SLOVENSKI STANDARD
oSIST prEN 304:2016

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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

Chaudières de chauffage - Règles d'essai pour les chaudières pour brûleurs à fioul à 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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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 304:2016) has been prepared by Technical Committee CEN/TC 57 “Central heating boilers”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA and ZB, which are an integral part of this document.

WARNING — Other requirements and other EU Directives may be applicable to the products falling within the scope of this European Standard.

1 Scope

The test code applies to the determination of the performances of heating boilers and combi boilers fired by liquid fuels. The requirements for the heating performances are laid down in prEN 303-1:2016 and prEN 303-2:2016.

This code 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.

The requirements and the performance of testing for the sanitary hot water production of combi boilers are laid down in EN 303-6.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 267:2009+A1:2011, *Automatic forced draught burners for liquid fuels*

prEN 303-1:2016, *Heating boilers — Heating boilers with forced draught burners — Part 1: Terminology, general requirements, testing and marking*

prEN 303-2:2016, *Heating boilers — Part 2: Heating boilers with forced draught burners — Special requirements for boilers with atomizing oil burners*

EN 303-6, *Heating boilers - Part 6: Heating boilers with forced draught burners - Specific requirements for the domestic hot water operation of combination boilers with atomizing oil burners of nominal heat input not exceeding 70 kW*

EN 15456, *Heating boilers - Electrical power consumption for heat generators - System boundaries - Measurements*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN 303-1:2016 and prEN 303-2:2016 and the following apply.

3.1
minimum continuous heat output
P_{minC}
minimum continuous heat output which is maintained automatically by the control device specified for each type of fuel in accordance with the requirements of this European Standard

4 General conditions for testing

The performance tests of the boiler shall be carried out by a test house complying with the requirements of EN ISO/IEC 17025.

The test sample shall correspond to a boiler as placed on the market including all parts and accessories necessary for the operation of the boiler. Boilers to be equipped with different burners shall be tested with one specified forced draught burner.

The boiler and the burner shall be operated in accordance with the operation manual throughout all tests.

When determining the thermal outputs P_N and 30 % P_N of a combi boiler, no sanitary hot water shall be drawn off during the test. The thermal outputs shall be determined from the heating circuit only.

When determining the testing the sanitary hot water production this is measured independently from the heating mode (see EN 303-6).

5 Measurement accuracies and uncertainties

The accuracy of the measurement devices for the following parameters shall not exceed:

a) Atmospheric pressure 50 Pa;

b) Water-side pressure loss 2 % of measured value;

c) Water flow rate 1 % of measured value;

d) Air volume flow rate 2 % of measured value;

e) Time

   1) up to 1 h: 0,2 s;

   2) beyond 1 h: 0,1 % of measured value

f) Auxiliary electrical energy 2 % of measured value;

g) Temperatures:

   1) Ambient 2 K;

   2) Water 1 K;

   3) Combustion products 2 K;

   4) Surface 2 K;

h) CO, CO_2, O_2, NO_x, C_XH_Y;

CO_2-content	0,1 % volume from full scale
O_2-content	0,1 % volume from full scale
CO-content	5 ml/m³
NO_x-content	5 ml/m³
C_xH_y-content	5 ml/m³

i) Mass 0,05 % of the full scale

j) Pressure flue gas:

   1) ≤ 60 Pa: 1Pa

2) > 60 Pa: 2 % of the measured value

The full range of the measuring apparatus is chosen to be suitable for maximum anticipated value. The measurement accuracies indicated above concern individual measurements.

For measurements requiring a combination of individual measurements, the lower accuracies associated with individual measurements may be necessary to attain the total required uncertainty. The test rig shall be set up in such a way that the efficiency can be determined within a uncertainty of 2 % points.

6 Measurements for the heating mode

6.1 General

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

The useful heat output transmitted to the water is determined either by measuring

a) the mass flow of cold water entering the boiler circuit and the rise of temperature between the outlet water temperature and the inlet water temperature or

b) the mass flow of the water circulating in the boiler circuit and its temperature rise or

c) the mass flow and the temperature rise over a secondary heat exchanger corrected by the heat loss of this secondary heat exchanger.

