



TEST REPORT

No. 39-5188/T

Product: Hot water boiler burning wood

Type designation: ORLAN 80

Versions: -

Customer: EKO-VIMAR ORLAŃSKI
ul. Nyska 17 B
48-385 Otmuchów
POLAND

Manufacturer: EKO-VIMAR ORLAŃSKI
ul. Nyska 17 B
48-385 Otmuchów
POLAND

Responsible employee: Ing. Aleš Onderek

Report issue date: 2005-11-10

Distribution list: 1 copy to the Engineering Test Institute
1 copy to the Customer



The tests were conducted on the basis of Order No. B-22772 of 9 September 2005, Contract No. B-22772/39 of 14 September 2005 and its supplement No. 0211-On/Mi/7899 of 7 November 2005.

I. Product description

A hot-water steel boiler designated for the central heating of larger residential premises (houses, flats, offices), or small community premises, business premises and stores, etc. The boiler rated capacity is 77 kW. The boiler is designed for use with soft lump firewood.

The boiler body is welded of steel sheets, the inner lining coming in contact with fuel has the thickness of 6 mm, while the boiler body outer shell is 4 mm thick. The sheet of the boiler outer shell is 0.8 mm thick. There is a fuel hopper situated at the upper part of the boiler body, with a starting shutter situated at the top, shortening the combustion product duct from the hopper directly to the chimney. The bottom part of the hopper includes a heat-resisting ceramic piece with an elongated hole for the passage of combustion products and gases. There is burning chamber at the bottom of the boiler body, equipped with a heat-resisting ceramic piece. In the rear part of the boiler, there is a vertical combustion product channel, formed by a tube plate.

The boiler features combustion product swirlers in the combustion product exchanger tube plate, with a manually controlled lever situated at the boiler side, which can be used for the cleaning of the combustion product exchanger tube plate without a need to dismantle the shell covers.

The boiler is equipped with two fans including a damper, blowing air into the hopper. The fan speed is controlled by the boiler automatics and the maximum revolution speed can be adjusted on the basis of the specific installation conditions from 40% to 100%.

In the rear side of the boiler, there is a heating water input branch (DN 70) and a G $\frac{3}{4}$ " connection for the discharge and filling valve; in the upper part, flue duct branch is located symmetrically, with a diameter of 210 mm. Above the hopper, there is an exchanger tube bellow situated above the hopper, serving for the removal of surplus heat, with connection branches situated on the right and left sides of the boiler.

In the boiler front wall, there is a charging door with ash-pan door beneath, and a supply air fan cover situated between. The heating water outlet from the boiler is situated in the rear part of the boiler upper wall. A thermometer well for the installation of a sensor serving for the removal of surplus heat is situated in the upper wall of the boiler body; the operating regulation sensor is fitted in the upper wall of the boiler body under the boiler shell thermal insulation (with a contact established). The boiler is automatically controlled by the RK 2001 R4E regulator, situated in the upper wall of the boiler shell.

The boiler shell consists of steel coated panels and includes heat insulation made of mineral wool.

II. Sample tested

Boiler type:	SZÚ reg. number	Date of testing	Place of testing	Quantity
ORLAN 80	0211.05.11591.000	04.10.2005	SZÚ Brno	1

Visual inspection, tests and verifications were conducted by: Roman Okřina
Ing. Václav Lank
RNDr. Blanka Cholková

The tests were conducted using measuring and testing equipment with valid calibration.



III. Results of tests and verifications

Test No.	Test name and specification	Technical standard/regulation applied		Test result	Evaluation (*)
1.	Heat capacity, calorific efficiency, temperature of combustion products, draught behind boiler	ČSN EN 303-5:2000, Art. 4.2, 4.2.1, 4.2.2, 4.2.4, 4.2.5, 5.8.2, 5.8.3, 5.8.4		page 5 – 7	+
		ČSN EN 303-5:2000 Annex A, Deviation A.1.1 Annex A		page 9	+
2.	Combustion efficiency, emissions	ČSN EN 303-5:2000, Art. 4.2.6		page 8 – 11	+
		ČSN EN 303-5:2000, Annex A (Deviations A.1.2, A.2 and A.5)	A.1.2	page 12-14	–
			A. 2		+
			A. 5		+

Note:

- + Requirement fulfilled.
- Requirement not fulfilled.
- x Requirement not evaluated (not verified).
- 0 Requirement does not apply to the product.

