This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: C159 – 06 (Reapproved 2021)

Standard Specification for Vitrified Clay Filter Blocks[1]

This standard is issued under the fixed designation C159; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification establishes the criteria for acceptance, prior to installation, of vitrified clay filter block used in trickling filters for the treatment of sewage and industrial wastes.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 The following precautionary caveat pertains only to the test method portions shown in Annex A1 – Annex A3. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C150/C150M Specification for Portland Cement
C896 Terminology Relating to Clay Products
E4 Practices for Force Verification of Testing Machines

3. Terminology

3.1 The definitions for clay, fire clay, shale, and surface clay are as defined in Terminology C896.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *compressive strength*—the pressure, measured in psi (kPa) which causes failure of vitrified clay filter block, with the load being applied to the block in the direction of use.

3.2.2 *filter block*—rectangular, vitrified clay units with interior drainage channels, having apertures that connect to the drainage channels through the upper surface. The apertures are arranged to form drainage and aeration grilles that pass air into, and liquids from, overlying filtering media. The drainage channels of the filter block provide for the conveyance of the filtered liquid away from the filter bed.

3.2.2.1 *Type I-S and Type I-H filter block*—one-piece units suitable for constructing a single-course trickling filter floor.

3.2.3 *lot*—unless otherwise specified, a lot shall consist of all filter block of each type of the contract or purchase order.

3.2.4 *walls*—Exterior vertical sides of vitrified clay filter block.

3.2.5 *webs*—interior supports separating channels of vitrified clay filter block.

4. Classification

4.1 Filter block are manufactured in the following types:

4.1.1 Type I-S, standard rate and

4.1.2 Type I-H, high rate.

4.2 The purchaser shall specify the type of filter block to be furnished.

5. Ordering Information

5.1 Orders for filter block under this specification shall include the following information:

5.1.1 Quantity,

5.1.2 Type of filter block,

5.1.3 ASTM designation and date of issue,

5.1.4 Required tests or certification, and

5.1.5 Inspection location; factory or point of delivery.

6. Materials and Manufacture

6.1 Filter block shall be formed from fire clay, shale, surface clay, or a combination of these materials.

6.2 Formed filter block shall be fired to a suitable temperature to yield a product that is strong, durable, and serviceable and conforms to this specification.

[1] This specification is under the jurisdiction of ASTM Committee C04 on Vitrified Clay Pipe and is the direct responsibility of Subcomittee C04.20 on Methods of Test and Specifications

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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7. Chemical Requirements

7.1 *Acid Resistance*—Acid-soluble matter in filter block shall not exceed 0.25 % by weight when tested as specified in this specification in any of the following acids: sulfuric (H_2SO_4), hydrochloric (HCl), nitric (HNO_3), or acetic (CH_3COOH). The test shall be performed only when specified.

7.2 The purchaser shall designate the acid or acids to be used in this test.

8. Physical Properties

8.1 *Compressive Strength*—Compressive strength tests shall be performed on full- or half-size block. The average compressive strength of filter block units shall be at least 450 psi (3.1 mPa), and no individual unit shall have a compressive strength less than 400 psi (2.8 mPa). The compressive strength shall be calculated on the gross area of the block.

8.2 *Absorption*—The average absorption of five filter block, determined by 1-h submersion in boiling water, shall not exceed 6 % by weight.

9. Dimensions and Permissible Variations

9.1 *Aperture*—The smallest dimension of an aperture in Type I-S and I-H filter block shall not exceed 1½ in. (38 mm), and the total aperture area shall be at least 20 % of the top area.

9.2 *Drainage Channels:*

9.2.1 The drainage channel cross-sectional area shall be defined as the channel area lying below the lowest level of the aperture. Minimum cross-sectional area of drainage channels in filter block shall be as shown in the following table:

Drainage Channel Cross-Sectional Area

Type	Area, min, in.^{2}/ft (cm^2/m) of width
I-S	20 (425)
I-H	40 (850)

9.2.2 Drainage channels of filter block shall be curved or narrowed at the bottom to maintain velocity in the channels at low flow.

9.2.3 The minimum depth of drainage channels in filter block shall be 2½ in. (64 mm), measured from the lowest level of the aperture.

