

Outline of European Standard EN 303 June 1999

Part 5: Heating boilers for solid fuels, hand and automatically stocked, with a nominal heat output of up to 300 kW – Terminology, requirements, testing and marking
English version of DIN EN 303-5

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1 Scope:

Applies to biogenic and fossil solid fuels central heating boilers

2 Normative references

Incorporating other standards by reference

3 Definitions

4 Requirements

4.1 Construction requirements

Quality of Welds and steel; wall thickness

Safety, Temperature control; Electrical

4.2: Boiler Performance Requirements

Efficiency divided into 3 classes and hand stoked v automatic feed.

Definition **3.13 boiler efficiency** η_K : ratio of the delivered useful heat output to the heat input.

Heat input is base on calorific value of fuel

Heat output is the useful heat to water delivered by the boiler

Class 3 = 73% to 82%

Class 2 = 63% to 72%

Class 1 = 53% to 62%

4.2.2-Gas Temperature

must be 160 K above room temperature unless special flue is recommended to prevent sooting

4.2.3 Maximum draught values

4.2.4 Minimum combustion period for hand stoked boilers

2 hr. biogenic / 4 hr. fossil fuel

4.2.5 Minimum heat output

Not more than 30% of nominal heat output.

Provision for "accumulator tank" to store heat for manual stoked boilers. Sounds like it is required more often than not.

4.2.6 Emission Limit

"Combustion shall be of low emission"

See excel sheet

CO, OGC (organically bound carbon) and PM are regulated

Not to be exceeded when operating at

Nominal heat output or

For boilers with heat output range, when operating an nominal heat output and minimum heat output

4.2.7 Surface temperature of the boiler

5. Test requirements

5.1 Test base

Boilers must meet safety standards before testing

5.1.1 Choice of boiler

Fittings and accessories must be installed correctly

5.1.2 Condition of Boiler

Must be as supplied for sale

5.1.3 Type Test

determines category of boiler for purpose fitting into standards grid: Manual v. Auto stoke, bio. v fossil, size

Sufficient to test largest and smallest boiler in a product range as long as heat output is no larger than 2:1. Otherwise, test intermediate sizes

5.2 Measuring instruments and methods

Refers to EN 304 - Standard for oil boilers

5.3 Test fuel

Birch, Beech, oak or spruce can be used as declared by mfg.

Moisture content for log wood is 12% to 20%

Ash Content $\geq 0.04\%$

Calorific value: 19,000 kJ/kg for softwood and 18,000 kJ/kg for hardwood

Specifications also given for other fuels

5.4 Pressure tests for sheet metal boiler

5.5 Pressure test for cast iron boiler

5.6 Test for gas side soundness

Test for boilers with positive pressure in combustion chamber

5.7 Conducting boiler performance test

5.7.1 General

To determine the heat output, boiler efficiency, combustion period, composition of the combustion gas, exit flue temperature, draught and emission properties, the boiler is operated throughout the tests within the heat output range. At nominal heat output the boiler is to be operated in such a way that continuous running is possible (with thermostat cutoff prevented). The minimum heat output can be regulated manually or automatically by a control device. The boiler is to be brought to operating temperature before the start of any measurements.

The appliance shall be operated in accordance with the manufacturer's operating instructions during the tests. The ambient air temperature shall be between 15 °C and 30 °C.

The draught is to be set according to the manufacturer's instructions.

During the test period, manual intervention in the form of poking or raking is not permitted.

For hand stoked boilers approx. 5 to 10 min is allowed before the datum fire bed is created, stoke the fire bed briefly. This serves to distribute unburnt fuel particles to obtain a better fire bed. This stoking is part of the refill operation and is not to be considered as a manual intervention during the combustion period; it is therefore permissible in every valid test.

5.7.2 Test rig set up

More reference to EN 304

5.7.3 Measured quantities

Pollutants measured are CO, OGC and "dust" (or "particulates" in other versions of EN 303-5. Exact measurement methods are not specified and may differ from analytical methods and definitions used in the US

Need to get test methods and definitions

5.7.3 Measured quantities

One-off measurement:

- water content of the fuel;
- fuel mass added;
- combustion period during hand stoking;
- surface temperatures (at nominal heat output in a typical operating condition).

Continuous measurement:

- heat output;
- flow temperature;
- return temperature;
- temperature of the entering cold water according to EN 304, figure A.2;
- ambient temperature;
- exhaust temperature;
- draught;
- oxygen O₂ or carbon dioxide CO₂ content;
- carbon monoxide CO content;
- organic gaseous substances OGC (shown as organically bound carbon);
- dust content (intermittent measurement).

NOTE: The state of the art is such that limit values for nitrogen oxides cannot be stated. It is recommended to measure NO_x-values. In addition the nitrogen should be determined of the test fuel. NO and NO₂ are measured and the result is shown as NO₂.

Emissions in the form of dust and nitrogen oxides are determined at nominal heat output only.

All the measured quantities to be determined continuously are at maximum intervals of 20 s and recorded as mean values at maximum intervals of 1 min. The time intervals are to be chosen in such a way that fluctuations in the measured values are recorded with sufficient accuracy.

The recorded mean values are the basis for making the mean value for the test period.

5.7.4 Test Duration

5.7.4.1 Heating Boilers with Manual Stoking

Before test, burn a complete fuel charge and establish a fire bed.

Test duration at nominal heat is 2 burn down periods at nominal heat output and 1 combustion period at minimum heat output.