The test and verification results apply to the tested product only.



Subject tested: Measuring and testing equipment used for testing
Sample tested: ORLAN 80
Date of testing: 04.10.2005

Name	Inventory number	Certificate valid through	Precision
Combustion products analyser Horiba, type 680 P	92 0004	Verified prior to measurement using calibration gases	O ₂ , CO ₂ , CO, SO ₂ , NO _x ± 0.5 % of the measurement range C _x H _y ± 1 % of the measurement range
Schember weighing machine	serial number: 54576/82	08/2007	± %
GRW water gauge type TGL 33259	02 1575	02/2007	100% ±0,2% 10% ±0,4 % 1% ±0,6 %
Recorder Zapra, type DT1	02 2241	01/2006	± 1 %
Therm thermometer Type 2290-3	02 1993	12/2007	± 0.1°C
Calorimeter IKA type C 5000	02 2236	12/2007	± 0.12 MJ/kg
Elementary analyzer Perkin Elmer type 2400 CHNS	02 2107 Z	Verified using calibration standards during measurement	C, H, A, S ± 0.5 % of the measured values
Analytical weighing machine Sartorius	02 1458	11/2007	± 0.0001 g
Barometer	11 3703	09/2007	± 0.1 kPa
Draught gauge	02 1702		± 1 Pa
Chronometer	18 2507	08/2005	± 0.05 %

Testing engineer responsible for the test results:

Roman Okřina
name
signature
5/10/2004
date

Reviewed by:

Ing. Aleš Onderek
name
signature
9/10/2004
date



Subject tested: Heat capacity, input, calorific efficiency
Sample tested: ORLAN 80
Date of testing: 04.10.2005

Tests conducted according to ČSN EN 303-5:2000 methodology.

AVERAGE MEASURED AND CALCULATED VALUES:

Test number:		1	2
Boiler type		ORLAN 80	
Testing date		04.10.2005	04.10.2005
Fuel type		birch chips L = 50cm	
Rated capacity declared by manufacturer		kW	77
Tested capacity		rated 1 st period of burning	rated 2 nd period of burning
Draft behind boiler	Pa	24,6	27,0
Fuel - unburn	kg.h ⁻¹	19,05	19,50
Water - input temperature	°C	58,0	50,3
Water - output temperature	°C	68,3	57,5
Water - cooling temperature	°C	58,0	50,3
Water - volume flow rate	m ³ .h ⁻¹	6,355	9,275
Air - indoor temperature	°C	25,1	25,4
Air - relative humidity	%	65,3	62,7
Air - barometric pressure	Torr	736,0	736,0
Combustion products - temperature	°C	129,4	110,4

Analysis of combustion products:

Test number:			1	2
Boiler type			ORLAN 80	
Testing date			04.10.2005	04.10.2005
Fuel type			birch chips L = 50cm	
Rated capacity declared by manufacturer			kW	77
Tested capacity			rated 1 st period of burning	rated 2 nd period of burning
Combustion products - analysis:	O ₂	%	8.6	6.8
	CO ₂	%	10.8	13.0
	CO	%	0.036	0.058
	NO _x	ppm	79.5	108.5
	CxHy	ppm	336	56
	SO ₂	%	0.00	0.00

Note: a) Test No. 1 was conducted with the boiler capacity amounting to 99.5% of the rated capacity.
 b) Test No. 2 was conducted with the boiler capacity amounting to 101.3% of the rated capacity.



Auxiliary combustion values (solid fuels):

Test number:		1	2
Boiler type		ORLAN 80	
Testing date		04.10.2005	04.10.2005
Fuel type		birch chips L = 50cm	
Rated capacity declared by manufacturer	kW	77	77
Tested capacity		rated 1 st period of burning	rated 2 nd period of burning
Stoich. oxygen volume	m ³ .kg ⁻¹	0.919	0.919
Stoich. air volume	m ³ .kg ⁻¹	4.375	4.375
Stoichiometric volume of dry combustion products	m ³ .kg ⁻¹	4.267	4.267
Volume of dry combustion products, actual	m ³ .kg ⁻¹	7.454	6.187
Combustion air multiple	-	1.67	1.46
Volume of H ₂ O in the combustion air	m ³ .kg ⁻¹	0.103	0.084
Volume of H ₂ O in the combustion products	m ³ .kg ⁻¹	0.966	0.947
Max. volume of CO ₂	%	18.93	18.93
Max. volume of SO ₂	%	0.07	0.00