9.2.4 There shall be at least two parallel drainage channels per foot (0.3 m) of width of Type I-S and I-H filter block.

9.3 *Exterior Walls and Interior Webs*—Thickness of exterior walls in Type I-S and I-H filter block shall be at least 9⁄16 in. (14 mm) and interior webs separating drainage channels shall be at least ½ in. (13 mm).

9.4 *Permissible Variations in Dimensions:*

9.4.1 Exterior dimensions of filter block shall be the dimensions stated by the manufacturer, ±¼ in./ft (21 mm/m).

9.4.2 The lower bearing surface of filter block shall not vary from a plane by more than 3⁄16 in./ft (16 mm/m) of the greatest dimension of the block.

10. Workmanship, Finish, and Appearance

10.1 Filter block shall be substantially free of laminations.

10.2 Blisters shall not exceed 2 in. (51 mm) in diameter, and blisters or pimples shall not project more than ⅛ in. (3 mm) above the surface.

10.3 Chips shall not exceed 2 in. (51 mm) in length, 1 in. (25 mm) in width, and a depth of 3⁄16 in. (5 mm).

10.4 Open cracks shall be no longer than 1½ in. (38 mm) and surface cracks no longer than 3 in. (76 mm). Open cracks shall not extend through the upper surface from the end of the filter block to an aperture opening, nor between aperture openings.

11. Sampling

11.1 *Selection of Test Specimens*—Full- or half-size filter block shall be selected by the purchaser or his representative at points he designates when placing the order. Specimens shall meet the dimensions, workmanship, finish, and appearance requirements of this specification.

11.2 *Number of Specimens*—The number of specimens to be tested shall be at least five full-size or half-size filter block selected from each lot, except the acid resistance tests shall be tested on one specimen from each lot. Additional specimens may be tested at the discretion of the purchaser.

11.3 *Identification*—Each specimen shall be marked so that it may be identified at any time. Filter block specimen markings shall not cover more than 5 % of the superficial area of the specimen.

12. Retesting

12.1 If test specimens from a lot fail to meet compressive strength, absorption, or acid resistance requirements, the manufacturer or seller may sort the shipment into two lots. New samples shall be selected by the purchaser from the lot to be retained. If the set of test specimens from the retained lot fails to meet these requirements, the retained lot shall also be rejected.

13. Test Methods

13.1 Physical and chemical tests shall be conducted in accordance with the procedures described in Annex A1 – Annex A3.

14. Inspection

14.1 Filter block shall be subject to inspection by the purchaser or the purchaser's representative. Inspection shall be made at the factory or promptly at the point and time of delivery. The purpose of this inspection is to determine whether the filter block meet the dimension, workmanship, appearance, and marking requirements of this specification.

14.2 Filter block that do not meet the dimensions, workmanship, appearance, and marking specifications shall be rejected and replaced by the manufacturer or seller with filter blocks that meet the specifications.

14.3 If the purchaser desires compressive strength, absorption, and acid resistance tests, the purchaser shall select filter block for testing in accordance with the sampling procedures of this specification. Ten days shall be allowed after sampling for completion of testing.

14.4 The cost of initial inspection and testing shall be borne by the purchaser. The cost of retesting because of failure of the filter block to pass the initial test shall be borne by the manufacturer.

15. Certification

15.1 When specified in the purchase order or contract, a manufacturer's certification shall be furnished to the purchaser stating that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. A report of the test results shall be furnished when required.

16. Product Marking

16.1 Identification marks shall be indented legibly on the exterior of the filter block as follows:

16.1.1 Manufacturer's name and

16.1.2 Type of filter block.

17. Precision and Bias

17.1 No statements are made on the precision or bias of the test methods for measuring compressive strength, absorption percentage, or acid resistance, (see Annexes) since conformance to specific criteria is the only measure for success specified in these test methods.

18. Keywords

18.1 clay blocks; drains; filters; filter drainage; media; media supports; support; trickling filters; underdrains

SUPPLEMENTARY REQUIREMENTS

These requirements apply only to Federal/Military procurement, not domestic sales or transfers.

S1. Government/Military Procurement

S1.1 *Responsibility for Inspection*—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless the purchaser disapproves. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

NOTE S1.1—In U.S. Federal contracts, the contractor is responsible for inspection.

