GB

NATIONAL STANDARD OF THE

PEOPLE'S REPUBLIC OF CHINA

ICS 91.140.30

Q 76

GB/T 13554-2020

Replacing GB/T 13554-2008

High efficiency particulate air filter

高效空气过滤器

Issued on: March 31, 2020 **Implemented on: February 01, 2021**

Issued by: State Administration for Market Regulation;

Standardization Administration of the People's Republic of China.

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High efficiency particulate air filter

1 Scope

This Standard specifies classification and marking, materials, structure and production environment, technical requirements, test methods, inspection rules, marks, packaging, transportation and storage for high efficiency air filter and ultra-low penetration air filter (hereinafter referred to as "the filter").

This Standard is applicable to the filter used in air supply and exhaust air purification system and equipment at room temperature.

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 191, *Packaging and storage marks*

GB/T 531.1, *Rubber vulcanized or thermoplastic - Determination of indentation hardness - Part 1: Durometer method (Shore hardness)*

GB/T 3274, *Hot-rolled plates and strips of carbon structural steels and high strength low alloy structural steels*

GB/T 3280, *Cold rolled stainless steel plate sheet and strip*

GB/T 3880.1, *Wrought aluminium and aluminium alloy plates, sheets and strips for general engineering - Part 1: Technical conditions of delivery*

GB/T 3880.2, *Wrought aluminium and aluminium alloy plates，sheets and strips for general engineering - Part 2: Mechanical properties*

GB/T 4857.23, *Packaging - Basic tests for transport packages - Part 23: Random vibration test method*

GB/T 6165, *Test method of the performance of high efficiency particulate air filter - Efficiency and resistance*

GB/T 6669, *Flexible cellular polymeric materials - Determination of compression set*

linear adhesive or other partitions to form an air channel

3.1.7 rated air flowrate

technical parameter that identifies the working capacity of the filter; it indicates the maximum air volume flow rate per unit time to ensure the efficiency of the filter

NOTE: The rated air flowrate is provided by the filter manufacturer.

3.1.8 resistance

the static pressure difference before and after the filter element under certain test wind speed or air volume conditions; for the filter, it is the static pressure difference before and after of the filter under the rated air volume

3.1.9 initial resistance

the resistance of the filter in the initial state of being clean and without any treatment

3.1.10 final test resistance

when the life cycle comprehensive energy efficiency test is carried out according to the method specified in this Standard, the filter element resistance determined as the test termination condition

3.1.11 final resistance

the specified resistance that the filter captures a considerable amount of dust during use and the filter shall be replaced

3.1.12 comprehensive average resistance

the weighted average resistance of the filter element obtained when the life cycle comprehensive energy efficiency test is carried out according to the method specified in this Standard

3.1.13 dust loading capacity

when the life cycle comprehensive energy efficiency test is carried out according to the method specified in this Standard, the weight gain when the tested filter element reaches the specified final test resistance

3.2 Abbreviations

The following abbreviations apply to this document.

DEHS: sebacic acid-bis (2-ethyl-)ester, with a common name of di-ethyl-hexyl-

Example 2: Minipleat-style ultra-low penetration air filter, of which the efficiency level is 65, the efficiency test method is counting method, scanning method is sued for leak test, dimensions are 610mm×1220mm×80mm, the rated air flowrate is 2400m^3/h, is marked as: CGW-65-J-S-610×1220×80-2400.

5 Materials, structure and production environment

5.1 Materials

5.1.1 Basic requirements

The fireproof performance of the filter shall meet the fireproof requirements of its application environment. The materials used shall maintain stable performance and no dust. When corrosion resistance is required, the materials used shall have corresponding anti-corrosion properties.

5.1.2 Filter material

5.1.2.1 The penetration and resistance of the filter material shall meet the performance requirements for similar filter materials in this Standard.

5.1.2.2 The tensile strength of filter paper shall meet the requirements of GB/T 12914. Its longitudinal tensile strength shall not be less than 0.7kN/m. The transverse tensile strength shall not be less than 0.5kN/m.

5.1.2.3 The thickness of the filter material under the pressure of (3.5±0.2)kPa shall not exceed 0.40mm. It shall be uniform and free of lumps. There shall be no cracks, scratches, pinholes and stains on the surface of the filter material.

5.1.2.4 The outgassing performance of the filter material shall meet the special requirements of the application environment.

