



VETO 30

TEST RESULTS OF THE BOILER TESTING ACCORDING TO EN 303-5

 FINAS Finnish Accreditation Service T001 (EN ISO/IEC 17025)	VTT, Expert Services Ltd	
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This report replaces the report VTT-S-02363-14. Partial heat output test has been done again, with better adjustments.

Tested appliance VETO 30

Testing has been undertaken according to the standard EN 303-5 – Part 5: Heating boilers for solid fuels, hand and automatically stoked, nominal heat output of up to 500 kW- Terminology requirements, testing and marking.

The standard EN 303-5 is listed on VTT's qualification certificate as an Accredited Laboratory.

Appliance description

VETO 30 is a wood chip boiler.

Photographs of the tested appliance are presented in appendix 1. Technical drawings of the tested appliance are given in appendix 2.

Test arrangement

The combustion equipment was measured using the 70 kW solid fuel boiler test rig, constructed to meet the requirements of EN 303-5 standard. Testing of VTT Expert Services Ltd is accredited by The Finnish Accreditation Service (FINAS). FINAS belongs to the European co-operation for Accreditation (EA).

Testing

The appliance construction was assessed against the requirements of Clause 4.1 of EN 303-5. The appliance performance was assessed against the requirements of Clause 4.2 in accordance with the test method

requirements and additional performance and safety requirements for the appliance given in Clause 5 of EN 303-5.

The performance type testing consisted of a nominal heat output test and a partial heat output test. The CO₂-, O₂-, CO-, OGC- and NO_x-concentrations, as well as the flue gas temperature and dust concentrations were measured at both heat outputs. The CO₂-, O₂-, CO-, OGC- and NO_x-concentrations were measured from dry flue gases and OGC-concentration (concentration of total organic carbon) from moist flue gas at about 180 °C. Concentrations are presented in % or ppm (= part per million; for example 10000 ppm = 1%) and in mg/Nm³ of dry flue gas, as well as converted to 10% of oxygen. Emissions are presented in mg/MJ.

Total efficiency was calculated based on measured boiler output and fuel consumption and its properties. Surface temperatures of the boiler and its operating components were also measured.

Particulate measurement was carried out using gravimetric method directly from flue gases. The measurement device was manufactured by the German company Paul Gothe following the method VDI 2066 and the standard EN 13284-1. Measuring system contains zero-pressure nozzle which ensures automatic isokinetic sampling and two filters in line. The first filter is a thimble filter and the other filter a plain filter having diameter of 45 mm. Both filters are inside the heater that is kept in 150 °C temperature.

Test fuel properties

Testing was carried out using birch wood chips. A representative sample was taken from the fuel batch for analysis and it was analysed in the accredited laboratory of Labtium Oy (Enas Oy) in Jyväskylä. The fuel moisture was analysed also by Labtium Oy. The properties of the test fuel are given in table 1.

Table 1. Test fuel properties.

Nominal heat output test	unit	Wood chips	
Moisture content	% (wet basis)	23.7	
Calorific value of DS	MJ/kg	18.36	
Calorific value as received	MJ/kg	13.43	
Partial heat output test			
Moisture content	% (wet basis)	26.5	
Calorific value of DS	MJ/kg	18.36	
Calorific value as received	MJ/kg	12.85	
		April 2014	April 2016
Ash content (550 °C)	m-% of DM	0.3	0.2
Carbon content	m-% of DM	49.9	49.6
Hydrogen content	m-% of DM	5.9	6.2
Nitrogen content	m-% of DM	0.14	0.16

Test results

Measured and calculated results of the nominal heat load test are presented in Table 2 and of the partial heat load test in Table 3. Results are averages of the total burning period.

Table 2. Measured and calculated results of *the nominal heat load test*. All concentrations are given in dry flue gas.

