SLOVENSKI STANDARD
SIST EN 304:1997

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Kotli za gretje - Preskušanje kotlov z razprševalnimi oljnimi gorilniki

Heating boilers - Test code for heating boilers for atomizing oil burners

Heizkessel - Prüfregeln für Heizkessel mit Ölzerstäubungsbrennern

Chaudieres de chauffage - Regles d'essai pour les chaudieres pour bruleurs a fioul a pulvérisation

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Heating boilers - Test code for heating boilers for atomizing oil burners

Chaudières de chauffage - Règles d'essai pour les chaudières pour brûleurs à fioul à pulvérisation

Heizkessel - Prüfregeln für Heizkessel mit Ölzerstäubungsbrennern

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Contents list

FOREWORD

This European Standard was drawn up by the Technical Committee CEN/TC 57 "Central heating boilers" of which the secretariat is held by DIN.

The following structure is intended for the Standards for heating boilers prepared by CEN/TC 57 :

* EN 303-1 : Heating boilers - Heating boilers with forced draught burners - Part 1: Terminology, general requirements, testing and marking

* EN 303-2 : Heating boilers - Heating boilers with forced draught burners - Part 2: Special requirements for boilers with atomizing oil burners

* : Heating boilers - Heating boilers with forced draught burners up to a heat output of 70 kW and an operating pressure of max. 3 bar - Terminology, special requirements, testing and marking (standard in preparation)

* EN 304 : Heating boilers - Test code for heating boilers for atomizing oil burners

This European Standard shall be given the status of national standard, either by publication of an identical text or by endorsement, at the latest by March 1993, and conflicting national standards shall be withdrawn at the latest by March 1993.

The Standard was approved and in accordance with the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard : Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

1 Scope

The test code applies to the tests of the thermal performance of oil-fired heating boilers (hereafter called 'boilers') and combined boilers and water heaters. The requirements are laid down in EN 303 part 1 and EN 303 part 2.

This standard includes the requirements and recommendations for carrying out and evaluating the procedure for testing boilers and also the details of the technical conditions under which the tests shall be carried out.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 267:1991	Atomizing oil burners of monobloc type; testing
EN 303-1:1992	Heating boilers; Heating boilers with forced draught burners; Part 1: terminology, general requirements, testing and marking
EN 303-2:1992	Heating boilers; Heating boilers with forced draught burners; Part 2: special requirements for boilers with atomizing oil burners

3 Principles of tests

3.1 Choice of boiler to be tested and its accessories

The parts and accessories used should be those supplied as standard by the manufacturer or those recommended by him.

For the test an atomizing oil burner shall be used which complies with EN 267 and which is suitable for the boiler (dimensions of the combustion chamber, pressure conditions, etc.).

3.2 Condition of the boiler

The condition and the equipment of the boiler to be tested shall conform to the normal supply specification. The use of additional thermal insulation to parts in contact with water, products of combustion and fire is not permitted.

When determining the thermal output of a boiler fitted with a water heater (either storage or instantaneous), no sanitary hot water shall be drawn off during the test. The thermal output shall be determined from the heating circuit only.

4 Measuring instruments and methods

Only such measuring instruments shall be used which meet the requirements noted in the following clauses. The use of recording instruments, which show the progress of the test in detail, is recommended, especially for measuring the water temperatures at the flow and return connections to the boiler, the draught at the outlet from the boiler, and the temperature and composition of the products of combustion.

Regarding admissible errors, the measuring instruments shall be chosen in such a way that the efficiency can be determined to an accuracy of ± 2 %. The tolerances for test equipment are given in annex A.

4.1 Fuel

The tests shall be carried out using commercially available heating gas oil or kerosine as selected by the boiler manufacturer.

The viscosity of the gas oil shall be 5,5 ± 0,5 mm²/s at 20 °C in accordance with EN 267.
The viscosity of kerosene shall be 1,3 mm²/s to 2,9 mm²/s at 20 °C.

