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Automobile shock absorber technique requirements and test methods

汽车减振器性能要求及台架试验方法

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Automobile shock absorber technique requirements and test methods

1 Scope

1.1 This standard specifies the performance requirements and bench test methods for automobile shock absorbers.

1.2 This standard is applicable to the shock absorbers, which are used for the suspension of categories M, N, O automobiles. The shock absorbers for cab suspension and other shock absorber components can be implemented with reference to it.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) is applicable to this standard.

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

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

QC/T 484 Automobile - Paint coating

QC/T 572 Directives for motor vehicle cleanliness - Measuring method

3 Terms and definitions

The following terms and definitions apply to this standard.

3.1

Telescopic shock absorber

The shock absorber, which is composed of the working cylinder and the outer cylinder for oil storage, is a telescopic shock absorber. In this standard, unless otherwise specified, the telescopic shock absorber is referred to as shock absorber for short.

3.2

Suspension struts

The telescopic shock absorber, which is installed on the suspension to play a guiding role, bears a certain lateral force, usually is composed of the accessories such as spring discs and brackets, is called a suspension struts-type shock absorber. Unless otherwise specified in this standard, the suspension struts-type telescopic shock absorber is referred to as the suspension struts.

3.3

Stroke

The maximum moving distance, that the piston can reach, during the use of the shock absorber. It is the difference, between the maximum length and the minimum length of the shock absorber product.

3.4

Force-displacement characteristic

Under a certain test stroke and frequency, when the two ends of the shock absorber perform relatively simple harmonic motion, the relationship between the damping force (F) and the test stroke (S) is the force-displacement characteristic. The curve (F-S) formed is called the force-displacement diagram.

3.5

Ratio of vacant path

The ratio -- of the fluctuation length (idle stroke) in the force-displacement diagram TO the test stroke, which is measured at any speed, -- is called the ratio of vacant path (δ).

3.6

Force-velocity characteristic

When the two ends of the shock absorber perform relatively simple harmonic motion, the relationship between the damping force (F) and the piston speed (V) is the force-velocity characteristic. The curve (F-v), which is formed at various speeds, is called the force-velocity characteristic diagram.

3.7

Force-temperature characteristic

Under the same speed conditions of the shock absorber, the relationship between the damping force (F), which is measured at different temperatures, and the temperature (t), is the force-temperature characteristic. The curve (F-t), which is formed by it, is called the force-temperature characteristic diagram.

3.8

Friction-force of damper (F_f)

When the shock absorber moves, at a speed not exceeding 5.0 x 10^{-3} m/s, the resistance it experiences at this time is defined as friction.

3.9

Air-force of damper (F_{air})

For gas-filled shock absorbers, when the piston is in the middle position of the working stroke, the force of the gas, which acts on the piston rod, is the air-force of damper.

Note: For the gas-force of damper, which is measured at the middle position of the non-working stroke, it shall indicate the test position in the results.

3.10

Anti-foam characteristic

The ability of a force-displacement characteristic to resist the effects of foam is called anti-form characteristic.

4 Basic dimensions and parameters

4.1 Working cylinder diameter and piston rod diameter of shock absorber

The diameter of the working cylinder and piston rod of shock absorber is as recommended in Table l.

parameters shall be automatically recorded, saved, output; the sampling frequency shall not be lower than 200 Hz.

6.1.3 The accuracy of sensors, such as displacement, load, speed, shall not be lower than ±0.5% of the full range of each sensor; the indication error of the temperature sensor shall not be greater than ±0.1 °C; the indication error of the weighing instrument, which is used in the test process, shall not be greater than ±1 g.

6.1.4 The test device, which is used for the durability test, can be single-action or double-action. The single-action test bench shall be able to conduct the test, according to the composite waveform, which is formed by the superposition of low-frequency waves and high-frequency waves.

6.2 Requirements for test method

6.2.1 Test preparation

6.2.1.1 Before the test, it shall ensure that the shock absorber samples are stored in a vertical state, at room temperature for at least 2 hours.

6.2.1.2 Unless otherwise specified, install the shock absorber in the vertical direction on the test bench for testing; ensure that there is no additional load, as caused by the installation.

6.2.1.3 Carry out the test, at the middle position of the working stroke of the shock absorber. During the test, the deviation, between the midpoint position of the piston's reciprocating motion and the middle position of the working stroke, shall not exceed ±5% of the working stroke.

