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Test method for evaluating gasoline cleanliness - Simulation test of intake valve deposit (IVD) of gasoline engine

汽油清净性评价 汽油机进气阀沉积物模拟试验法

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Caution —— This Standard covers certain hazardous materials, operations, and equipment, but does not make recommendations for all safety problems. Therefore, users, before using this Standard, shall establish appropriate safety precautions; and determine the applicability of the relevant regulatory restrictions.

1 Scope

This Standard specifies the simulation test method of the intake valve deposit of the inlet jet gasoline engine, is used for evaluating the tendency of the formation of intake valve deposit of gasoline engine.

This Standard applies to motor gasoline and motor gasoline detergent.

Note: The test conditions for the application of this Standard to motor ethanol gasoline have not been determined. Further investigations of the engine correlation are required.

2 Normative references

The following documents are indispensable for the application of this document. For the dated references, only the editions with the dates indicated are applicable to this document. For the undated references, the latest edition (including all the amendments) are applicable to this document.

GB/T 4756 Method for manual sampling of petroleum liquids

GB 17930 Gasoline for motor vehicles

GB/T 19230.6 Test method for evaluating gasoline detergent in use - Part 6: Engine dynamometer test method for influence of intake valve and combustion chamber deposit tendencies of gasoline detergent (M111 method)

5.2.2 Dryer: It contains a desiccant.

5.2.3 Oven: The temperature can be controlled at 100 °C±2 °C.

5.2.4 Micro sample injector: 1000 μL, 250 μL.

5.2.5 Volumetric flask: 300 mL.

5.2.6 Tweezers.

5.2.7 Balance gloves.

5.2.8 Digital camera: no less than 8 million pixels.

6 Reagents and materials

6.1 Reagents

6.1.1 N-heptane: analytically pure.

6.1.2 Petroleum ether: 60 °C~90 °C and 90 °C~120 °C, analytically pure.

6.1.3 Xylene: analytically pure.

6.1.4 Trimethylbenzene: industrial grade.

6.1.5 Tetramethylbenzene: industrial grade.

6.1.6 Anhydrous ethanol: analytically pure.

6.1.7 Isopropanol: analytically pure.

6.2 Materials

6.2.1 Scouring pad: particle size 240~280.

Note: The 3M 8698 scouring pad complies with the use requirements of this method.

6.2.2 Water sandpaper: 62 μm.

6.2.3 Deposit accelerant: See the requirements of B.2.1 in Appendix B.

6.2.4 Iron naphthenate diluent: See B.2.2.

6.2.5 Calibration reference fuel: The composition requirements are shown in Table B.1.

6.2.6 Calibration reference detergent: See the requirements of B.2.4.

back into the dryer; and after 10 s, is weighed again. If the difference between the two consecutive readings of weighing balance is no more than 0.1 mg, it can be used as a stand-by. If the difference is greater than 0.1 mg, the collector is placed back into the dryer. After 30 min, it is re-weighed, until the difference between the two consecutive readings is no more than 0.1 mg.

Note: The spare collector cannot be touched directly with bare hands and can be picked-placed with gloves worn.

8.2 Preparation of test equipment

8.2.1 The test time of the instrument is set to 85 min. The oil injection time is set to 75 min. The test temperature is set to 175 °C (When the room temperature is ≤20 °C, the temperature is set to 174 °C). The temperature control accuracy is ±1 °C. TURN on the air source; adjust the air pressure to 80 kPa±1 kPa, and the air flow rate to 700 L/h±20 L/h.

8.2.2 POUR 30 mL of the mixed solution (The volume ratio of n-heptane to xylene is 2:1) into the sample cup; REMOVE the sponge at the oil inlet of the sample cup cap; then COVER the sample cup.

8.2.3 After using the mixed solution to thoroughly clean the inner wall of the sample cup, PLACE the solvent recovery box in front of the nozzle; CLOSE the cap of test hood.

8.2.4 TURN on the power switch of the equipment. USE the cleaning mode to quickly spray the solution in the sample cup through the oil inlet hose and nozzle to the solvent recovery box, until the spray is completed.

8.2.5 Continue to blow for about 3 min, to dry the line; END the cleaning mode; SWITCH to the test mode; TAKE out the solvent recovery box. At the oil inlet, a new sponge is replaced.

Note: When putting in and taking out the solvent recovery box, it shall avoid touching the fuel spray nozzle.

8.2.6 Adjustment of peristaltic pump: The rate of the metering pump varies depending on the ambient temperature at the time of the test. Adjust the rate of peristaltic pump, so that 300 mL of oil is sprayed within 73 min~75 min.

8.3 Equipment verification

According to Appendix B, the simulation testing machine of intake valve deposit of gasoline engine is verified.

stick into the thermometer hole of the collector, to absorb the reagent in the hole.