The heat produced by the boiler is transferred to the cooling water by means of a secondary heat exchanger. The heat received by the latter is calculated from the mass flow and the temperature rise of the cooling water. The heat losses from the well-insulated connections between the boiler and the secondary heat exchanger and those of the secondary 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.

6.2 Determination of the nominal heat output

The tests for the determination of the nominal heat output shall be carried out at a firing rate such that the output is at least 100 %, but does not exceed 105 % of the nominal value, and the requirements concerning the nominal heat output shall be met.

If the heat output exceeds 105 % a second test shall be carried out at a firing rate between 95 % and 100 % of the nominal heat output of the boiler.

The actual value for the nominal heat output shall be determined by linear interpolation between the two test results.

The nominal heat output shall be determined at a water rate that is adjusted to obtain a return water temperature of (60 ± 1) °C and a temperature difference between the flow and return water temperature of (20 ± 2) °C.

NOTE The conditions for determination of the rated heat output in former versions of EN 304 have been a mean flow temperature of between 80 °C and 90 °C, and the mean temperature difference between flow and return has been between 10 K and 25 K. However, this is not in line with the Regulation EU 813/2013.

6.3 Determination of the boiler efficiency at nominal heat output

The boiler efficiency at nominal heat output is measured as the determination of the nominal heat output (see 6.2).

The efficiency shall be determined on the basis of the net calorific value NCV.

The direct method according to 6.5.4.1 shall be applied. The indirect method allows an additional check of test accuracy of the test rig to be made by means of an energy balance.

6.4 Performance of testing

6.4.1 General test conditions

The boiler is installed in accordance with the technical instructions in a well-ventilated, draught free room (air speed less than 0,5 m/s), which has an ambient temperature of (20 ± 5) K. The boiler is protected from direct solar radiation.

The settings of the burner shall not be manually changed after adjustment .No change shall be me made to the water flow or any other test parameter during one test period.

The temperature, pressure and composition of the products of combustion shall be measured continuously and shall be recorded with a sampling rate below 10 seconds.

The flow temperature t_F and the return temperature t_R shall not differ by more than 0,5 (K/h) × test period (h) at the beginning and the end of the test period.

6.4.2 Draught adjustment

6.4.2.1 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.

6.4.2.2 Boilers operating under positive pressure

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

6.4.3 Establishment of steady-state conditions

The boiler shall be operated for at least 1 h before the start of the performance and efficiency test at the output intended for the test without any further interference.

The steady-state condition is reached when the water temperatures t_F and t_R shall not vary by more than ± 0,5 K/h.

6.4.4 Test period

The test period shall be at least 60 min. Intermediate results shall be taken every 30 min. If the efficiency results of 2 consecutive 30 min test sequences deviate by more than 0,5 % points, the test shall be extended by periods of 30 min until this requirement is met.

6.5 Calculation

6.5.1 General

The calculations shall be based on the mean values of the individual readings of all recorded parameters during the test period of 2 consecutive 30 min test sequences which meet the requirements of 6.4.4.

6.5.2 Nominal heat output

The necessary formulae relevant to the individual test methods are given in A.5.

6.5.3 Boiler heat input

For these calculations, formulae in A.6 are to be used.

6.5.4 Boiler efficiency

6.5.4.1 Direct method

In the direct method the boiler efficiency is determined by:

$$\eta_K = \frac{P}{Q_B} \quad (1)$$

P and Q_B as described in Annex A

NOTE P equals either P_N or 30 % P_N

6.5.4.2 Indirect method

The indirect method is used for checking purposes only. The indirect boiler efficiency is given by:

$$\eta_k = 1 - q_A - q_U - q_S \quad (2)$$

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)

These heat losses are calculated in A.7

6.6 Determination of the waterside resistance

The hydraulic resistance of a boiler (measured in mbar) shall be determined for the water rate corresponding to operation of the boiler at the nominal heat input with a water flow temperature of 80 °C and a temperature difference between the flow and the return water of 20 K.

Other conditions are accepted if documented.

The test is carried out with the water at ambient temperature.

The test rig is specified in Figure 8. Before or after the test, the two test pipes are connected directly to each other in order to determine their own resistance for the specified flow rate.

6.7 Determination of the standby heat loss

6.7.1 General

For the determination of standby heat loss two methods can be used.