Combustion period = time to burn maximum fuel charge down to basic fire bed level (i.e. sufficient to bring boiler back to nominal heat output with new fuel charge.) Test starts immediately after placing fuel on fire bed

5.7.4.1 Heating boilers with manual stoking

Before the start of the test the boiler shall be brought to its normal working condition using a complete fuel charge (up to the maximum filling height). The duration of the initial period shall be sufficient to ensure the necessary basic firebed is established.

The test period shall begin when the basic firebed is either judged visually to be achieved or if using a platform scale when the mass of basic firebed is indicated on the scale.

The test starts immediately after placing the fuel on the basic firebed. The test time runs from the time the fuel is placed on the basic fire bed to the next refill. The refill and the stoking are included in the test time.

Test duration at nominal heat output: 2 burning down periods;
test duration at minimum heat output: 1 combustion period.

Both burning-down periods at nominal heat output shall show similar test results (heat output $\pm 20\%$).

5.7.4.2 Boilers with automatic stoking

Test for 6 hr. at nominal heat output and 6 hr. at minimum heat output

5.8 Determining heat output and efficiency

5.8.1 Measuring heat output

Measure heat transferred to water directly in boiler circuit or by heat exchanger.

5.8.1.1 Determining heat output in boiler circuit

Measure mass flow of water entering boiler circuit and rise in temperature of water leaving boiler.

5.8.1.2 Determining heat output by heat exchanger

Measure throughput and temperature rise in cooling water of heat exchanger. Sum with predetermined heat loss of exchanger and connections.

5.8.2 Determining Nominal Heat Output

Manufacturers nominal heat output must be achieved in at least one combustion period. Specifies required temperature differences between inflow and outflow.

5.8.3 Determining Minimum Heat Output

Conducted at lowest output specified by manufacturer

5.8.4 Determination of Boiler Efficiency (direct method)

Direct method is to be used for all boilers. Indirect method to be use as check of accuracy of test rig.

5.9 Determination of Emission Values

5.9.1 Emissions at Nominal Heat Values

5.9.1.1 Manual Stoked Boiler

2 successive burn-down periods. Refill period to be included in test results. Average CO₂ or O₂, CO, OGC determined over entire test period.

PM testing - Each burn-down period divided into a minimum of 2 equal time sections. PM measurement starts at beginning of each time section. First measurement beginning immediately after fuel is placed and door closed. Filter suction time limited to 30 min. Average PM determined from 4 half-hour values at minimum.

5.9.1.2 Boilers with automatic stoking

Average CO₂ or O₂, CO, OGC determined over entire test period. PM test period divided into minimum of 4 equal time sections. Sampling begins at the start of the sections. First measurement taken when the test begins. Filter suction time limited to 30 min. Average PM determined from 4 half-hour values at minimum.

5.9.2 Determining emissions at minimum heat output

5.9.2.1 Boilers with manual stoking

Measurements made over one burn-down period. Average CO₂ or O₂, CO, OGC determined over entire test period.

5.9.2.2 Boilers with Automatic Stoking

Average CO₂ or O₂, CO, OGC determined over entire test period

5.10 Calculations

5.10.1 Boiler heat output

Average output recorded during test period. Refer to A.7 of EN 304.

5.10.2 Heat input

Refer to A.8.1 of EN 304

5.10.3 Boiler efficiency

5.10.3.1 Direct Method

Measured heat output during test (Q) divided by heat input (QB)

5.10.3.2 Indirect method for checking purpose only (A.9 of EN 304)

5.10.4 Emissions

The velocity of the flue gas at the measurement point used to determine dust emissions is calculated from the volume of combustion gas, taking into account pressure and temperature.

For the calculation of the mean value of the emissions of CO₂ respectively O₂, CO, OGC and NO_x the measured concentrations have to be weighted of the flue gas volume.

Acceptable approximation for the calculation of the mean value is the calculation of the mean value of the period independent of the volume stream of the flue gas.

First the recorded mean values are used to form the mean value for the entire testing period.

The mean value of the volume parts (ppm) should be calculated on the mass values (mg). For rate of exchange f from ppm to mg should be used:

$$\begin{aligned}f_{\text{CO}} &= 1,25 \\f_{\text{OGC}} &= 1,64 \text{ (if propan is the calibrate gas)} \\f_{\text{NO}_2} &= 2,05\end{aligned}$$

The part of organic gas parts should be determined as organically bound carbon (OGC) in dry flue gas. The determined nitric oxide (NO_x) is determined as NO₂.

All determined emissions are calculated a dry flue gas basis at 10 % oxygen and standard condition (mg/m³) at 0 °C and 1013 mbar.

5.11 Determination of Waterside Resistance

5.12 Surface Temperature

5.13 Function check of temperature controller and safety temperature limiter

5.14 Function test on the device for dissipating excess heat

6. Test reports and other documents

7. Designation - Boiler data plate

7.1 Information on plate

7.2 Data plate requirements - Durable, abrasion-proof, not discolor

8. Technical documentation, supplied with boiler

8.1 Installation instructions

8.2 Operating instructions

Annex (Appendix) A

A.1 Austria

Stricter Boiler efficiency

Hand stoking: 73% to 83%

Auto stoking: 76% to 86%

Emissions: PM 40-60 mg/MJ At. vs. 125-200 mg/m³ CEN

A.2 Germany

Only Class 3 Boilers allowed

PM 0.15 g/m³ (O₂ at 8%)

A.3 UK

"Dark smoke shall not be emitted from chimney of any building"

Many differences in UK standards including limits at low and intermediate use and under mis-use

A.4 Sweden

Accepts Class 3 with different CO limit; differing construction and weld standard

A.5 Switzerland

Only Class 3 allowed for boilers with "natural state wood"

Annex B Sampling equipment

Annex C Special national conditions - disclaimer