电机净功率测试方法

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Table of Contents

Foreword 3

1 Scope 5

2 Normative references 5

3 Terms and definitions 5

4 General principles 7

5 Requirements 7

6 Result evaluation 8

Appendix A (Normative) Main characteristics of the engine and information related to the test 10

Appendix B (Normative) Main characteristics of the drive motor and information related to the test 17

Appendix C (Normative) Test method for net power of engine 19

Appendix D (Normative) Test method for net power and maximum 30 min power of drive motor system 31

Appendix E (Normative) Technical requirements for benchmark fuels 35

Bibliography 40

Measurement methods of net power for automotive engines and drive motor

1 Scope

This document describes the method for conducting net power test and maximum 30 min power test of drive motor systems for engines and drive motor systems for M and N category vehicles, based on the net power versus speed curve proposed by the manufacturer.

This document applies to reciprocating piston engines (spark ignition or compression ignition) or rotary engines (spark ignition or compression ignition), but not to free piston engines.

This document applies to drive motor systems.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the version corresponding to that date is applicable to this document; for undated references, the latest version (including all amendments) is applicable to this document.

GB 17691-2018, Limits and measurement methods for emissions from diesel fueled heavy-duty vehicles (CHINA VI)

GB 18352.6-2016, Limits and measurement methods for emissions from light-duty vehicles (CHINA 6)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in GB 17691-2018 and GB 18352.6-2016 as well as the following apply.

3.1

net power

The power measured at the corresponding speed at the engine crankshaft end (or the shaft end of the drive motor system) or its equivalent end on the test bench according to the prescribed test method. The engine product needs to be corrected according to standard atmospheric conditions.

4 General principles

4.1 Product certification

4.1.1 Engines or drive motor systems submitted for certification in accordance with the requirements of Chapter 5 (the main characteristics and test-related information shall be in accordance with the provisions of Appendix A or Appendix B) shall undergo product certification tests in accordance with the provisions of Appendix C or Appendix D.

4.1.2 The product certification test results shall comply with the provisions of 6.1.

4.2 Production consistency

4.2.1 In order to verify that the engine or drive motor system produced after product certification meets the quality requirements, a sample shall be selected for testing in accordance with the provisions of Appendix C or Appendix D, and the test results shall comply with the provisions of 6.2.

4.2.2 If the above sample cannot meet the requirements of 6.2, two more samples shall be selected for testing in accordance with the requirements of Appendix C or Appendix D. The test results shall meet the requirements of 6.2.

5 Requirements

5.1 Basic requirements

5.1.1 Parts that affect the power of the engine or drive motor system shall meet the technical standards of the manufacturer during the design, manufacturing and assembly process to ensure that the engine or drive motor system can operate normally and stably.

5.1.2 For hybrid electric vehicles, the engine and drive motor system shall be tested separately.

5.1.3 For dual-fuel engines with diesel mode, the test shall consist of the dual-fuel mode and diesel mode on the same engine.

5.2 Test requirements for net power for engine

5.2.1 Carry out the net power test of the engine in accordance with the requirements of Appendix C. The accessories installed during the test shall meet the requirements of Table C.1.

5.2.2 Except for the following cases, the fuel used in the engine test shall be commercially available fuel. In case of dispute, the benchmark fuels in Appendix E shall be used.

a) For engines not equipped with adaptive fuel supply, when the fuel is liquefied petroleum gas, the benchmark fuel A specified in Table E.3 shall be used; when the fuel is natural gas, commercially available fuel can be used, while its Wobbe index shall be at least 52.6 MJ/m^3 (4 ℃, 101.3 kPa). In case of dispute, the benchmark fuel G_{20} specified in Appendix E shall be used.

b) For natural gas engines marked with a specific fuel calorific value range, if it is marked as a high calorific value fuel (H range), commercially available fuel may be used, but its Wobbe index must be at least 52.6 MJ/m^3 (4℃, 101.3 kPa). In case of dispute, standard fuel G_{20} specified in Appendix E shall be used. If it is marked as a low calorific value fuel (L range), commercially available fuel may be used, but its Wobbe index must be at least 47.2 MJ/m^3 (4 ℃, 101.3 kPa). In case of dispute, the benchmark fuel G_{23} specified in Appendix E shall be used.

c) For engines marked with specific fuel components, the fuel indicated shall be used and this shall be stated in the test report.

5.3 Test requirements for net power and maximum 30 min power for drive motor system

5.3.1 Carry out the net power and maximum 30 min power test of the drive motor system according to the requirements of Appendix D; the accessories installed during the test shall meet the requirements of Table D.1.

5.3.2 Control the drive motor system to perform the maximum 30 min power test at rated speed.

Note: The rated speed of the drive motor system refers to the maximum speed corresponding to the maximum mechanical torque that the drive motor system can output for a long time.