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

6.7.2 Standby heat loss method 1

6.7.2.1 Test arrangement and measurement

The boiler shall remain as set up for the determination of P_N and η_K. The flow water connection and the return water connection shall be connected by a short circuit connection.

If the boiler is equipped with a control for the pump, it shall be kept in operation as delivered.

If the boiler is not equipped with a control for the pump, the short circuit of the test rig may be equipped with a pump which is used to avoid thermal stratification in the boiler. It starts via the water temperature controller together with the burner and shall stop 3 min after the burner is switched off.

The tests are normally carried out with burners without air dampers. If an air damper is used this shall be stated in the test report.

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 result of the measuring includes the boiler losses and the short circuit losses. The losses of the short-circuit section are deducted from the result of the test.

At the end of each test period the fuel consumption shall be measured. The standby heat loss shall be calculated at the end of each test period — from the beginning of the test.

The test can be finished, if two successive results differ by no more than 5 %. The smallest of the two results shall be used to calculate q_B — related to the desired value of the temperature.

$$\frac{q_{n+1-q_n}}{q_n} < 0,05 \tag{3}$$

where

q_{n+1} standby heat loss (in W) of period 1 to n+1

q_n standby heat loss (in W) of period 1 to n

EXAMPLE 1: $n = 1$

$$\frac{q_{1+2} - q_1}{q_1} < 0,05 \tag{4}$$

where

q_{1+2} standby heat loss of period 1 to 2

q_1 standby heat loss of period 1

EXAMPLE 2: $n = 3$

$$\frac{q_{1+2+3+4} - q_{1+2+3}}{q_{1+2+3}} < 0,05 \tag{5}$$

where

$q_{1+2+3+4}$ standby heat loss of period 1 to 4

q_{1+2+3} standby heat loss of period 1 to 3

The fuel consumption, the boiler temperature and the air temperature at mid height of the boiler shall be measured.

A negative pressure of between 5 Pa and 7 Pa shall be maintained at the measuring section when the burner is not firing during the whole test period.

6.7.2.2 Calculation

The calculation is in accordance with A.8

6.7.2.3 Standby heat loss from combi boilers

For boilers producing sanitary hot water, the hot and cold water feed pipes remain connected, the cylinder shall be charged with a temperature of $(40\ ^{+5}_{-0})$ K above the ambient temperature.

During the test it is to be noted that the hot water heating period can be longer than that of the boiler (see Figure 7). In this case the period for the heating of the hot water is to be used for the determination of the standby heat loss and is calculated in accordance with 6.7.2.2

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

6.7.3 Standby heat loss method 2

The test installation is described in Figures 3, 4 and 5.

The circuits joining the different parts of the installation shall be insulated and as short as possible. The inherent losses of the test installation and the thermal contribution of the pump for the different flow rates shall be determined at the beginning to be able to take account of them (see Annex B).

The boiler is fitted with the largest diameter test flue stated by the manufacturer in the technical instructions and equipped with a burner but is not in operation. Normally the test is carried out with a burner without air dampers. If a burner with air dampers is used this shall be stated in the test report.

The boiler water temperature is brought to a mean temperature of (30 ± 5) K above ambient temperature. The pump (11) and the boiler pump, if any, are stopped, the exchanger circuit (12) is shut off.

With the water circulating continuously by means of the pump (5) of the test rig, the thermal contribution of the electric boiler is adjusted so as to obtain, in the steady-state condition, a difference of (30 ± 5) K between the mean water temperature and the ambient temperature.

Throughout the test the variation in room temperature shall not exceed 2 °C/h.

The following information shall be noted:

— Pm in kW, the electrical power consumed by the auxiliary electric boiler, corrected for the losses of the test rig and the thermal contribution of the pump (5);