11 April 2014	Unit	Result
Test period	hour	6.00
Temperature of out flow water	°C	80.3
Temperature of return water	°C	59.9
Ambient temperature	°C	21.2
Amount of fuel burned	kg	56.4
Energy in fuel	kWh	210.3
Energy to water circuit	kWh	186.8
Boiler efficiency	%	88.8
Boiler output	kW	31.1
Electrical consumption	W/h	202
Under pressure in the stack	Pa	-48
Flue gas temperature	°C	118.9
CO ₂ concentration	%	11.3
O ₂ concentration	%	9.1
CO concentration	ppm	323
CO concentration	ppm (at 10 % O ₂)	299
CO concentration	mg/Nm ³ (at 10 % O ₂)	374
CO emission	mg/MJ	187
OGC concentration	ppm	10
OGC concentration	mg org C/m ³ (at 10 % O ₂)	15
OGC emission	mg org C/MJ	8
NO _x concentration	ppm	107
NO _x concentration	ppm (at 10 % O ₂)	99
NO _x concentration	mg/Nm ³ as NO ₂ (at 10 % O ₂)	203
NO _x emission	mg/MJ as NO ₂	101
Particulate concentration		
- measurement 1	mg/Nm ³	29
- measurement 2		30
- measurement 3		29
- measurement 4		30
Average particulate concentration	mg/Nm ³ (at 10 % O ₂)	27
Particle emission	mg/MJ	14

Table 3. Measured and calculated results of *the partial heat load test*. All concentrations are given in dry flue gas.

22 April 2016	Unit	Result
Test period	hour	6.00
Temperature of out flow water	°C	78.6
Temperature of return water	°C	60.4
Ambient temperature	°C	23.5
Amount of fuel burned	kg	16.0
Energy in fuel	kWh	57.0
Energy to water circuit	kWh	50.9
Boiler efficiency	%	89.2
Boiler output	kW	8.5
Electrical consumption	W/h	121
Under pressure in the stack	Pa	-5.9
Flue gas temperature	°C	63.8
CO ₂ concentration	%	12.0
O ₂ concentration	%	8.6
CO concentration	ppm	114
CO concentration	ppm (at 10 % O ₂)	101
CO concentration	mg/Nm ³ (at 10 % O ₂)	127
CO emission	mg/MJ	63
OGC concentration	ppm	4
OGC concentration	mg org C/m ³ (at 10 % O ₂)	6
OGC emission	mg org C/MJ	3
NO _x concentration	ppm	85
NO _x concentration	ppm (at 10 % O ₂)	75
NO _x concentration	mg/Nm ³ as NO ₂ (at 10 % O ₂)	154
NO _x emission	mg/MJ as NO ₂	76
Particulate concentration	mg/Nm ³	
- measurement 1		21
- measurement 2		22
- measurement 3		18
- measurement 4		17
Average particulate concentration	mg/Nm ³ (at 10 % O ₂)	18
Particle emission	mg/MJ	9

Surface temperatures

Surface temperatures of the boiler are presented in table 4.

Table 4. Surface temperatures.

Hottest points of the boiler *)	Temperature	Exceeding ambient room temperature by
	°C	K
Front	47.0	25.8
Back	31.6	10.4
Right side	31.6	10.4
Left side	33.9	12.7
Top	37.7	16.5
Bottom	-	-

*) boiler operating doors excluded

Surface temperatures were measured using the infrared camera ThermaCAM™ E2 and K-Type thermocouple. Temperature of the surrounding was 21.2 °C. Temperatures of the boiler surface did not exceed the maximum allowed temperature according to the standard which is $21.2 + 65 = 86.2$ °C.

Summary

The boiler **VETO 30**, met construction requirements detailed in clause 4.2 of EN 303-5.

The boiler **VETO 30**, met the safety requirements detailed in clause 5 of EN 303-5.

The boiler **VETO 30**, met the performance requirements detailed in clause 4.4 of EN 303-5. The mean carbon monoxide emission, calculated at 10% oxygen content, is below the maximum limit value of 500 mg/m³ for the best class 5 specified in clause 4.4.7 of EN 303-5. The mean organic gaseous compounds (OGC) content, calculated at 10% oxygen content, is below the maximum limit value of 20 mg/m³ for the best class 5 specified in clause 4.4.7 of EN 303-5. The mean particulate concentration, calculated at 10% oxygen content, is below the maximum limit value of 40 mg/m³ for the best class 5 specified in clause 4.4.7 of EN 303-5. The mean particulate concentration at partial heat output, calculated at 10% oxygen content, was 18 mg/m³@ 10% O₂.