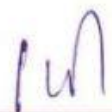


Calculated values - thermal balance


Test number:		1	2
Boiler type		ORLAN 80	
Testing date		04.10.2005	04.10.2005
Fuel type		birch chips L = 50cm	
Rated capacity declared by manufacturer	kW	77	77
Tested capacity		rated 1 st period of burning	rated 2 nd period of burning
Loss of sensitive heat	%	9.82	6.77
Loss of gas underburning	%	0.22	0.29
Loss of mechanical underburning	%	0.34	0.34
Other loss (to the environment)	%	1.11	0.96
Total loss	%	11.5	8.4
Efficiency - indirect method	%	88.5	91.6
Heat input	kW	83.80	85.77
Heat capacity	kW	76.63	77.98
Efficiency - direct method	%	91.4	90.9
Power / rated capacity	%	99.5	101.3

The efficiency of the ORLAN 80 boiler burning wood meets - at the rated capacity – the requirements for Class 3 according to ČSN EN 303-5:2000, Figure 1.

Testing engineer responsible for the test results:

Roman Okřina		8/2007
name	signature	date

Reviewed by:

Ing. Aleš Onderek		2/2007
name	signature	date



Subject tested: Heat capacity, input, calorific efficiency
Sample tested: ORLAN 80
Date of testing: 04.10.2005

Fuel analysis

Fuel type		birch chips
Water	[%]	15.18
Ash	[%]	1.01
Carbon	[%]	43.83
Hydrogen	[%]	6.08
Sulphur	[%]	0.00
Nitrogen	[%]	0.45
Oxygen	[%]	33.44
Heat of combustion [MJ/kg]		17.35
Caloric value	[MJ/kg]	15.65

Testing engineer responsible for the test results:

Roman Okřina

name

signature

3/2007

date

Reviewed by:

Ing. Aleř Onderek

name

signature

3/2007

date



Subject tested: Combustion efficiency (emissions)
Sample tested: ORLAN 80
Date of testing: 04.10.2005

Tests conducted according to ČSN EN 303-5:2000 methodology.

Test results:

Test No. 1 - Rated capacity (1st period of burning)

Fuel type	Draft Pa	CO ₂ % by vol.	O ₂ % by vol.	CO ppm	NO _x ppm	CO % by vol. n = 1	CxHy ppm	CO mg/m ³ (O ₂ =10%)	OGC mg/m ³ (O ₂ =10%)	Dust mg/m ³ (O ₂ =10%)
birch chips L = 50cm	24.6	10.8	8.6	362	80	0.063	336	401	159.8	13.8

The values of CO and dust emissions correspond to class 3, OGC corresponds to class 2.

Test No. 2 - Rated capacity (2nd period of burning)

Fuel type	Draft Pa	CO ₂ % by vol.	O ₂ % by vol.	CO ppm	NO _x ppm	CO % by vol. n = 1	CxHy ppm	CO mg/m ³ (O ₂ =10%)	OGC mg/m ³ (O ₂ =10%)	Dust mg/m ³ (O ₂ =10%)
birch chips L = 50cm	27.0	13.0	6.8	584	109	0.085	56.4	565	23.4	13.8

The values of CO, OGC and dust emissions correspond to class 3.

Average of tests No. 1 + 2

Fuel type	Draft Pa	CO ₂ % by vol.	O ₂ % by vol.	CO ppm	NO _x ppm	CO % by vol. n = 1	CxHy ppm	CO mg/m ³ (O ₂ =10%)	OGC mg/m ³ (O ₂ =10%)	Dust mg/m ³ (O ₂ =10%)
birch chips L = 50cm	25.8	11.9	7.7	472.8	94	0.074	196	483	91.6	13.8

The values of CO, OGC and dust emissions correspond to class 3.

Testing engineer responsible for the test results:

Roman Okřina

name

signature

date

3 / 2007

Reviewed by:

Ing. Aleš Onderek

name

signature

date

2 / 2007



Subject tested: Output concentration of solid pollutants

Sample tested: ORLAN 80

Date of testing: 4.10.2005

A) Test conditions:

The measurement was performed with the boiler in operation condition for rated capacity, in accordance with Article 5.9 of ČSN EN 303-5:2000. Consumption of fuel: wood - birch chips 19.5 kg/h.