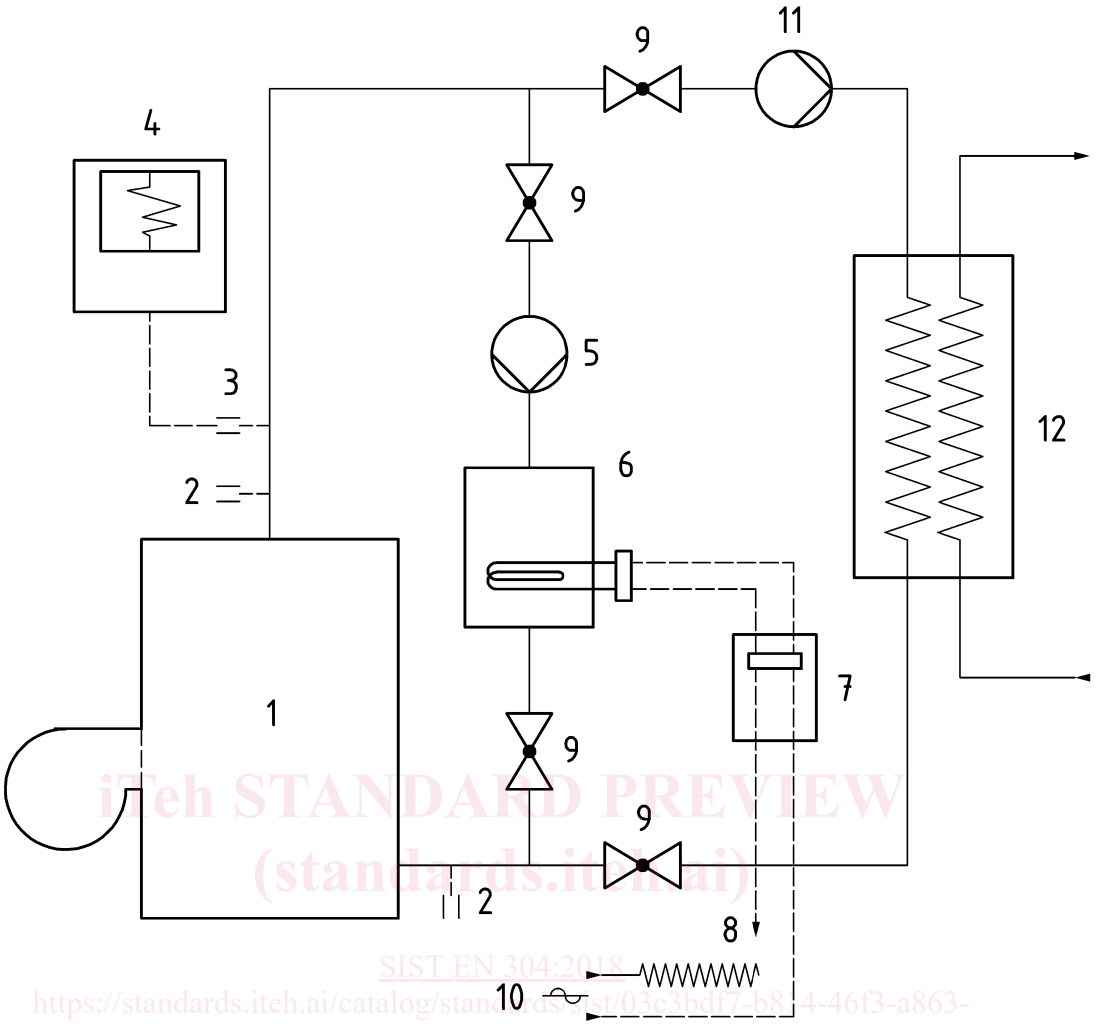
— T in °C, the mean water temperature equal to the mean of the temperature indicated by the two probes (2) at the return and the flow of the boiler during the test;

— T_A in °C, the mean ambient temperature during the test.

The standby heat loss, expressed for a mean water temperature of 30 K above an ambient temperature of 20 °C are given in kW, by:

$$P_{stby} = P_m \left[\frac{30}{T - T_A} \right]^{1,25} \tag{6}$$

Determination of the heat losses from the test rig and the heat contributions of the circulating pump of the test rig are given in Annex E.



Key

1 Boiler with the burner

2 Temperature probes

3 Low inertia thermocouple

4 Recorder

5 Pump with a rate such that the temperature difference between the two probes is between 2 °C and 4 °C at the maximum test temperature

6 Auxiliary electric boiler

7 Device for measuring the electric power

8 Voltage regulator

9 1/4 turn valves

10 Electrical supply

11 Additional pump (if necessary)

12 Heat exchanger

Figure 1 — Test installation to determine the heat emissions of the boiler when the burner is off and the thermal capacity of the boiler