5.1.2.5 Other properties of the filter material shall meet the relevant regulations of JG/T 404.

5.1.3 Frame

5.1.3.1 The frame material shall have the required strength and rigidity. Material thickness shall be selected according to material and side length.

5.1.3.2 When using the following materials, it shall meet the requirements of relevant standards. And it shall take corresponding anti-rust or anti-corrosion measures:

a) Cold rolled steel plate shall meet the requirements of GB/T 3274. The thickness shall be 1.0mm~2.0mm. After forming and welding, it shall be galvanized, sprayed or take other anti-rust measures;

5.2 Structure

5.2.1 Filter cartridge

5.2.1.1 Filter cartridge of separator-style filter

When the filter cartridge is fixed in the frame, the separator shall expose the filter material folds by 3mm~5mm and retract into the frame end face by 5mm~8mm.

5.2.1.2 Filter cartridge of minipleat-style filter

When the filter cartridge is fixed in the frame, the filter material and divider shall be retracted into the end of the frame by 3mm~5mm.

5.2.2 Frame

5.2.2.1 The frame structure shall be strong. It shall have sufficient rigidity and overall stability.

5.2.2.2 The four corners of the frame and the joints shall not be loose. Adhesives and sealants shall not be degummed or cracked. The filter material shall not be loose and deformed in the frame.

5.2.2.3 The frame width shall be 15mm~20mm. For the filter with a side length not less than 600mm, the frame width shall be 20mm.

5.2.3 Sealing gaskets

5.2.3.1 The section of the gasket shall be rectangular (the width shall be greater than 15mm and not exceed the frame, and the thickness shall be 5mm~8mm) or semicircular (the diameter shall be 15mm). The bonding surface and sealing surface of the rectangular section gasket shall be peeled.

5.2.3.2 The gasket shall be integrally or spliced formed. The splicing shall be at the corner. It shall adopt Ω type or dovetail connection mode. The joint shall be firmly bonded with adhesive. The number of splicing of the entire gasket shall not exceed 4.

5.2.3.3 The gasket and the frame shall be firmly bonded. The inner and outer edges of the gasket shall not exceed the inner and outer edges of the frame.

5.2.4 Liquid tank sealing

For filters with liquid tank sealing method, the performance of the non-Newtonian fluid sealing material used shall ensure that it does not flow and is flexible at working temperature. The height of the knife edge shall match the depth of the liquid tank. The height of the knife edge and the depth of the liquid

tank shall be determined according to the surface wind speed and the final resistance of the filter when the filter is used.

5.2.5 Filter splicing and repair

5.2.5.1 There shall be no more than one splicing joint for the filter material of each separator-style high efficiency particulate air filter. The filter material of the ultra-low penetration air filter shall not have splicing joints.

5.2.5.2 When splicing two pieces of filter material by overlap, the overlap width shall not be less than 13mm.

5.2.5.3 The overlap interface shall not be set at the turning point where the filter material is folded.

5.2.5.4 Each repair area shall not exceed 20mm×20mm. The total repaired area shall not exceed 1% of the net area of the filter end face.

5.3 Production environment

The production environmental conditions of the filter shall ensure that the whole process of filter production (to the time of packing) is not polluted. The indoor air cleanliness level of the assembly workshop of high efficiency particulate air filter shall reach level 8. The indoor air cleanliness level of the assembly workshop of ultra-low penetration air filter shall reach level 7.

6 Technical requirements

6.1 Appearance

6.1.1 There shall be no contaminants and damages such as mud, oil, viscous object on the filter surface. There shall be no frame bumps, twists or cracks. The surface coating layer shall not have uneven and peeling damage.

6.1.2 Filter materials, dividers, and protective nets shall not be deformed. Sealing gaskets shall not loose.

6.1.3 The sealant shall be neat without cracks. The infiltration height along the filter material and the separator shall not be greater than 5mm.

6.2 Size deviation

6.2.1 For filters with side length greater than 500mm, the end face size deviation shall be (0,-3.2) mm. For filters with side length not greater than 500mm, the end face size deviation shall be (0,-1.6) mm.

6.2.2 The deviation of the filter depth shall be (+1.6,0) mm.

7 Test methods

7.1 Appearance

Visual inspection can be used for appearance. The sealant infiltration height shall be checked with a steel ruler. Its graduation value shall not be greater than 1mm.