4.1.1 Quantities

The fuel quantities are either weighed or measured volumetrically (see figure 1)

4.1.2 Determination of the calorific values for oil fuels.

4.1.2.1 Heating gas oil

a) If the calorific value is not determined calorimetrically and in the absence of a complete analysis, the value for fuel oil can, with sufficient accuracy, be assumed as follows:

H_u = 42,689 MJ/kg
where
Carbon content c = 0,86 kg/kg
Hydrogen content h = 0,136 kg/kg
Sulphur content s = 0,003 kg/kg
density at 15 °C: 0,85 kg/dm³

b) If the density and sulphur content is known (e. g. by analysis) the calorific value can be calculated as folows:

$H_u = 52,92 - (11,93 \cdot \rho_{15}) - (0,3 \cdot s)$ in MJ/kg
where
ρ_{15} = densitiy of the heating gas oil at 15°C in kg/dm³
s = Sulphur content in kg/kg

4.1.2.2 Kerosene

a) If the calorific value is not determined calorimetrically and in the absence of a complete analysis, the value for kerosene can with sufficient accuracy be assumed as follows:

H_u = 43,300 MJ/kg
where
Carbon content c = 0,85 kg/kg
Hydrogen content h = 0,141 kg/kg
Sulphur content s = 0,004 kg/kg
density at 15° C: 0,79 kg/dm³

b) If the density and sulphur content is known (e. g. by analysis) the calorific value can be calculated in accordance with 4.1.2.1 b).

4.1.3 Combustion parameters

The necessary combustion parameters can be calculated from the analysis of the fuel (see annex A.4).

4.2 Determination of the composition of the products of combustion

In order to minimize the errors of measurement, the instruments shall be installed in a zone of as constant temperature as possible and shall be in operation some time before the commencement of the tests. (See annex A.5).

5 Tests

5.1 Determination of the heat output and the efficiency of the boiler

5.1.1 Method for the measurement of the heat output

The amount of useful heat transmitted to the heat carrier (water) is measured. It can be determined directly in the boiler circuit or indirectly by means of a heat exchanger.

5.1.1.1 Measurement of heat output in the boiler circuit

The useful heat output transmitted to the water is determined either by measuring the mass flow of cold water entering the boiler circuit and the rise of temperature to the outlet temperature, or by measuring the mass flow of the water circulating in the boiler circuit and its temperature rise.

5.1.1.2 Measurement of heat output by means of a heat exchanger

The heat produced by the boiler is transferred to the cooling water by means of a heat exchanger. The heat received by the latter is calculated from the throughput and the temperature rise of the cooling water. The heat losses from the well-insulated connections between the boiler and the heat exchanger and those of the heat exchanger itself, are determined either by preliminary tests or by calculation.

The heat output of the boiler is the sum of the two amounts of heat

5.2 Determination of the rated heat output

The tests for the determination of the rated output shall be carried out at a firing rate such that the output is at least 100 %, but does not exceed 105 % of the rated value, and the requirements concerning the rated heat output shall be met. If one of the requirements is not met during the tests, a second test shall be carried out at 95 % to 100 % of the rated output of the boiler. The actual value for the rated heat output shall be determined by linear interpolation between the two test results.

The determination of the rated heat output shall be carried out with a mean flow temperature of between 80 °C and 90 °C, and the mean temperature difference between flow and return shall be between 10 K and 25 K.

A temperature rise of

$$\frac{t_V + t_R}{2} - t_L \geq 50{,}0 \text{ K}$$

shall be maintained.

5.3 Determination of the boiler efficiency (direct method)

The efficiency is determined on the basis of the net calorific value H_u.

The direct method is to be used. The indirect method allows an additional check of test accuracy of the test rig to be made by means of a heat balance. From this the values of other losses will also be determined.

5.4 Test operation

5.4.1 Basic details

The boiler and the burner shall be operated in accordance with the manufacturers instructions throughout the tests.

The minimum ambient temperature shall be ≥ 15 °C.

The settings of the combustion equipment shall not be manually adjusted during the test, and no change shall be made to the water flow.

The temperature, pressure and composition of the products of combustion shall be measured at intervals of not more than once per minute or continuously and shall be recorded simultaneously on recording instruments. The time intervals shall be selected so that any variations of measured values are detected with sufficient accuracy.

The temperatures t_V and t_R shall not differ by more than 0,5 (K/h) x test period (h) at the beginning and the end of the test.

During the test for efficiency determination the burner heat input shall remain constant and shall not be interrupted by the thermostat or the safety temperatur limiter.

5.4.2 Draught adjustment

5.4.2.1 Boilers operating under negative pressure

For boilers operating under negative pressure the draught at the boiler outlet shall be adjusted so that there is a negative pressure in the combustion chamber. The draught shall be measured.

5.4.2.2 Boilers operating under positive pressure

In positive pressure boilers the pressure shall be set at the boiler outlet to approximately 0 mbar. The pressure difference between combustion chamber and boiler outlet shall be measured.

5.4.3 Establishment of steady state conditions

It is recommended that the boiler be operated for about 1 h before the commencement of the performance and efficiency test at the output intended for the test.

