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## Performance Test Method of Three-way Catalyst

汽车尾气三效催化剂性能试验方法



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**Standardization Administration of the People's Republic of China.**

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# Foreword

This Standard was drafted in accordance with the rules given in GB/T 1.1-2009.

This Standard was proposed by China Petroleum and Chemical Industry Federation.

This Standard shall be under the jurisdiction of Subcommittee 10 on Catalysts of National Technical Committee 63 of Standardization Administration of China.

The main drafting organizations of this Standard: Fuzhou University State Engineering Research Institute of Fertilizer Catalysts, Research Institute of Nanjing Chemical Industry Group, Shandong Institute for Product Quality Inspection.

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# Performance Test Method of Three-way Catalyst

## 1 Application Scope

This Standard specifies the test method of light-off temperature, air-fuel ratio and oxygen storage capacity of three-way catalyst for gasoline vehicles.

This Standard applies to the three-way catalyst for the purification of the tail gas of vehicles, which is made by using cordierite honeycomb ceramics or metallic honeycombs as base and loading catalyst coating.

## 2 Normative References

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

GB 18352.5-2013, *Limits and Measurements Methods for Emissions from Light-duty Vehicles (China 5)*

## 3 Terms and Definitions

For the purposes of this Standard, the following terms and definitions apply.

**3.1**

**three-way catalyst**

A catalyst which is capable of oxidizing carbon monoxide, hydrocarbons and reduced nitrogen oxides at the same time, near the theoretical air-fuel ratio 14.63 or oxidizing-to-reducing components ratio 1.

**3.2**

**light-off temperature**

The temperature of catalyst inlet corresponding to the conversion of some pollutant up to 50%. It is expressed with the symbol $T_{50(i)}$.

NOTE "*i*" represents pollutants carbon monoxide (CO), hydrocarbons (HC) and nitrogen oxides ($NO_x$).

**3.3**

**5.2.4** Reactor: inner diameter 30 mm; rated temperature 1 000°C, power meeting the maximum temperature rise rate 30°C/min, temperature control accuracy ± 2°C; constant-temperature zone not less than 10 cm; reaction temperature as the temperature of 2 cm from the axis of catalytic bed in the catalyst gas inlet direction, temperature measurement accuracy not lower than 1.5°C.

**5.2.5** System control and sampling recording system: the sampling frequency of the data acquisition system for temperature and pollutant concentration shall not be less than 1 Hz.

### 5.3 Verification and tolerances

Under normal conditions, the parallelism and reproducibility of the test apparatus shall be determined once each month at least using reference specimens. Under special circumstances, they may be verified at any time.

One reference specimen shall be used for three repeated tests at least; the reproducibility of the light-off temperature (maximum difference value) is not greater than 10°C; and the reproducibility of oxygen storage capacity (relative value) is within ± 5%.

## 6 Test Procedures

**Warning: The raw gases and tail gas used in the tests involved in this Standard pose toxic, combustible and explosive hazards to the health and safety of human body, so air leakage of the system shall be prevented, no open fire is allowed on site, and necessary fire-fighting equipment and ventilation equipment and other protective facilities shall be provided.**

### 6.1 Preparation of specimens

The dimensions of specimens are $\phi$ 25 mm × 50 mm; and the specimens shall be maintained for structural integrity and free from visible defects and cracks.

### 6.2 Filling of specimens

After wrapping high temperature resistant ceramic fibre cotton at both ends of the specimens, load in the reactor, use ceramic fibre cotton to seal tightly the gaps at both ends of catalyst, and connect to the system.

### 6.3 System leak test

Pump air into the system, maintain for 10 min under the condition of pressure not lower than 0.1 MPa, use the methods including brushing neutral foaming agent to check all sealing points, and deal with it in case of any leak. After the test result is approved, open the system to ventilate to reduce the pressure of the system to normal pressure. Insert the temperature measurement thermocouples for the inlet into the thermowell,

of the catalyst specimens for carbon monoxide (CO), hydrocarbons (HC) or nitrogen oxides ($NO_x$).

**6.5.2** Air-to-fuel ratio

Raise the temperature of the reactor at 10°C/min until the catalyst inlet temperature becomes stabilized at 450°C, pump mixed gas of oxidizing-to-reducing components ratio ($\lambda$) 0.940 ~ 1.060 (see Table 1), and maintain the airspeed at 60 000 $h^{-1}$ and the system pressure at normal pressure. Measure in real time the values of carbon monoxide (CO), hydrocarbons (HC) or nitrogen oxides ($NO_x$) at the inlet and outlet of catalyst. The test points shall not be less than 10.

Use the oxidizing-to-reducing components ratio as abscissa and the conversion as ordinate to plot the air-to-fuel curve.

Calculate the conversion of the specimens for carbon monoxide (CO), hydrocarbons (HC) or nitrogen oxides ($NO_x$) when the oxidizing-to-reducing components ratio $\lambda$ = 0.998.

**6.5.3** Oxygen storage capacity

Raise the temperature of the reactor at 10°C/min until the catalyst inlet temperature becomes stabilized at 450°C, pump mixed gas of oxidizing-to-reducing components ratio ($\lambda$) 0.940, and maintain for a certain time ($t_1$) (not less than 5 s) before switching the reaction atmosphere instantly to mixed gas of oxidizing-to-reducing components ratio 1.060 (see Figure 2). Measure the $\lambda$ value of catalyst using air-to-fuel ratio meter or exhaust gas analyzer and obtain the time $t_2$ of the specimens' $\lambda$ signal changing suddenly to $\lambda$ = 1. Repeat the test for 5 times. When the 5 consecutive test results have no an identical kind of tendency and the relative deviation between two test results is not greater than 5%, the oxygen storage capacity test is completed. Take the arithmetic mean value of the 5 consecutive test results as the test result.

# 7 Test Data Processing

## 7.1 Conversion

The conversion is calculated in terms of $E$ in accordance with Formula (1):

$$E = \frac{\varphi_{i1} - \varphi_{i2}}{\varphi_{i1}} \times 100\% \qquad \text{.....(1)}$$

where,

$\varphi_{i1}$—the volume by volume concentration of the gas pollutant $i$ at the catalyst inlet, expressed in %;

$\varphi_{i2}$—the volume by volume concentration of the gas pollutant $i$ at the catalyst outlet,