The measurement was conducted at a plain section of the output pipeline with a diameter of 150 mm in accordance with ČSN 12 4070:1989.

The measurement of the flow rate of air and the concentration of solid pollutants was performed at a single point at the pipeline axis.

The length of the pipeline straight section where the measurement was performed was 1,000 mm.

B) Measuring devices applied:

Name	Inventory number	Certificate valid through	Precision
Gravimat SHC 5 - TU	92-0002	11/2005	± 5 % of volume
Laboratory weighing machine	02-1458	11/2005	± 0.02 mg
Moisture meter, thermometer, barometer, anemometer - therm 2290-3	02-1993 Z	1/2006	± 1 %
Excicator	-	not subject	not determined
Laboratory furnace	02-1428	not subject	not determined
Heated tube	-	not subject	not determined
Condenser	-	not subject	not determined
Mercury U-manometer	-	not subject	± 100 Pa
Water gas meter	02-1822 Z	3/2007	± 1 %

Combustion products analyser		Type: Horiba Enda 680P	drawing number 9920680
Measurement principle. Paramagnetic principle (O ₂), FID detector (C _x H _y), NDIR spectrometry		Manufacturer: HORIBA Ltd., Kyoto, Japan	
	Measurement ranges	Calibration gas concentrations - verification prior to measurement	Detection limit
O ₂	0-10 / 0-25% of volume	ambient air	0.01% of volume
CO ₂	0-15 / 0-25% of volume	10% in N ₂	0.01% of volume
CO	0-5000 ppm	900 ppm in N ₂	0.1 ppm
CO	0-50000 ppm	10000 ppm in N ₂	10 ppm
NO _x	0-250 / 0-500 ppm	100 ppm in N ₂	0.1 ppm
SO ₂	0-200 ppm	100 ppm	0.1 ppm



SO ₂	0-1000 ppm	100 ppm	1 ppm
C _x H _y	0-20 / 0-200 / 0-2000 ppm	102 ppm of methane in synthetic air	0.01 ppm

C) Method of measurement:

Measurement of the flow rate of air according to ČSN 12 4070:1989 based on the SZÚ methodology 047 - M - 004/M and in accordance with the requirements of ČSN EN 303-5:2000.

The flow rate at the defined points in the measurement cross section was measured with the use of the Prandtl tube and the FD 9612 S6F pressure sensor, Therm 2290-3. The air humidity was measured using the condensation method.

Measurement of the concentration of solid pollutants according to ČSN 83 4611:1982 and ČSN 12 4070:1989 based on the SZÚ Brno methodology No. SZÚ 047 - M - 003/M and SZÚ 047 - M - 004/M.

At the measurement cross section, a short one-off measurement was carried out comprising four short-term measurements (30 minutes each measurement).

Isokinetic collection of an air sample was conducted with the use of a probe with the diameter of 11.5 mm, with a sharp edge at the determined point (the pipeline axis) in the measurement cross section. Samples were collected 4 times and the average value was calculated from the observed values.

The trap included filtration material of glass fibre with the diameter of 50 mm (manufacturer - Schleicher and Schuell). The weight of the trapped material was identified as the difference in the weight of the filtration elements prior to and after the measurement, i.e. after 2 hours in the excicator.

For the determination of the air humidity and reference content of O₂, measurement of the content of the air (combustion products) was carried out according to the SZÚ methodology 044-M-003.

The measurement of emissions was carried out in accordance with the requirements of Art. 5.7.3, 5.9 and 5.10.4 of ČSN EN 303-5:2000.

D) Measured and calculated values:

1) Boiler ORLAN 80, birch chips

Table 1

Concentration of solid pollutants at the boiler output		Date: 4.10.2005		
Measurement number	1	2	3	4
beginning – end of measurement (hour, min.)	11 ²⁰ -11 ⁴⁰	12 ²⁰ -12 ⁴⁰	13 ²⁰ -13 ⁴⁰	14 ²⁰ -14 ⁴⁰
ambient temperature (°C)	25.1	25.0	25.5	25.5
number of measuring points ()	1	1	1	1
duration of consumption at the measuring point (min.)	30	30	30	30
air temperature (°C)	157.4	125.5	116.8	111.5
negative (positive) pressure in the measurement	-25	-25	-27	-26
atmospheric air pressure (Pa)	98 125			
measurement cross-section (m ²)	0.0177			
fictitious humidity under standard conditions (kg/m ³)	0.1077			
dew point temperature (°C)	49.6			
relative air humidity (%)	12.3			
humid air density under standard conditions (kg/m ³)	1.2791			
operating content of O ₂ (%)	7.7			
air volume flow rate (m ³ /h)	237.8			
air volume flow rate under standard conditions (m ³ /h)	151.7			
dry air volume flow rate under standard conditions (m ³ /h)	133.0			
medium exhaust rate (m/s)	3.7	3.7	3.7	3.7
weight of solid pollutants (mg)	7.2	6.4	6.8	6.3
air sample volume (m ³)	0.688	0.692	0.693	0.695