S2. Packaging and Marking for U.S. Government Procurement:

S2.1 *Packaging*—Unless otherwise specified in the contract, the materials shall be packaged in accordance with the supplier's standard practice in a manner ensuring arrival at destination in satisfactory condition and which will be acceptable to the carrier at lowest rates. Containers and packing shall comply with Uniform Freight Classification rules or National Motor Freight Classification rules.

S2.2 *Marking* —Marking for shipment shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

NOTE S2.1—The inclusion of U.S. Government procurement requirements should not be construed as an indication that the U.S. Government uses or endorses the products described in this document.

ANNEXES

(Mandatory Information)

A1. COMPRESSIVE STRENGTH TEST

A1.1 Preparation of Specimens

A1.1.1 *Drying*—Dry the specimen at least 16 h in a ventilated oven at a temperature between 230 and 240°F (110 and 115°C) and until two successive weighings at intervals of not less than 3 h show a weight loss at any weighing not greater than 0.1 % of the original weight of the specimen.

A1.2 Capping Test Specimens

A1.2.1 If the filter block surfaces that will become bearing surfaces during the compression test are recessed or paneled, fill the depressions with mortar composed of 1 part by weight of quick-hardening portland cement conforming to the requirements of Type III cement of Specification C150/C150M and 2 parts by weight of sand before capping them. Where the depression exceeds ½ in. (13 mm), fill the depression with either a brick or tile slab section or a metal plate before applying the mortar. Cap the test specimens using the following procedures.

A1.2.2 Coat the two opposite bearing surfaces of each specimen with shellac and allow to dry thoroughly. Bed one of the dry shellacked surfaces of the specimen in a thin coat of neat paste of calcined gypsum (plaster of paris) that has been spread on an oiled nonabsorbent casting plate such as glass or machined metal. The casting plate shall be a plane within 0.003

in. (0.08 mm) in 16 in. (405 mm) and sufficiently rigid and supported that it will not deflect measurably during the capping operation. Repeat this procedure with the other shellacked surface. Take care that the opposite bearing surfaces so formed will be approximately parallel and perpendicular to the vertical axis of the specimen and that the thickness of the caps will be approximately the same and not exceeding ⅛ in. (3 mm). Age the caps at least 24 h before testing the specimens.

A1.3 Procedure

A1.3.1 Test the filter block specimens in a position such that the load is applied in the same direction as in service. Center the specimens under the spherical upper bearing within 1⁄16 in. (1.6 mm).

A1.3.2 The testing machine shall conform to the requirements of Practices E4.

A1.3.3 The upper bearing shall be a spherically seated, hardened metal block firmly attached at the center of the upper head of the machine. The center of the sphere shall lie at the center of the surface of the block in contact with the specimen. The block shall be closely held in its spherical seat, but shall be free to turn in any direction, to allow for specimens whose bearing surfaces are not exactly parallel. The diameter of the bearing block surface shall be at least 5 in. (125 mm). When the bearing area of the spherical bearing block is not sufficient to cover the area of the specimen, place a steel plate with a thickness equal to at least one third of the distance from the edge of the spherical bearing to the most distant corner of the capped specimen. Use a hardened metal bearing block beneath the specimen to minimize wear of the lower platen of the machine. The bearing block surfaces intended for contact with the specimen should have a hardness not less than 60 HRC (620 HB) and the surfaces shall not depart from plane surfaces by more than 0.001 in. (0.03 mm).

A1.3.4 *Speed of Testing*—Apply the load, up to one half of the expected maximum load, at any convenient rate, after which, adjust the controls of the machine so that the remaining load is applied at a uniform rate in not less than 1 nor more than 2 min.

A1.4 Calculation and Report

A1.4.1 Calculate the compressive strength of each specimen as follows:

$$\text{Compressive strength, } C = W/A \qquad (A1.1)$$

where:

C = compressive strength of the specimen, psi (or kPa),
W = maximum load indicated by the testing machine, lbf (or kgf) and
A = average of the gross areas of the upper and lower bearing surfaces of the specimen, in.^{2} (or mm^2).