7.2 Size deviation

7.2.1 The size deviation inspection shall be carried out on a stable and level horizontal workbench.

7.2.2 The length shall be checked with steel ruler. Its graduation value shall not be greater than 1mm.

7.2.3 The flatness shall be checked with tablet and feeler gauge. The tablet accuracy shall be level 3. The thickness range of the feeler gauge shall be 0.02mm~0.50mm.

7.2.4 The verticality shall be checked with an angle gauge. Its graduation value shall not be greater than 0.5°.

7.3 Leak detection

7.3.1 The leak detection test of high efficiency particulate air filter can be carried out according to Annex B or refer to the provisions of Annex C. The benchmark method is the method specified in Annex B. The counting scan method specified in Annex B shall be used for the leak detection of ultra-low penetration air filter.

7.3.2 Local leak defects found in the scanning leak detection test can be repaired, which shall comply with the provisions of 5.2.5. After the repair is completed and the sealant is fully cured, the leak detection test shall be carried out once again for the filter.

7.4 Efficiency

7.4.1 Before the efficiency test, the filter shall be air blown at the rated air flowrate, until the influence of the particulate matter emitted by the filter on the efficiency test has been eliminated.

7.4.2 The efficiency of the high efficiency particulate air filter at the rated air flowrate shall be measured according to the method specified in GB/T 6165.

7.4.3 The efficiency of the ultra-low penetration air filter at the rated air flowrate shall be measured according to the counting method specified in GB/T 6165.

8.2 Rules for determination

8.2.1 Exit-factory inspection

When all sub-items are nonconforming or any one of the main items is nonconforming, products shall be rejected otherwise they shall be accepted.

8.2.2 Type inspection

When all sub-items are nonconforming or any one of the main items is nonconforming, products shall be rejected otherwise they shall be accepted.

9 Marks, packaging, transportation and storage

9.1 Marks

Each filter shall have a mark (label or direct printing) on the surface of the outer frame perpendicular to the pleats and separators. The mark shall be firmly fixed to the outer frame of the filter. The handwriting shall be clear, not easy to wipe off, and shall include at least the following:

a) Manufacturer's name and symbol;

b) Filter model, specification and exit-factory number;

c) Rated air flowrate, in “m^3/h”;

d) Efficiency or penetration at rated air flowrate as well as testing methods;

e) Whether it passes the leak detection experiment;

f) Initial resistance at rated air flowrate, in “Pa”;

g) Arrows indicating the direction of airflow;

h) Product exit-factory (testing) date;

i) Product certification.

9.2 Packaging

9.2.1 Product packaging shall be able to be protected from damage and destruction caused by external forces before loading and unloading, transportation, handling, and storage until the user installs it in place.

9.2.2 The filter shall be packed in a plastic bag before packing. The airflow direction section of the filter shall be protected by cardboard. The outer packing box can be made of cardboard. The packaging box shall indicate the model

B.1.2.1 The test party can choose liquid oil aerosol (such as DEHS, PaO, paraffin oil) or solid aerosol (such as fully dried PSL, NaCl, KCl aerosol) according to actual needs. The test aerosol shall be non-toxic and harmless, in accordance with environmental protection and occupational health regulations.

B.1.2.2 When the test aerosol and test counter divisions meet the relevant regulations of GB/T 6165, the overall filtration efficiency of the tested filter can be calculated by the cumulative count downstream of the filter during the scanning process.

B.1.2.3 The stability of the test aerosol shall meet the requirement that the total particle concentration fluctuation of the tested particle size is not more than 10% within 30min.

B.1.2.4 During the test, the test aerosol count concentration shall not be greater than 1×10^7 particles per cubic centimeter.

B.1.3 Test instruments

B.1.3.1 The leak detection test can be carried out by selecting a condensation nucleus counter or an optical particle counter according to the monodisperse characteristics of the test aerosol. All instruments used shall be calibrated regularly. The calibration cycle and calibration method shall meet the requirements of relevant national standards and calibration procedures.

B.1.3.2 When an optical particle counter is used for leak detection, the smallest particle size gear of the counter shall not be selected for testing.

B.1.3.3 When it is necessary to calculate the overall filtration efficiency of the tested filter based on the results of the leak detection test, the selection of the particle size gear shall comply with the relevant regulations of GB/T 6165.

