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**Fuel consumption test methods for heavy-duty commercial
vehicles**

重型商用车燃料消耗量测量方法

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Fuel consumption test methods for heavy-duty commercial vehicles

1 Scope

This Standard specifies the measurement method for fuel consumption of heavy-duty commercial vehicles.

This Standard is applicable to commercial vehicles that burn gasoline and diesel, of which the maximum design total mass is greater than 3500kg, including trucks, semi-trailer tractors, ordinary passenger cars, dump trucks and city buses. Concrete mixer trucks can refer to the relevant measurement methods of dump trucks. For other special transport vehicles, refer to the relevant measurement methods for trucks.

This Standard does not apply to special purpose vehicles, including van-type special operation vehicle, tank-type special operation vehicle, special dumping operation vehicle, warehouse grid-type special operation vehicle, hoisting and lifting special operation vehicle and special structure special operation vehicle. This Standard does not apply to hybrid electric vehicles.

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.

GB/T 1413-2008, *Series 1 freight containers - Classification, dimensions and ratings*

GB/T 1884, *Petroleum and liquid petroleum product - Determination of density - Hydrometer method*

GB/T 3730.1, *Motor vehicles and trailers - Types - Terms and definitions*

GB/T 12534-1990, *Motor vehicles - General rules of road test method*

GB/T 15089, *Classification of power-driven vehicles and trailers*

GB/T 17350, *Terms marks and designation for special purpose vehicles and special trailers*

GB 17691-2018, *Limits and measurement methods for emissions from diesel fuelled*

heavy-duty vehicles (CHINA VI)

GB/T 18297-2001, *Performance test code for road vehicle engines*

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

GB/T 38146.2-2019, *China automotive test cycle - Part 2: Heavy-duty commercial vehicles*

3 Terms and definitions

For the purposes of this document, the terms and definitions defined in GB/T 3730.1, GB/T 15089, GB/T 17350 and GB/T 38146.2-2019 as well as the followings apply.

3.1 basic vehicle type

vehicles applied by vehicle manufacturers as basic types

3.2 variant of a vehicle type

a new model formed by modifying the design or changing the structural configuration on the basis of the approved basic type

3.3 equivalent inertia

the inertial mass corresponding to the moving part and the rotating part during the driving process of the vehicle

4 General requirements

4.1 It shall use chassis dynamometer method to determine fuel consumption of basic vehicle type. Indicate it as the basic vehicle type in the test report specified in Annex A.

4.2 The vehicle manufacturer chooses to use the chassis dynamometer method or the simulation calculation method to determine the fuel consumption of variant of a vehicle type. Indicate the basic vehicle type corresponding to this variant of a vehicle type in the corresponding test report specified in Annex A or Annex B. Submit a fuel consumption test report for basic vehicle type.

4.3 Measure the fuel consumption of the vehicle in accordance with the China Heavy Commercial Vehicle Driving Conditions (CHTC) specified in Annex A of GB/T 38146.2-2019. Where,

- a) Trucks adopt CHTC-LT (maximum design total mass GVW $\leq 5500\text{kg}$) or CHTC-HT (GVW $> 5500\text{kg}$) driving conditions;

commercially available vehicle fuel that meets the relevant national standards.

5.3.3.2 Determine the fuel density according to GB/T 1884.

5.3.3.3 When using the carbon balance method to calculate the fuel consumption, the hydrogen-to-carbon ratios of gasoline and diesel are assumed to be 1.85 and 1.86, respectively.

5.4 Test procedure

5.4.1 Place the vehicle according to C.2.2.1. Connect the fuel flow meter, exhaust sampling system and other test equipment. Verify that the fuel line is leak-free and functioning properly.

5.4.2 Adjust the chassis dynamometer according to C.2.2 or C.3.2.

5.4.3 During the test, only the equipment necessary to drive the vehicle is allowed to work. Vehicle load conditions shall ensure that the vehicle does not slip during the test. For tractors, the load shall be vertical at the saddle position.

NOTE: If the test department can prove that there will not be a slip phenomenon that will obviously affect the measurement results, it may not be loaded with the consent of the vehicle manufacturer.

5.4.4 Set the chassis dynamometer to road resistance simulation mode. Connect the data acquisition system and the driver assistance system.

5.4.5 During the test, run the road simulation cooling fan, vehicle speed and time recorder and other related equipment synchronously. Before the formal test, 1~2 complete CHTC driving conditions shall be carried out or other methods shall be used to fully warm up the test vehicle and chassis dynamometer.