The measured total efficiency at nominal heat output was 89% and exceeded the requirement of not less than 88.5 % for the best class 5 specified in clause 4.4.2 of EN 303-5.

Measured flue gas temperature at nominal heat output was 119 °C and was less than 160 K above the test room temperature. The manufacturer shall make recommendations regarding the flue installation in order to ensure sufficient draught and to prevent sooting up of the chimney and condensation.

The appliance operating instructions supplied by the manufacturer satisfied the requirements for the appliance operating instructions as detailed in Clause 8 of EN 303-5.

Jyväskylä, 26 April 2016


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Appendices 2 pieces

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VETO 30

Figure 1. Photograph of the tested appliance.

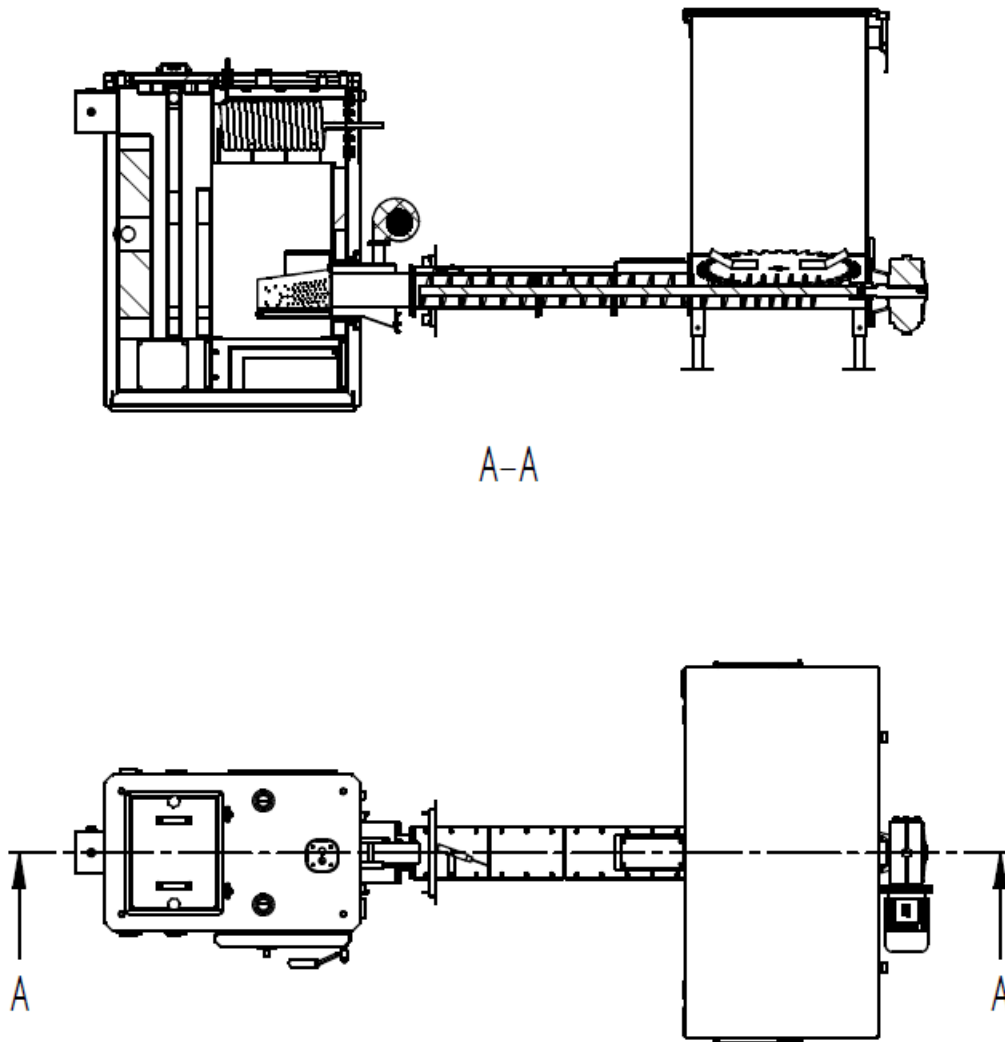


Figure 2. Technical drawings of the tested appliance.