6 Result evaluation

6.1 Product certification test results

6.1.1 The engine product is based on the manufacturer's declared curve. If the net power value on the declared curve corresponds to a single speed, the test is conducted within the deviation of the speed corresponding to each declared value within ±1.5%; if the declared value corresponds to the speed range (X_1 ~ X_2), the test is conducted within the speed range corresponding to each declared value from (X_1 + 1.5% X_1) r/min to (X_2-1.5% X_2) r/min (X_1<X_2). The deviation between the net power value measured in the test and the corresponding declared value shall meet the following requirements: the maximum net power measured point on the declared curve shall not exceed ±2%, and the other measured points shall not exceed ±4% and shall not exceed 2% of the declared maximum net power value.

C.4.6 Torque, fuel consumption and intake air temperature shall be measured simultaneously as far as possible. The measurement time shall be no less than 10 seconds. The average value of two consecutive stable values shall be taken. The difference between the two torque measured values shall be less than 2%.

C.4.7 The coolant temperature at the engine outlet shall meet the requirements for specified value of the manufacturer. If the manufacturer does not specify, this temperature shall be 88 ℃ ± 5 ℃. For air-cooled engines, the temperature at the manufacturer's specified point shall be maintained within the range of 0 ℃ ~ -20 ℃ of the maximum value specified by the manufacturer.

C.4.8 The fuel temperature shall be measured at the carburetor inlet, at the fuel injection system inlet or at a representative location specified by the manufacturer. The temperature shall be kept within the limit specified by the engine manufacturer.

C.4.9 The oil temperature measured at the outlet of the oil pan or oil radiator (if installed) shall be maintained within the limits specified by the manufacturer.

C.4.10 If necessary, an auxiliary regulating system may be used to maintain the temperature specified in C.4.7, C.4.8 and C.4.9 within the specified range.

C.5 Measurement error

C.5.1 Torque: ±1% of the measured value. The torque measurement system of the dynamometer shall be dynamically calibrated to eliminate the influence of friction resistance. When the torque is below 50% of the full range of the dynamometer, the error can be ±2% of the measured torque.

C.5.2 Engine speed: ±0.5% of measured value.

C.5.3 Fuel consumption: ±1% of the measured value.

C.5.4 Fuel temperature: ±2 ℃.

C.5.5 Engine intake temperature: ±2 ℃.

C.5.6 Atmospheric pressure: ±0.1 kPa.

C.5.7 Inlet pipe pressure: ±0.05 kPa.

C.5.8 Exhaust pipe pressure: ±0.2 kPa.

C.6 Power correction factor

C.6.1 Correction power

Calculated according to Formula (C.1), the power correction coefficient α is used to obtain the power of the engine under the standard atmospheric conditions specified in C.6.2.

D.3.3 During the test, set the DC bus voltage of the drive motor system to the rated voltage and the drive motor system in the electric state.

D.3.4 To determine the complete power curve, no less than 10 speed points shall be taken within the operating speed range of the drive motor system. The lowest speed point should not be greater than 10% of the maximum operating speed, and the interval between adjacent speed points shall not be greater than 10% of the maximum operating speed. Test the maximum net power of each speed point by the drive motor controller controlling the drive motor system. The duration of each speed point should be no less than 10 s, and the entire test shall be completed in the shortest possible time.

D.4 Maximum 30 min power test method

D.4.1 The drive motor system needs to be in an environment of 23 ℃ ± 5 ℃.

D.4.2 If liquid cooling is used, the liquid cooling inlet temperature of the drive motor system shall be controlled at 50 ℃ ± 2 ℃, and the flow rate shall be set in accordance with the product technical documents; for other cooling methods, the cooling conditions shall be set in accordance with the product technical documents.

D.4.3 During the test, set the DC bus voltage of the drive motor system to the rated voltage and the drive motor system in the electric state.

D.4.4 The drive motor system needs to be tested on the bench for the maximum 30 min power, which is provided by the product manufacturer. The sampling frequency during the test shall not be less than 0.1 Hz. During the test, the output power of the drive motor system shall be within ±5% of the power at the start of the test.

D.5 Data to be recorded

D.5.1 The current, power supply voltage, torque, speed, duration of each operating point, coolant inlet temperature (or inlet air temperature) and flow rate shall be recorded (but not limited to).

D.5.2 If necessary, the recorded coolant temperature at the inlet of the drive motor system shall be maintained within ±5 °C of the value set by the product manufacturer. For air-cooled drive motors, the temperature at the designated location (inlet) of the product manufacturer shall also be maintained in the range of 0 °C ~ -20 °C of the maximum value specified by the product manufacturer.

D.5.3 Record the ambient temperature.

D.5.4 If necessary, an auxiliary regulating system may be used to maintain the temperature specified in D.5.2 within the specified range.

D.6 Measurement error

D.6.1 Speed: ±0.5% of the measured value.

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