5.4.6 During the test, the shifting strategy shall be determined jointly by the vehicle manufacturer and the testing agency. If the vehicle has undergone a simulation test, the calculated shift point can be used as a reference for the chassis dynamometer test. The following items are available for the determination of the shifting strategy:

- a) The corresponding gear shall be selected according to the characteristics of the vehicle. The shifting process shall be fast and smooth;
- b) When the vehicle cannot reach the specified speed of the CHTC driving condition in a higher gear and the speed deviation exceeds the specified value in 5.5.1, it may lower the first gear to continue the test. When the vehicle re-enters the uniform speed state that can use the higher gear to drive, change to the higher gear again for the test;
- c) For the vehicles with energy efficient driving indication, shift operations can be performed according to the corresponding instructions.

5.4.7 When decelerating, release the accelerator pedal properly. Continue to keep the clutch engaged. Disengage the clutch, downshift or stop until the test vehicle speed drops to the lowest stable vehicle speed in that gear. If necessary, use the vehicle's brakes and auxiliary braking devices to decelerate.

5.4.8 The vehicle test shall run three complete CHTC driving conditions. Record the test results separately after each complete CHTC driving condition.

5.4.9 Between two adjacent full CHTC driving conditions, vehicles and related equipment shall continue to operate or use other methods to maintain a warm engine state.

5.5 Test deviation

5.5.1 During the test, the actual running state of the vehicle shall be basically consistent with the CHTC driving condition. The maximum deviation of its speed is $\pm 3\text{km/h}$. The single time exceeding the speed deviation shall not be greater than 2s. The accumulated time shall not be greater than 15s.

5.5.2 When the test vehicle cannot reach the acceleration or test speed required by the CHTC driving condition, the accelerator pedal shall be fully depressed. This operation does not count towards the single or cumulative time that exceeds the speed deviation. When the test vehicle cannot reach the deceleration or test speed specified in the CHTC driving condition, the brake pedal shall be fully applied or other deceleration measures shall be used, until the vehicle running state returns to the deviation range specified by CHTC driving conditions again. This operation counts towards the single or cumulative time that exceeds the speed deviation. Any conditions exceeding the driving condition deviation shall be noted in the test report.

5.6 Data processing and test results

5.6.1 Data collection and processing steps

5.6.1.1 Data logging can be done by automated acquisition systems or manually.

NOTE: The automatic acquisition system shall be able to continuously record the fuel consumption and fuel temperature in real time with the acquisition frequency not less than 1Hz.

5.6.1.2 At the end of each complete CHTC driving condition, the running results such as vehicle speed shall be stored. Calculate each speed interval and comprehensive fuel consumption of CHTC driving conditions according to the methods described in 5.6.2 and 5.6.3.

5.6.2 Calculation of fuel consumption

5.6.2.1 Determination of fuel consumption by the carbon balance method

Calculate the fuel consumption Q according to formula (1) or formula (2):

6 Simulation method

6.1 Algorithm

The simulation calculation method is based on the test data of the universal characteristics of the automobile engine. Input key parameters such as the vehicle, transmission, tires into the computer program. The running state of the test vehicle under the CHTC driving condition is simulated by the computer program. Calculate the fuel consumption of the test vehicle. See Annex G for the flow chart of the simulation calculation method.

6.2 Input parameters

6.2.1 The vehicle parameters that shall be input include:

- a) Vehicle type;
- b) Vehicle curb weight;
- c) Maximum design total mass;
- d) Maximum design load mass;
- e) Maximum design towing mass (only for semi-trailer tractors);
- f) Rated number of passengers (including driver);
- g) Drive type;
- h) Number of axles (for semi-trailer tractors, it refers to the number of axles of car trains).

6.2.2 The engine parameters that shall be input include:

- a) The universal characteristics of the engine shall be determined according to 8.5 of GB/T 18297-2001. During the test, at least 81 data points shall be selected as uniformly as possible to measure fuel consumption within the normal engine speed range, starting from no more than 10% of the maximum torque to the maximum torque. Rated speed, idle speed and 200r/min above idle speed are mandatory. Each speed does not exceed 10% of the maximum torque and the maximum torque is a must;
- b) The engine anti-drag torque shall be prepared for the test according to 8.5 in GB/T 18297-2001 and measured according to 8.7. During the test, at least 9 data points shall be selected as uniformly as possible between the idle speed of the engine and the maximum speed to measure the anti-drag torque. Idle speed and maximum speed are required points. When measuring the anti-drag torque, for

engines without a governor, the maximum speed shall be 1.05 times the maximum power speed or the speed when it exceeds the maximum power speed and the torque decreases by 3%, whichever is the smaller. For the engine equipped with a governor, the maximum speed is the maximum speed with load;

NOTE: Anti-drag torque refers to the resistance torque that the engine gives to the vehicle when the vehicle drags the engine crankshaft to rotate.

