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Performance test methods for facepiece of filter type respirator

过滤式防毒面具面罩性能 试验方法

Replaced (Obsolete)

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Performance test methods for facepiece of filter type respirator

1 Subject content and scope of application

This Standard specifies the air leakage coefficient for the wearing, actual dead space, field of view, assembly air tightness, exhalation valve air tightness, exhalation valve resistance to air, lens transmittance (transmittance ratio) and facepiece inhalation resistance and other performance test methods for filter type respirators.

This Standard applies to the test and evaluation of the performance of filter type respirators (hereinafter referred to as facepieces); it also applies, as a reference, to other related products.

2 Normative references

GB/T 528, Rubber, vulcanized or thermoplastic - Determination of tensile stress-strain properties

GB 2410, Transparent plastics - Transmissivity and haze test

GB 2428, Head-face dimensions of adults

3 Technical content

3.1 Test method for air leakage coefficient for the wearing of facepiece (oil mist method)

3.1.1 Principle

After a person wears a respirator, the ratio OF the concentration c of harmful substances leaked into the facepiece through the facepiece sealing frame, exhalation valve and facepiece component assembly parts AND the external concentration c_0 is called the air leakage coefficient of the facepiece, which is expressed in percentage (%).

3.1.2 Test device

See Figure 1 for the test device system.

c. Speak and take a deep breath for about 1 minute.

3.1.3.4 The oil mist concentration in the oil mist chamber shall be within the range of 1 000 ~ 2 500 mg/m^3.

3.1.3.5 The filtration efficiency of the canister for oil mist shall be higher than 99.995%. During the test, measures shall be taken to make the canister absorb the air outside the oil mist chamber.

3.1.3.6 The air tightness of the exhalation valve and the air tightness of the assembly of the tested facepiece shall meet the standard requirements.

3.1.3.7 Mount a sampling tube on the tested facepiece; ensure air tightness of the interface; make the tube end close to the mouth and nose area.

3.1.4 Test procedures

3.1.4.1 Preparation

3.1.4.1.1 Prepare the tested facepiece; mount the sampling tube; take measures to make the canister absorb the air outside the oil mist chamber; prepare alcohol cotton balls for disinfection;

3.1.4.1.2 Select the subjects; register the selected head and face size and special features; inform the subjects of the test requirements;

3.1.4.1.3 Check all instruments and equipment to make them in normal working condition.

3.1.4.2 Test

3.1.4.2.1 Pass the oil mist into the oil mist chamber, and make its concentration meet the requirements and be basically stable. Start the air pump to take a sample of the airflow; measure it through the oil mist turbidity meter; adjust the instrument indication to 100%, which is c_0;

3.1.4.2.2 Let the subject wear a respirator; conduct a preliminary air tightness inspection according to the use method; adjust it properly; connect the sampling tube to the turbidity meter;

3.1.4.2.3 Start the air pump; measure the concentration of air flow when the subject breathes in the smoke-free air outside the oil mist chamber; take 5 samples, and get the background concentration c_e on average;

3.1.4.2.4 Let the subject enter the oil mist chamber and act according to the regulations in 3.1.3.3; measure the concentration of air flow in each case, 5 data for each; obtain the air leakage concentration c on average;

d. Make the instrument in a state available for working according to the instructions of the selected CO_2 analysis instrument;

e. Start the ventilation equipment to keep the indoor CO_2 concentration indoors not greater than 1%.

3.2.4.2 Test

a. Unscrew the CO_2 steel cylinder; inflate about 3 ~ 5 L into the air storage bag 1 and drain it. Rinse 2 times in this way; fill 1 bag with about 3/4 volume, and slow down the inflation speed;

b. Put the facepiece under test on the standard head-face; pay attention to wearing it correctly, properly loose and tight, and the sealing frame is airtight;

c. Start the mechanical lung to breathe for about 0.5 min; then, remove the air storage bag 5 to exhaust air; repeat it twice; at this time, the concentration of the air bag and the mechanical lung sampling system reaches a stable balance;

d. Stop the operation of the mechanical lung 1 minute after the formal breath sampling; take off the facepiece under test;

e. Detect the gas sample concentration of the CO_2 analysis instrument supplied from the gas storage bag 5; analyze the gas sample 3 times each time; calculate the average value.