9.4.3 After the collector is placed in an oven at 100 °C for 15 min, it is taken out into a dryer. The dryer is placed near the balance; and cooled to room temperature.

9.4.4 The collector is weighed. The difference between the mass readings weighed twice in a row shall be within 0.1 mg. The weighing result is the mass of the deposit collector after the test. If the difference is greater than 0.1 mg, the collector is placed back into the dryer. After 30 min, it is re-weighed, until the difference between the two consecutive readings is no more than 0.1 mg.

9.5 Photograph

PHOTOGRAPH the deposit collector after the test.

10 Calculation

The simulated intake valve deposit mass of the sample shall be calculated according to formula (1):

$$m = m_1 - m_0 \qquad \cdots\cdots(1)$$

Where:

m - The mass of deposit produced by the test, in milligrams (mg);

m_1 - The mass of the deposit collector after the test, in milligrams (mg);

m_0 - The mass of the deposit collector before the test, in milligrams (mg).

11 Test report

The report shall include the following:

a) Sample information, sample type;

b) The deposit mass of the sample (see Clause 10). The result shall be accurate to 0.1 mg;

c) An image of the deposit collector after the test (see 9.5);

d) When the sample is a motor gasoline detergent, the deposit mass of the base test gasoline is also reported. The result shall be accurate to 0.1 mg.

Appendix A

(Normative)

Technical requirements for simulation testing machine of intake valve deposit of gasoline engine

A.1 General

This appendix specifies the technical requirements for simulation testing machine of intake valve deposit of gasoline engine. The schematic diagram of the equipment is shown in Figure A.1. The main part of the equipment consists of the deposit test assembly described in A.2, as shown in Figure A.2. A.3 describes the oil, gas, and electricity control parts of the equipment.

A.2 Deposit test assembly

A.2.1 Deposit collector

The deposit collector is made of aluminum plate with a thickness of 4 mm and made of 1060 aluminum. The processing dimensions and shape are shown in Figure A.3. 2 rectangular notches on the lower edge of the collector are used for positioning. There is a thermocouple jack in the middle of the upper end of the collector. The aperture is φ1.7 mm. The diameter of the thermocouple is φ1.5 mm.

A.2.2 Fan nozzle body

The nozzle body uses an air atomizing fan nozzle. The product model is B1/4J+SUF1, in which B1/4J is the nozzle body; the interface is 1/4BSPT internal thread; SUF1 is the spray device, which is composed of air cap PA73420 and liquid cap PF2850. The needle valve at the rear end of the nozzle body is used to adjust the output of liquid. The opening is generally not more than 2.5 turns. The front end of the nozzle body is 16 mm~17 mm away from the deposit collector. The shape of the fan nozzle sprayed onto the deposit collector is lip-shaped, with a length of about 27 mm~32 mm and a width of about 5 mm~8 mm.

A.2.3 Plate heater

The plate heater is made of aluminum or copper. Its shape and dimensions are shown in Figure A.4. In the heater, two heating tubes are placed. The total heating power is 300 W. At one end of the heater, an over-temperature

B.2.4 Calibration reference detergent

A gasoline detergent with stable physicochemical properties, tested using GB/T 19230.6, and with an average intake valve deposit of 40 mg~60 mg.

B.3 Calibration requirements

B.3.1 The deposit formation amount of calibration reference fuel containing the calibration reference detergent is 2.0 mg±0.2 mg.

B.3.2 The deposit formation amount of calibration reference fuel is 8 mg±1 mg.

B.4 Calibration procedures

B.4.1 The deposit test of the calibration reference fuel after adding the calibration reference detergent. ADD the appropriate amount of calibration reference detergent to 300 mL of calibration reference fuel. By adjusting the amount of addition of deposit accelerant, the deposit mass produced by two consecutive tests meets the requirements of B.3.1. The results of two consecutive tests differ by no more than 0.3 mg. At this time, the amount of deposit accelerant is the calibration amount of the equipment.

B.4.2 The deposit test of calibration reference fuel. The calibration amount of deposit accelerant (B.4.1) is added to 300 mL of calibration reference fuel. The test results shall meet the requirements of B.3.2. The results of two consecutive tests differ by no more than 0.3 mg.

B.4.3 When the B.4.2 test does not meet the requirements; it is necessary to adjust the equipment. For the adjustment method, refer to the equipment description or consult the equipment manufacturer.

B.4.4 After the equipment is adjusted, REPEAT B.4.1~B.4.3, until the two calibration requirements of B.3 can be satisfied at the same time.

B.5 Calibration cycle

When the following occurs, the simulation testing machine of intake valve deposit of gasoline engine needs to be calibrated:

a) The equipment, after installation, is ready for use;

b) After the replacement of key equipment parts (nozzle body, plate heater, temperature controller, thermocouple, etc.);

c) When the sample verification result is obviously unreasonable;

d) When changing different batches of deposit accelerant;

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