- c) The external characteristic torque of the engine shall be determined according to the provisions of 8.3 in GB/T 18297-2001, and at least 9 data points shall be selected as uniformly as possible within the normal speed range of the engine. The rated speed is a must;
- d) Engine idle speed and idle fuel consumption;
- e) Engine rated speed;
- f) Maximum engine speed.

6.2.3 The transmission parameters that shall be input include: the type of transmission (AT, MT, AMT), the number of gears of the main (auxiliary) transmission, the gear ratio, the main reduction ratio, and so on.

6.2.4 In addition to the above parameters, the tire size shall also be input. If the sliding energy variation method is used to determine the driving resistance, the corresponding test data shall also be submitted in the format of H.1.2 in Annex H.

6.3 Determination of driving resistance

6.3.1 Carry out the coasting test in accordance with Annex C to determine the running resistance. The time average sequence format corresponding to several taxi speeds is shown in H.1.2, which is used as the read-in file of the simulation program.

6.3.2 If the vehicle manufacturer agrees, the driving resistance can be determined according to the recommended value of the driving resistance coefficient specified in Annex E as an alternative method. Determine the construction method of the taxiing resistance file according to the requirements of H.1.2.

6.4 Tire rolling radius calculation

Calculate the tire rolling radius r according to formula (6):

$$r = \frac{F \times d}{2\pi} \dots\dots\dots (6)$$

Where,

Annex C

(normative)

Driving resistance determination and simulation on chassis dynamometer

C.1 Test preparation

C.1.1 Test road

C.1.1.1 The road sliding test shall be carried out on a clean, dry and straight asphalt concrete or concrete road surface.

C.1.1.2 The length of the test road shall meet the test requirements. The longitudinal slope error is within $\pm 0.1\%$.

C.1.2 Environmental conditions

C.1.2.1 The test shall be carried out in the weather without rain and fog.

C.1.2.2 The relative humidity is less than 95%.

C.1.2.3 The atmospheric temperature is between 0°C and 40°C.

C.1.2.4 The average wind speed measured at 1.6m above the road surface is not more than 3m/s. The gust is not more than 5m/s.

C.1.3 Loading mass

C.1.3.1 Unless otherwise specified, the test vehicle shall be in the state of maximum design total mass.

C.1.3.2 Load the vehicle according to the requirements of 3.1 in GB/T 12534-1990.

C.1.4 Test vehicle

C.1.4.1 When testing trucks, the bodywork with the largest windward area shall be used.

C.1.4.2 When the semi-trailer tractor is tested, the semi-trailer shall be loaded with the 1AA container specified in Chapter 4 of GB/T 1413-2008. Use radial tires.

C.1.4.3 The windows and cab vents shall be closed during the test.

C.1.5 Test equipment accuracy

C.1.5.1 When the gliding energy variation method is used, the time measurement accuracy shall not be lower than 0.1s. The accuracy of the vehicle speed measuring

Annex F

(normative)

Technical characteristics of chassis dynamometer

F.1 Overview

This appendix specifies the technical characteristics and requirements of a single-shaft, single-drum AC-electric chassis dynamometer for use in fuel consumption testing of heavy commercial vehicles. Other types of chassis dynamometers can refer to it for the implementation.

F.2 Chassis dynamometer characteristics

F.2.1 The chassis dynamometer shall meet the following structural and functional requirements:

- a) It has two drums that can be respectively coupled with the tires;
- b) Conduct drive power absorption and inertia simulation through electrical inertia;
- c) It has the measurement function of time, speed and driving distance;
- d) It has additional braking function;
- e) The road simulation fan can be synchronized with the speed of the car.

F.2.2 The accuracy of the chassis dynamometer shall meet the following requirements:

- a) The deviation of torque (driving force) static calibration shall not be greater than $\pm 0.1\%$;
- b) The basic inertia deviation shall not be greater than $\pm 0.5\%$;
- c) The deviation of acceleration and deceleration shall not be greater than $\pm 1\%$;
- d) When the speed is greater than 10km/h, the speed measurement deviation shall not be greater than $\pm 0.5\text{km/h}$;
- e) When the speed is greater than 30km/h, the deviation of the total driving resistance of the stable simulation shall not be greater than $\pm 3\%$;
- f) The deviation between the wind speed of the simulated fan and the speed of the vehicle shall not be greater than $\pm 5\text{km/h}$.

F.3 Chassis dynamometer requirements

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