air sample volume under standard conditions (m ³)	0.423	0.459	0.470	0.478
dry air sample volume under standard conditions (m ³)	0.371	0.403	0.412	0.419
medium weight concentration of solid pollutants (mg/m ³)	10.5	9.2	9.8	9.1
medium weight concentration of solid pollutants under standard conditions (mg/m ³)	17.0	13.9	14.5	13.2
medium weight concentration of solid pollutants in dry air under standard conditions (mg/m ³)	19.4	15.9	16.5	15.0
mass flow rate of solid pollutants (g/h)	2.50	2.19	2.33	2.16
average medium weight concentration of solid pollutants (mg/m ³)	9.7			
average medium weight concentration of solid pollutants under standard conditions (mg/m ³)	14.7			
average medium weight concentration of solid pollutants in dry air under standard conditions	16.7			
average medium weight concentration of solid pollutants in dry air under standard conditions at 10%	13.8			
average mass flow rate of solid pollutants (g/h)	2.3			
standard deviation for determination of medium weight concentration of solid pollutants (mg/m ³)	0.65			
standard deviation for determination of average mass flow rate of solid pollutants (g/h)	0.16			

Note: standard conditions – temperature: 0 °C, pressure: 101.325 kPa

Testing engineer responsible for the test results:

Milan Holomek

7.11.2005

name

signature

date

Ing. Aleš Onderek

Reviewed by:

name

signature

date



Subject tested: Combustion efficiency (emissions) according to Annex A to ČSN EN 303-5:2000, deviation type A
Sample tested: ORLAN 80
Date of testing: 04.10.2005

Tests conducted according to ČSN EN 303-5:2000 – Annex A

A.1 Deviation for Austria:

A.1.1 Boiler efficiency 10 to 200 kW with manual fuel charging, for rated heat capacity and minimum heat capacity:

boiler, ORLAN 80

Boiler capacity	Required efficiency	Measured efficiency
Rated – 1 st burning period	79.8	91.4
Rated – 2 nd burning period	79.8	90.9

A.1.2 Limit values of emissions

The following limits are determined for boilers burning wood with manual fuel charging:

biological fuels: - CO: 1100 mg/MJ
- OGC: 80 mg/MJ
- NO_x: 150 mg/MJ
- dust: 60 mg/MJ

boiler, ORLAN 80

Boiler capacity	Average values of emissions								
	Values measured					Converted values			
	O ₂ [%]	CO [ppm]	CxHy [ppm]	NO _x [ppm]	Dust mg/m ³	CO [mg/MJ]	OGC [mg/MJ]	NO _x [mg/MJ]	Dust [mg/MJ]
Rated – 1 st burning period	8.6	362	336.2	79.5	13.8	365	194	131	11.1
Rated – 2 nd burning period	6.8	584	56.4	109	13.8	427	24	130	8.1

A.2 Deviation for Germany:

For Germany, only Class 3 is permissible from the perspective of emission limit values according to Table No. 7 of ČSN EN 303-5:2000.

In addition, central heating boilers using solid fuels with rated calorific capacity exceeding 15 kW must be constructed and operated so that the emissions meet the following requirements, depending on the used fuel:

- dust: 0.15 g/m³, related to the content of O₂ in the combustion gases of O₂ = 13 %
- carbon monoxide CO (for boilers with the capacity of 50 to 150 kW): 2 g/m³ (related to the content of O₂ in combustion products O₂ = 13 %)



boiler, ORLAN 80

Boiler capacity	Values measured				Converted values				
	O ₂ [%]	CO [ppm]	CxHy [ppm]	Dust [mg/m ³]	CO O ₂ = 10 % [mg/m ³]	OGC O ₂ = 10 % [mg/m ³]	Dust O ₂ = 10 % [mg/m ³]	CO O ₂ = 13 % [g/m ³]	Dust O ₂ = 13% [g/m ³]
rated	7.7	472.8	196.3	13.8	483	91.6	13.6	0.57	0.02