B.1.4 Scanning system

B.1.4.1 Scanning testing method

The filter manufacturer can choose automatic scanning mechanism. He can also choose to manually scan the filter to scan the leak detection test. When it is necessary to calculate the overall filtration efficiency of the tested filter based on the results of the scanning leak test and perform a scanning leak detection test for the ultra-low penetration air filter, automatic scanning detection method shall be adopted.

B.1.4.2 Downstream sampling probe

B.1.4.2.1 The opening area of the sampling probe shall be $8cm^2$~$10cm^2$. The shape shall be square. When a rectangular probe is used, the side length ratio shall not exceed 15:1. When selecting the sampling flow rate of the probe, it

shall be ensured that the difference between the flow velocity at the probe opening and the wind velocity on the filter surface is not more than 25%.

B.1.4.2.2 The direction of the probe opening shall be parallel to the direction of the airflow. The distance between the probe and the air outlet surface of the filter shall be 1cm~5cm.

B.1.4.3 Aerosol delivery tube

There shall be no dead bends along the aerosol delivery tube. The tube material shall have a smooth surface and no particles shall be emitted.

B.1.4.4 Scanning probe drive control

B.1.4.4.1 The scanning probe shall move at a constant speed in the direction perpendicular to the airflow. The moving speed of the probe shall not exceed 8cm/s.

B.1.4.4.2 The deviation between the actual walking speed of the probe of the automatic scanning mechanism and the set value shall not exceed 10%. The automatic scanning mechanism shall be able to locate and mark the coordinates during the movement of the probe and the detected leaks. The return accuracy of the probe mechanism at any point on the downstream section of the filter shall not be greater than 1mm.

B.1.5 Isolation measures

The downstream of the tested filter shall be isolated from the dirty air of the surrounding environment. Clean air can be used as a protective shell gas around the tested filter, or fences can be used as isolation measures.

B.1.6 Test steps

B.1.6.1 Install the tested filter on the test bench and ensure the seal. Start the test bench fan. Adjust the test air flowrate to the rated air flowrate of the tested filter.

B.1.6.2 When the aerosol generator upstream of the tested filter is not turned on, check whether the optical particle counter used can be self-cleaned.

B.1.6.3 Introduce test aerosol on the upstream of the tested filter. Test the upstream aerosol concentration C_u after confirming that the upstream aerosol concentration is stable.

B.1.6.4 Scan the width of the probe according to the optical particle counter used. Determine the upper limit of scanning speed according to formula (B.1):

Annex C

(informative)

Other leak detection test methods for high efficiency particulate air filter

C.1 Smoke plume test

C.1.1 Place the filter horizontally on the tuyere, around sealed. Use an aerosol generator to generate aerosol smoke with a mass average diameter of 0.3μm~1.0μm and a mass concentration of 1.5g/m^3. Make the air flow containing aerosol flow upward through the filter under test at a speed of 1.3cm/s.

C.1.2 Use light to illuminate the air outlet surface of the filter vertically. The surrounding area of the filter and the observation background are dark. Shield out disturbing airflow around the filter.

C.1.3 Observe the windy side. If there is smoke, it is judged that there is leakage. If no smoke is seen, it is judged that there is no leakage.

C.2 Dual air flowrate efficiency test

C.2.1 For special shape filters such as cylindrical, W-shaped that are not suitable for scanning leak detection test, the dual air flowrate efficiency test can be used to determine whether the filter has local leakage defects.

C.2.2 Install the tested filter on the test bench in accordance with GB/T 6165. According to GB/T 6165, perform filtration efficiency tests at 100% rated air flowrate and 20% rated air flowrate respectively.

C.2.3 If the filter under test has a penetration ratio of less than 0.1 at 20% rated air flowrate to 100% rated air flowrate, it is determined that the tested filter has partial leakage defects.

D.4.1 The temperature of the room where the static elimination cabinet is located shall be controlled at (25±5)°C. The relative humidity shall be controlled at (40±20)%.

D.4.2 The weather condition of the filter with constant weight and the temperature of the test air shall be controlled at (23±5)°C. The relative humidity should be controlled at (45±10)%.

D.5 Test method

D.5.1 The tested air filter shall be placed in the test air for at least 30min. Then weigh, to the nearest of 1g. Test the filtration efficiency and resistance in the initial state when the static electricity is not eliminated according to the method specified in GB/T 6165. The efficiency test method shall be consistent with the filter's nominal exit-factory efficiency test method.

D.5.2 Inject isopropanol solution with a concentration of not less than 99.5% into the isopropanol tray. And weigh each tray, to the nearest of 1g.

