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BSI Standards Publication

Bitumens and bituminous binders — Determination of the resistance to hardening under influence of heat and air

Part 1: RTFOT method

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee PTI/13, Petroleum Testing and Terminology.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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English Version

Bitumens and bituminous binders - Determination of the resistance to hardening under influence of heat and air - Part 1: RTFOT method

Bitumes et liants bitumineux - Détermination de la résistance au durcissement sous l'effet de la chaleur et de l'air - Partie 1 : Méthode RTFOT

Bitumen und bitumenhaltige Bindemittel - Bestimmung der Beständigkeit gegen Verhärtung unter Einfluss von Wärme und Luft - Teil 1: RTFOT-Verfahren

This European Standard was approved by CEN on 16 September 2024.

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European foreword

This document (EN 12607-1:2024) has been prepared by Technical Committee CEN/TC 336 “Bitumens and bituminous binders”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2025, and conflicting national standards shall be withdrawn at the latest by May 2025.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12607-1:2014.

EN 12607-1:2024 includes the following significant changes with respect to EN 12607-1:2014:

a) Clause 1, Scope, has been revised and expanded;

b) Clause 2, Normative references, has been updated;

c) Clause 3, Terms and Definitions, has been added;

d) Clause 4, Principle, has been revised for clarification purposes and the reference duration of the RTFOT method has been added;

e) Clause 5, Apparatus, together with the Figures 1 to 3, has been revised and completed;

f) Clause 6, Calibration and verification, has been added including the former requirements regarding the RTFOT oven and the temperature measuring device;

g) the former subclause-structure of Clause 7, Sampling, has been removed and the former subclause 5.3, Initial Characteristics, has been removed;

h) the titles of the subclauses of Clause 8, Procedure, have been changed for clarification purposes;

i) Clause 12, Test report, has been revised;

j) Annex B has been added;

k) the Bibliography has been updated.

A list of all parts in the EN 12607 series, published under the general title *Bitumens and bituminous binders — Determination of the resistance to hardening under the influence of heat and air*, can be found on the CEN website.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

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1 Scope

This document specifies a method for the conditioning of bitumen or bituminous binders in order to provide for measuring the combined effects of heat and air on a thin moving film of bitumen or bituminous binder simulating the hardening which most bituminous binders undergo during mixing in an asphalt mixing plant. The method is referred to as RTFOT – Rolling Thin Film Oven Test.

The method described is applicable to paving grade bitumen. The method described is also applicable to other bituminous binders considering that the reference temperature can result in excessive hardening that does not resemble real conditions during mixing at the plant. It is possible that the method does not represent the hardening that occurs during mixing bitumen used for warm mix asphalt.

The method described is not applicable to those binders having a viscosity at the tested temperature not allowing to provide a moving film. In some cases, it is possible that the test sample creeps out of the glass container and flows on the heating elements of the oven during testing.

The method described is not applicable to binders with volatiles components present. In case of cutback bitumen or bituminous emulsion, the described procedure is only applicable after being stabilized, e.g. in accordance with EN 13074-2 [9].

WARNING — Use of this document can involve hazardous materials, operations and equipment. This document does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this document to identify the hazards and assess the risks involved in performing this test method and to implement sufficient control measures to protect individual operators (and the environment). This includes appropriate safety and health practices and determination of the applicability of regulatory limitations prior to use.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

EN 58, *Bitumen and bituminous binders — Sampling bituminous binders*

EN 1425, *Bitumen and bituminous binders — Characterization of perceptible properties*

EN 12594, *Bitumen and bituminous binders — Preparation of test samples*

EN 12597, *Bitumen and bituminous binders — Terminology*

EN 12735-1, *Copper and copper alloys — Seamless, round tubes for air conditioning and refrigeration — Part 1: Tubes for piping systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12597 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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4 Principle

A moving film of bituminous binder is heated in an RTFOT oven to a specified temperature for a given period of time with constant supply of air. The reference temperature is 163 °C and the reference duration is 75 min.

The effects of heat and air are determined based on the change in mass or on the change in the bituminous binder's characteristics such as penetration in accordance with EN 1426 [5], softening point in accordance with EN 1427 [6] or dynamic viscosity in accordance with EN 12596 [8] or EN 13302 [10], and other tests before and after the period in the RTFOT oven.

5 Apparatus

The usual laboratory apparatus and glassware, together with the following shall be used.

5.1 RTFOT oven, rectangular, double-walled, and electrically heated. The RTFOT oven shall be capable of providing the selected test temperature and to endure the selected test temperature over the full duration of the test.

The inside dimensions of the RTFOT oven excluding the air plenum shall be as follows:

— height of (340 ± 15) mm;

— width of (405 ± 15) mm;

— depth of (445 ± 15) mm.