A.5 Deviations for Switzerland:

For Switzerland, only Class 3 is permissible from the perspective of emission limit values according to Table No. 7 of ČSN EN 303-5:2000. In addition, boilers with the rated heat capacity Q_N 70 to 200 kW must meet the following requirement concerning emission:

Fuel: wood

- carbon monoxide CO: 2000 mg/m³ (related to the content of O₂ in the combustion gases of O₂ = 13%)
- dust: 150 mg/m³, related to the content of O₂ in the combustion gases of O₂ = 13 %

boiler, ORLAN 80

Boiler capacity	Values measured				Converted values				
	O ₂ [%]	CO [ppm]	CxHy [ppm]	Dust [mg/m ³]	CO O ₂ = 10 % [mg/m ³]	OGC O ₂ = 10 % [mg/m ³]	Dust O ₂ = 10 % [mg/m ³]	CO O ₂ = 13 % [mg/m ³]	Dust O ₂ = 13% [mg/m ³]
rated	7.7	472.8	196.3	13.8	483	91.6	13.6	571	16

Testing engineer responsible for the test results:

Roman Okřina

name

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3/2007

date

Reviewed by:

Ing. Aleš Onderek

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date



IV. Conclusion

The product - Hot-water boiler burning wood (with manual fuel charging) ORLAN 80 – meets the requirements laid down in ČSN EN 303-5:2000.

The requirements of deviations of type A in Annex A to ČSN EN 303-5:2000 are evaluated for the following countries: Austria (AT), Switzerland (CH) and Germany (DE). The above-said requirements regarding deviations are not fulfilled in OGC of the 1st burning period for Austria (ČSN EN 303-5:2000 A.1.2).

V. List of referenced documents

- Order B-22772 of 9 September 2005
- Contract B-22772/39 of 14 September 2005, concluded with the customer
- Contract Supplement 0211-On/Mi/7899 of 7 November 2005
- ČSN EN 303-5:2000 – Central heating boilers – Part 5: Central heating boilers burning solid fuels, with manual or automatic supply and max. rated heating capacity of 300 kW, Terminology, requirements, testing and labelling
- Documentation filed for task No. 37-4009.

The persons stated below are accountable for the accuracy of the above-specified data:



Ing. Aleš Onderek
Head of Boiler and Industrial Devices Team



Ing. Jiří Dvořák
Heat and Ecological Equipment Testing Station
Manager



Annex – photo-documentation



Fig. 1: - boiler controls



Fig. 2: - overall view of the boiler



Fig. 3: - combustion air fans



Fig. 4: - view of the boiler combustion chamber

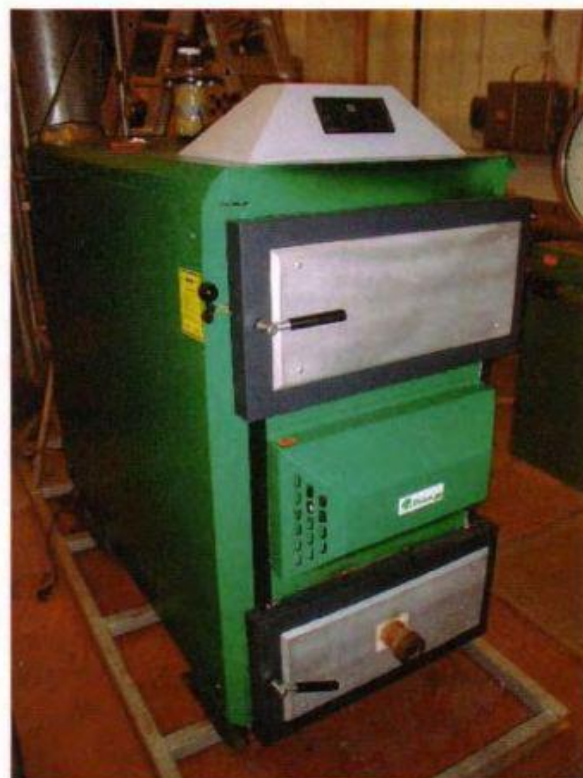


Fig. 5: - overall view of the boiler (with a combustion chamber test door and covered fan)