3.2.4.3 Retest

a. For each facepiece, follow the steps in 3.2.4.2 and repeat 3 ~ 4 times;

b. During the test, sample and analyze the CO_2 concentration from the surrounding environment of the facepiece to obtain c. If c is not greater than 0.5%, when calculating P according to Formula (4), c can be ignored.

3.2.5 Test result

Calculate the average value and standard deviation from the obtained 4 ~ 5 P values for each facepiece.

3.2.6 Test report

According to 3.1.6.

3.3 Test method for the field of view of the facepiece

3.3.1 Principle

Mount a low-voltage light bulb at the eyeball position of a standard head-face, so that the solid angle of the light is equal to the solid angle of the average Chinese adult's field

of view. After wearing the facepiece, the light cone shrinks due to the limitation by the eye window of the facepiece; and the percentage it preserves is equivalent to the preservation rate of field of view after the standard head-face wears the facepiece. Use a medical perimeter to measure the field of view after wearing the facepiece. Measure the total area of field of view of the two eyes together and the area of the binocular field of view of the common part of the two eyes. Find their corresponding percentages when not wearing a facepiece, and use the correction coefficient to correct the total field of view preservation rate and the binocular field of view preservation rate. The lower field of view (degree) of wearing the facepiece is then determined by the position of the lower cross point of the binocular field of view.

3.3.2 Test devices

3.3.2.1 Perimeter: consists of three parts:

a. Semi-circular arc bow: radius 300 ~ 340 mm; can rotate around the horizontal radius passing through the midpoint of 0°; there is a scale every 5° from 0° on both sides, extending to 90°; the arc bow is equipped with a slidable white visual target;

b. Recording device: the recording needle is linked with the visual target through the shaft wheel and other components; record the orientation and angle of the visual target on the visual field drawing;

c. Stand: used for supporting the semi-circular arc bow and fixing the recording device.

3.3.2.2 Standard head-face: shall comply with GB 2428; with black paint on the surface, 6.3 V small light pools installed in the pupils of the two eyes; the connection line of the light bulb vertexes is 7±0.5 mm behind the midpoint of the two eyes; the field of view of the head-face itself shall comply with the average Chinese adult's field of view. The standard head-face shall be installed on the workbench so that the left and right eyes can be placed at the center of the semi-circular arc bow respectively and look directly at its "0" point.

3.3.2.3 Recording paper: used together with the recording device, with the average visual field curve printed on it.

3.3.2.4 Planimeter: for measuring the graphic area, with an accuracy of 0.1 cm^2.

3.3.3 Test conditions

3.3.3.1 According to the number of the facepiece under test, select the standard head-face of the corresponding number.

3.3.3.2 The test work shall be carried out in a dark room.

a. Use alcohol cotton to wipe the exhalation valve under test; air-dry or blow dry.

b. The connection between the exhalation valve under test and the constant volume cavity shall be airtight, perpendicular to the horizontal plane, and the valve plate shall not be deformed by force.

3.5.4 Test procedures

3.5.4.1 Check the air tightness of the instrument system; close the constant-volume cavity and the through-hole of the exhalation valve; pump air to a negative pressure of 1 180 Pa; no pressure change shall be observed within 2 minutes after closing the pump control valve.

3.5.4.2 Prepare test samples according to test conditions.

3.5.4.3 Install the exhalation valve on the constant volume cavity.

3.5.4.4 Pump air at a flow rate not greater than 500 mL/min until the negative pressure in the constant volume cavity is 1 250 Pa; close the control valve.

3.5.4.5 Starting from the negative pressure of 1 180 Pa, start the stopwatch and record the negative pressure change value in 45 s or the time required to return to 0.

3.5.4.6 Replace the exhalation valve and repeat the above test.

3.5.5 Test result

It is unqualified when any of the following conditions occurs:

a. The pumping flow rate has reached 500 mL/min, but the negative pressure cannot reach 1 180 Pa.

b. The negative pressure change within 45 s of the exhalation valve for the full-face mask is greater than 590 Pa.

c. It takes less than 20 s for the exhalation valve for half mask to return to normal pressure.

3.5.6 Test report

According to 3.1.6.