The front door shall contain a window of the following dimensions:

— width of (320 ± 15) mm;

— height of (215 ± 15) mm.

The window shall contain two parallel layers of heat-resistant glass separated by an air space. Both layers shall be positioned in such a way that an unobstructed view into the interior of the RTFOT oven through the complete window is ensured.

The top of the upper heating element shall be (25 ± 9) mm below the floor of the RTFOT oven.

The RTFOT oven shall be ventilated by convection currents of air. The RTFOT oven shall have air inlets and outlets for the evacuation of hot gases. The air inlets toward the bottom of the RTFOT oven shall be located so that the air is able to flow around the heating elements and their total open area shall be (1 500 ± 100) mm^2. The outlets for the hot gases' evacuation shall be located in the upper part of the RTFOT oven and their total open area shall be (1 000 ± 100) mm^2.

The RTFOT oven shall incorporate an air flow around the side walls and ceiling. The air plenum between the wall and the sheaths shall be of uniform thickness (38 ± 3) mm, see Figure 1 a).

The inside of the RTFOT oven shall be equipped with a vertical circular aluminium carriage with a diameter of (300 ± 10) mm, see Figure 2 a). The horizontal axis of the circular carriage is located (160 ± 10) mm from the upper inside wall of the RTFOT oven, excluding the air plenum. The carriage shall be provided with suitable openings and spring clips for firmly holding eight glass containers (5.4) in a horizontal position, see Figure 2 b). The carriage shall be mechanically driven by a 20 mm diameter shaft and shall be capable of rotating at a rate of (15,00 ± 0,25) r/min. The front surface of the carriage shall be (110 ± 5) mm from the rear inside wall of the RTFOT oven.

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On the upper surface and at the midpoint of the width of the RTFOT oven and (150 ± 5) mm from the front face of the carriage, a squirrel cage-type fan shall be mounted with an outside diameter of (135 ± 5) mm and a thickness of (75 ± 5) mm and turned at (1 725 ± 100) r/min by an externally mounted motor.

The fan shall be set so that it turns in an opposite direction to its vanes. The air flow characteristics shall be suction from the floor of the RTFOT oven then flow along the walls in the sheaths fitted for this purpose and exhaust at the upper surface through the fan, see Figure 1 a) and b).

The RTFOT oven shall be equipped with a thermostat capable of maintaining a constant temperature with a tolerance of ± 0,5 °C throughout the entire periphery of the vertical circular carriage. The corresponding regulation probe shall be situated on the right side of the RTFOT oven as described in Figure 1 or symmetrically on the left side.

The temperature measuring device (5.3) shall be placed inside the oven with the reading point (25 ± 5) mm below a horizontal line through the axle of the carriage, (50 ± 5) mm from the inside wall and (115 ± 5) mm from the front face of the carriage.

The heating capacity of the RTFOT oven shall be sufficient to bring the RTFOT oven back to the test temperature within a 10 min period after insertion of the containers.

The RTFOT oven shall be equipped with an air jet positioned to blow heated air into each glass container at its lowest point of travel. The air jet shall have an outlet orifice with a diameter of (1,0 ± 0,1) mm connected to a copper tubing in accordance with EN 12735-1 with an external diameter of (8,0 ± 0,1) mm and a length of approximately 7,6 m. This tube shall be coiled to lie flat on the bottom of the RTFOT oven and lead to a source of oil-free, dried and dust-free air. The orifice of the tubing shall be between 5 mm and 10 mm from the opening in the glass container. The air jet shall blow along the main axis of the glass container.

NOTE Activated silica gel treated with an indicator is a suitable desiccant for the air.

5.2 Flow meter, capable of measuring the airflow at a rate of (4,0 ± 0,2) l/min at ambient temperature and pressure.

5.3 Temperature measuring device. The temperature measuring device, combining sensor and reading unit, shall:

— have a measuring range covering at least 150 °C to 200 °C;

— be readable to the nearest 0,1 °C or less; and

— have a maximum permissible error of ±0,5 °C or better.

Sensors based on platinum resistance thermometers have been found suitable but sensors applying other principles may also be used.

When measuring and controlling nominally constant temperatures, as in this method, the thermal response time can be rather high, e.g. slow response to a change in temperature. Care shall be taken to consider this aspect since low thermal response times of the sensor can indicate greater cyclic variations than the bituminous material in practice experiences. The thermal response time of the temperature measuring device shall be comparable to that of the former reference thermometer[1], the characteristics of which are given for information in Annex A.

[1] It is not the former reference thermometer as such but its characteristics with regard to the thermal response time that serve as reference for assessing the suitability of a temperature measuring device.

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