6.2.1.4 The shock absorber is first subject to 3 cycles of gas exhaust. The exhaust process is carried out, at a maximum speed of 0.52 m/s, which is obtained by adjusting the test stroke s = 100 mm and frequency f = 1.67 Hz. For shock absorbers, which have a working stroke of less than 100 mm, it may select 75 mm, 50 mm or 25 mm as the test stroke, according to the product, OR according to the agreement between the supplier and the buyer. The movement speed v of the piston of shock absorber is calculated, according to formula (4):

$$v = \pi \cdot s \cdot f \times 10^{-3} \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (4)$$

6.2.2 Force-displacement characteristic test

6.2.2.1 Prepare the sample before the test, according to 6.2.1.

6.2.2.2 After the exhaust process is completed, conduct the test, in the form of a sine wave, according to the test stroke used in 6.2.2.1. Adjust the frequency, to make the test speed be 0.13 m/s, 0.26 m/s, 0.52 m/s, 1.04 m/s. Record the displacement and load data

requirements of 5.5. Both the supplier and the buyer may refer to the provisions of 6.2.6.1 ~ 6.2.6.5, to conduct the test, to obtain the rate of change of the damping force and the force-temperature characteristic diagram of other speeds and temperatures; evaluate the results, according to the technical requirements of the supplier and the buyer.

6.2.7 Anti-foaming test

6.2.7.1 Prepare the sample before the testing, according to 6.2.1.

6.2.7.2 Under the condition that the shock absorber is allowed to be air-cooled and dissipated, use the test stroke, which is selected in 6.2.7.1, to make 100 consecutive movements, in the form of sine waves at a speed of 1.04 m/s. Record the last 3 movements continuously, namely the force-displacement diagrams of the 98^{th}, 99^{th}, 100^{th} cycles.

6.2.7.3 The anti-foaming properties of the shock absorber shall meet the requirements of 5.6.

6.2.8 Durability test

6.2.8.1 The relevant functional parts and accessories, that affect heat dissipation, such as dust cover, shall be removed as far as possible from the test piece, to improve the cooling effect.

6.2.8.2 Weigh the test piece. Record the mass of the test piece, m_0, before durability test.

6.2.8.3 Install the sample on the durability test bench. The temperature measurement unit shall be installed on the outer wall of the outer diameter guide of the shock absorber's liquid cylinder, at a position more than 20 mm downward from the upper end of the liquid cylinder; it shall be thermally insulated from outside. During the test, forced cooling is allowed, to dissipate heat from the shock absorber.

6.2.8.4 Carry out the test, under one of the following two conditions. During the test, the temperature of the shock absorber shall be controlled within the range of (70 ± 10) °C:

1) The test condition of the low-frequency end (upper end) is f_1 = 1.67 Hz; the test stroke s_1 = 100 mm. The test condition of the high-frequency end (lower end) is f_2 = 10 Hz; the test stroke s_2 = 16 mm;

2) The test condition of the low-frequency end (upper end) is f_1 = 1 Hz; the test stroke s_1 = 80 mm. The test condition of the high-frequency end (lower end) is f_2 = 12 Hz; the test stroke s_1 = 20 mm.

During the test, when the temperature exceeds the requirements of temperature range, the test equipment is allowed to drive the piston of shock absorber, to reciprocate at a

low speed, to speed up the cooling of the sample under the forced cooling environment; however, the number of cooling cycles shall not be included in the number of cycles of the durability test.

6.2.8.5 The number of test cycles shall be accumulated, according to the high frequency end, which shall not be less than 3.0 x 10^6 cycles.

6.2.8.6 For shock absorbers, whose working stroke is less than 100 mm, it may select 75 mm, 50 mm or 25 mm as the test stroke, for the low frequency end, according to the product, OR according to the agreement between the supplier and the buyer. The movement speed v of the piston of shock absorber is calculated, according to formula (4), to meet the speed requirements of low frequency and high frequency.

6.2.8.7 During the durability test, lateral force is allowed to be applied within the range of more than 20 mm, downward from the upper end of the liquid cylinder. The magnitude and direction of the lateral force can be determined, through negotiation between the supplier and the buyer.

6.2.8.8 After completing the number of tests required in 6.2.8.5, perform the force-displacement characteristic test on the test piece, according to 6.2.2. Weigh the test piece, according to the same conditions as 6.2.8.2. Record the mass of the test piece, m_1, after the durability test.

6.2.8.9 Calculate the change rate of the damping force of shock absorber, before and after durability test, according to formula (9) and formula (10):

$$\varepsilon_{nr} = \frac{F_r - F_{nr}}{F_r} \times 100\% \qquad \cdots\cdots (9)$$

$$\varepsilon_{nc} = \frac{F_c - F_{nc}}{F_c} \times 100\% \qquad \cdots\cdots (10)$$

Where:

F_{nr} – The recovery resistance after durability test;

F_{nc} - The compression resistance after durability test.

6.2.8.10 Calculate the damping oil atomization rate of shock absorber, λ, according to formula (11):

$$\lambda = \frac{m_0 - m_1}{m_{oil}} \times 100\% \qquad \cdots\cdots (11)$$

6.2.8.11 The durability test of the shock absorber shall meet the requirements of 5.7. After the coordination between the supplier and the buyer, the durability index assessment can also be carried out, at other speeds according to 6.2.8.1 ~ 6.2.8.10; the

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