3.6 Test method for exhalation valve resistance to air flow

3.6.1 Test device

3.6.1.1 See Figure 6 for the test device.

3.7.2.1 For masks with detachable canisters, the canisters must be removed. For structures that cannot be disassembled (such as filter element bags), the resistance of the individual filter elements to air flow is deducted from the test results to represent the inhalation resistance of the mask.

3.7.2.2 The standard head-face used in the test matches the number of the facepiece and is worn correctly. The airtight frame shall not leak air; the airway shall be bent by 180°.

3.7.2.3 The test continuous air flow is 30 ± 0.6 L/min.

3.7.3 Test procedures

3.7.3.1 Check that each connecting part of the test device shall be airtight.

3.7.3.2 Make the flowmeter and micromanometer work normally.

3.7.3.3 Start the air pump; adjust the screw clamp so that the air flow is 30 ± 0.6 L/min; measure the system resistance P_1.

3.7.3.4 Wear the facepiece according to the requirements of 3.7.2.2; adjust the suction flow to 30 ± 0.6 L/min; measure the resistance P_2.

3.7.4 Test result

The resistance value of a single facepiece is:

$$P = P_2 - P_1 \qquad \cdots\cdots (7)$$

3.7.5 Test report

According to 3.1.6.

3.8 Test method for light transmittance (light transmittance ratio) of facepiece lens

Same as GB 2410.

Prepare the test report according to 3.1.6.

3.9 Test method for 300% constant tensile strength before aging, breaking strength and breaking elongation of hood-type facepiece (rubber)

Same as GB/T 528.

Take the sample from the edge of the sealing frame of the hood-type facepiece and from the head.

Prepare the test report according to 3.1.6.

3.10 Test method for hot air aging of the exhalation valve

3.10.1 Principle

Measure the air tightness of the exhalation valve block of qualified air-tightness after aging for a certain period of time under the action of hot air at normal pressure and specified temperature.

3.10.2 Test device

The hot air aging box shall meet the following requirements:

a. The temperature fluctuation range of the test area in the box is ±2 °C;

b. There must be a continuous blower device in the box;

c. There shall be an air inlet and an exhaust port.

3.10.3 Test conditions

a. aging temperature: 100 ± 2 °C;

b. aging time: 8 h.

3.10.4 Test procedures

3.10.4.1 Adjust the temperature in the aging box to 100 ± 2 °C. After the temperature is stable, place the test sample on the valve seat and seal it in the aging box in a free state. The distance between the samples is not less than 5 mm; the distance between the sample and the box wall is not less than 50 mm.

3.10.4.2 Put the sample into the constant temperature aging box as required and take it out after 8 hours. After placing it at room temperature for 4 hours, check whether it is sticky or deformed, and test its air tightness according to 3.5.

3.10.5 Test result

According to 3.5.5.

3.10.6 Test report

According to 3.1.6.

3.11 Test method for bonding strength between facepiece, airway and canister (box)

3.11.1 Principle

Use a rubber tensile machine to test the bonding strength between the facepiece and the airway, the canister (box) or between the airway and the canister.

3.11.2 Test device

The tester is a pendulum rubber tensile machine, and the technical requirements are:

a. measuring range: 0 ~ 980 N;

b. traction speed of the lower fixture: 100 ± 5 mm/min.

3.11.3 Test procedures

3.11.3.1 Clamp the lower part of the Y-shaped tube of the facepiece that has been assembled and placed for 24 hours into the main clamp of the tensile machine. The direction of the clamp shall be perpendicular to the Y-shaped tube.

3.11.3.2 Clamp the lower end of the air duct into the lower fixture so that the lower fixture is about 20 ~ 30 mm away from the Y-shaped nozzle. Turn on the tensile machine, and stop the test when the reading on the load dial is greater than the specified value.

3.11.3.3 The test of the bonding strength between the facepiece and the canister (box), or between the airway and the canister can be carried out according to 3.11.3.1 and 3.11.3.2 after being fixed with auxiliary measures.

3.11.4 Test result

Read the bonding strength value from the load dial respectively; it is qualified when the reading is greater than the specified value.

3.11.5 Test report

According to 3.1.6.

Note: The bonding strength between respirator parts can also be tested by the static hanging weight method. The hanging weight of the duct respirator test is 15 kg, and the hanging weight of the direct respirator test is 5 kg.

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