The steady state condition is regarded as reached when the water temperature does not vary by more than ± 0,5 K/h.

5.4.4 Test period

For the rated heat minimum output test, the test period shall be at least 60 min. Intermediate results shall be taken every 30 min. If the efficiency results deviate by more than 0,5 % points, the test shall be extended by periods of 30 min until this requirement is met.

5.4.5 Setting up the test rig

The test rig shall be set up in such a way that the test conditions laid down in annex A.6 are met, and the efficiency can be determined within a tolerance of ± 2 % points.

Other equivalent arrangements of rigs may be used.

5.5 Calculation

The calculations are to be based on the mean values of the individual readings recorded during the test period.

5.5.1 Boiler heat output

The necessary formulae relevant to the individual test methods are given in annex A.7.

5.5.2 The heat input

For these calculations, formulae in annex A.8 are to be used.

5.5.3 Boiler efficiency

5.5.3.1 Direct method

In the direct method the boiler efficiency is determined by:

$$\eta K = \frac{Q}{Q_B} \qquad (1)$$

5.5.3.2 Indirect method (only to be used for checking purposes see annex A.9)

In the indirect method the boiler efficiency is given by:

$$\eta_K = 1 - q_A - q_U - q_S \qquad (2)$$

where:

q_A is the loss through sensible heat of the products of combustion (values relative to the heat input)

q_U is the loss through incomplete combustion (values relative to the heat input)

q_S is the loss through radiation, convection and conduction (values relative to the heat input)

5.6 Determination of the waterside resistance

The water side resistance (measured in mbar) shall be determined for the flow which is equivalent to the rated output of the boiler at a temperature difference of Δt = 10 K and 20 K between the flow and return.

5.7 Determination of the standby loss

5.7.1 General

No useful heat shall be extracted for heating or hot water.

5.7.2 Test arrangement and measurement (see annex A.11)

The boiler shall remain as set up for the determination of Q and η_K. The short circuit section remains connected. For boilers producing hot water, the hot and cold water feed pipes remain connected, the cylinder is kept full.

The circulation in the short circuit section is interrupted during the 'off' period of the burner.

5.7.3 Standby heat loss

The thermostat shall be set in such a way that the mean temperature at the sensor exceeds the ambient temperature by 50 ± 3 K during the operation of the burner when no transmission of useful heat takes place. If the mean temperature difference deviates from the prescribed temperature by more than 3 K the test shall be repeated after the thermostat has been adjusted.

The boiler temperature and the air temperature at mid height of the boiler shall be measured by automatic instruments.

A negative presssure of between - 0,05 mbar and - 0,07 mbar shall be maintained at the measuring section when the burner is not firing during the whole test period.

The electrical energy used during the test shall be measured and included in the test report.

5.7.3.1 Calculation

The calculation is in accordance with annex A.11.2.

5.7.3.2 Standby heat loss from boilers with and without water heaters

After heating the boiler up, the test begins at a burner start. The test ends at a subsequent burner start (a period commences at a burner start and ends at the next burner start).

The standby heat loss shall be calculated from the measured fuel consumption during the test periods, always using complete periods.

The standby loss shall be calculated from the beginning of the test at the end of each test period.
The test can be terminated when two consecutive results vary from one another by not more than 5 %. The smaller value of these two results will be used as the basis for the calculation of q_B at the reference temperature.(See annex A.11).

5.7.3.3 Standby heat loss from boilers with temperature controlled water heaters where switching times of the burner and feed pump overlap

The equipment shall be pre-heated to the specified temperature above ambient temperature as follows:

- boiler without modulating control: 50 ± 3 K

- water heater: $40\ ^{+5}_{-0}$ K

During the test it is to be noted that the hot water heating period can be longer than that of the boiler (see figure 5). In this case the period for the heating of the hot water is to be used for the determination of the standby loss and is calculated in accordance with 5.7.3.2.

After heating the boiler and water heater the test begins with the first burner start caused by the heating of the water storage tank.

The same procedure is applicable to other combinations of equipment with overlapping periods.

5.8 Functional test for the temperature thermostat control and system limit thermostat control on the boiler

The water side conditions shall be as for the determination of the maximum nominal output of the boiler.
The heat input shall be adjusted to give the maximum normal output of the boiler.
The output from the test rig shall be 40 ± 5 % of the boiler output.
The circulation pump shall be in operation and the temperature control is fixed at the maximum value.
The same test shall be caried out with the control thermostat out of operation.
The safety limit thermostat shall switch off at a temperature equal to or less than that given by the manufacturer.