D.5.3 Place the tray containing the isopropanol solution in the static elimination cabinet. Close the cabinet door and wait 30min.

D.5.4 Open the filter compartment door of the static elimination cabinet. Quickly put in the air filter to be tested, and then close the cabinet door tightly.

D.5.5 Start static elimination test. Expose the tested filter to a mixture of saturated isopropanol vapor and air for 24h. During the test, the temperature and humidity in the room shall be recorded every 1h.

D.5.6 After reaching the static elimination time, open the cabinet door and quickly take out the tested filter. Take out the isopropanol tray and weigh it, so as to determine the evaporation of isopropanol solution.

D.5.7 Equilibrate the tested filter in the test air for at least 30min. Then weigh. According to the method specified in GB/T 6165, test filtration efficiency and resistance. The efficiency test method shall be consistent with the test method of filter's nominal exit-factory efficiency. After blowing the tested air filter with dry clean air for 10min, test the filtration efficiency again. When the difference between the two filtering efficiency mantissas is greater than 5, repeat D.5.2~D.5.6 again for 24h static elimination test until the difference of two filter efficiency is less than 5.

D.5.8 If the following conditions occur, a new filter shall be used to perform the static elimination test again:

a) Before and after static elimination, the mass of the tested filter is changed by more than ±1% or more than ±20g;

Annex E

(informative)

Test method for life cycle comprehensive energy efficiency of high efficiency particulate air filter element

E.1 Test principle

This Annex, for filter media and filters, by generating high concentration, particle size distribution characteristics as close as possible to the actual solid aerosol, USES experimental methods to simulate the dust accumulation process of the accelerated filter element during actual use. By monitoring the efficiency and resistance changes in the dust accumulation process, pre-estimate the comprehensive energy efficiency performance of the tested sample during actual use.

The test method specified in this Annex is only used to evaluate the comprehensive energy efficiency of the filter element life cycle under the specified test conditions.

E.2 Filter material test method

E.2.1 Test devices

E.2.1.1 The test devices comply with the relevant regulations of GB/T 6165.

E.2.1.2 The scale division value used for weighing the test sample during the dust holding process is at least 0.0001g.

E.2.2 Test dust source

Use dried solid KCl, NaCl dust or dust with particle size distribution that meets the requirements of this Standard as the test dust source. Test dust is fully dried. Perform charge neutralization if necessary. The median diameter of test dust count (counting peak particle size) is in the range of 75nm~125nm. The geometric standard deviation is not more than 1.90. During the test, the test dust mass concentration is maintained within the range of 10mg/m^3~20mg/m^3.

E.2.3 Test method

E.2.3.1 Test sample

No creases, wrinkles, holes or other abnormalities in the test sample. The minimum size of the test sample is 200mm×200mm. Test size is 100cm^2. All test samples have the following clear and permanent marks:

E - Test sample efficiency, in percentage (%);

E0 - Efficiency of the test sample in the initial state, in percentage (%);

$\overline{E}$ - Combined average efficiency, in percentage (%);

a, b, c, d - Fitting polynomial constants;

m - Dust holding capacity, in grams (g);

M_x - Specified dust holding capacity used to calculate average resistance, as 0.040g.

E.3 Filter test method

E.3.1 Test devices

E.3.1.1 The test devices comply with the relevant regulations of GB/T 6165.

E.2.1.2 The scale division value used for weighing the test sample during the dust holding process is at least 0.1g.

E.3.2 Test steps

Use dried solid KCl dust or dust with particle size distribution and other properties that meet the requirements of this Standard as the test dust source. Test dust is fully dried. Perform charge neutralization if necessary. The median diameter of test dust count (counting peak particle size) is in the range of 75nm~125nm. The geometric standard deviation is not more than 1.90. During the test, the test dust mass concentration is kept within the range of 5mg/m^3~15mg/m^3.

E.3.3 Test method

E.3.3.1 Test sample

The surface of the test sample is intact, without visible stain and damage. There are clear signs and comply with the requirements of 9.1.

E.3.3.2 Test air flowrate

The test sample is tested under its nominal rated air flowrate.

E.3.3.3 Final test resistance

For filters with resistance less than 80Pa in the initial state, the final test resistance is 160Pa. For filters with resistance of 80Pa~150Pa in the initial state, the final test resistance is 300Pa. For filters with resistance of 150Pa~250Pa in

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