A2. ABSORPTION TEST

A2.1 Test Specimens

A2.1.1 Filter block specimens for the absorption test shall consist of full- or half-size blocks or three representative pieces from each of these filter blocks. If small pieces are used, take two from the exterior wall and one from an interior web, the weight of each piece being not less than 250 g. The specimens shall have had their rough edges or loose particles ground off and, if taken from block that has been subjected to compressive strength tests, specimens shall be free of cracks, shellac, and other testing material.

A2.2 Weighing Apparatus

A2.2.1 The weighing apparatus shall be a balance having a capacity of not less than 2000 g and shall be sensitive to 0.5 g. If other than metric weights are used, the same degree of accuracy shall be observed.

A2.3 Procedure

A2.3.1 Dry the specimens using the procedure described in the compressive strength test of this specification.

A2.3.2 Weigh the dry specimens to the nearest 0.5 g. Record the weights.

A2.3.3 Suspend the dried specimens in distilled water; heat to boiling, boil for 1 h, and then cool in the water to ambient temperature. Take care that no fragments are broken from the specimens by physical disturbance during the test. When cool, remove the specimens from the water and drain for not more than 1 min. Then remove the superficial moisture by a damp cloth.

A2.3.4 Weigh the specimens immediately to the nearest 0.5 g. Record the weights.

A2.4 Calculation and Report

A2.4.1 Calculate the absorption of each specimen as a percentage of the initial dry weight as follows:

$$\text{Absorption, \%} = [(SW - DW)/DW] \times 100 \qquad (A2.1)$$

where:

DW = initial dry weight of specimen, and
SW = weight of specimen after boiling 1 h.

A2.4.2 Report the result for each specimen, together with the average for the sample being tested.

A3. ACID RESISTANCE TEST

A3.1 Determine the acid resistance of clay filter block by the extraction of acid-soluble matter.

A3.2 Reagent

A3.2.1 When testing with sulfuric (H_2SO_4), hydrochloric (HCl), nitric (HNO_3), or acetic acid (CH_3COOH), as specified by the purchaser, a 1 *N* acid solution shall be used.

NOTE A3.1—These 1 *N* solutions should contain, respectively, 49, 36.5, 63, and 60 g of the acid per litre of solution. For the purpose of these tests, the solutions can be prepared by taking the following volumes of acid and diluting to 1 L: H_2SO_4 (sp gr 1.84), 28.5 mL; HCl (sp gr 1.19), 88.9 mL; HNO_3 (sp gr 1.42), 65 mL; and CH_3COOH (sp gr 1.05), 57.7 mL.

A3.3 Test Specimens

A3.3.1 Select the specimens for acid resistance tests, whenever possible, from filter block that have been broken in the compression test. Specimens shall be about 2 in. (51 mm) square, and weight not more than 200 g. They shall be sound pieces with all edges freshly broken, free of cracks or shattered edges, and shall be cleaned thoroughly.

A3.4 Weighing Apparatus

A3.4.1 The balance used in weighing the specimens shall be sensitive to 0.01 g when loaded with 200 g.

A3.5 Procedure

A3.5.1 Dry the specimens using the procedure described in the compressive strength test of this specification.

A3.5.2 Weigh each specimen to the nearest 0.01 g. Record the weights.

A3.5.3 Suspend the dried specimens in the acid at a temperature between 70 and 90°F (21 and 32°C) for a period of 48 h, then remove them from the solution and thoroughly wash them with hot distilled water, allowing the washings to run into the solution in which the specimen was immersed. Filter the solution and wash the filter with hot distilled water, adding the washings to the filtrate. Add 5 mL of H_2SO_4 (sp gr 1.84) to the filtrate, then evaporate the solution (avoid loss by spattering) to about 5 mL; transfer to a porcelain crucible (previously ignited to constant weight), and heat cautiously to dryness. Then ignite the residue to constant weight.

A3.5.4 Weigh the residue to the nearest 0.01 g. Record the weight.

A3.6 Calculation and Report

A3.6.1 Calculate the percentage of acid-soluble matter as follows:

$$\text{Acid} - \text{soluble matter, } \% = (R/W) \times 100 \qquad (A3.1)$$

where:

R = weight of residue, and
W = initial weight of the specimens.

A3.6.2 Report the results.

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