

Report on Type testing of the pellets boiler “Balance K / Typ HP 02” of the company “Hapero Energietechnik GmbH”



Order number	PL-12034/2-E-P
Person responsible for testing	E. Padouvas L. Kleemann
Number of pages	14
Number of pages in appendix	6

Report written	am: 28.02.2012 von: E. Padouvas	Report approved:	am: 09.03.2012 von: H. Hofbauer
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This report is the translation of the original German report with the order number PL-09075-P from 29.05.2009

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1 The Client

Hapero Energietechnik GmbH
Gewerbepark Ost 3
5141 Moosdorf

2 Scope of testing

The client applied for testing of heat engineering in accordance with the requirements of the EN 303-5 and of the agreement pursuant to Article 15a B-VG of the Federal Constitution Act on “protective measures related to small scale combustion equipment” and “energy saving” for the fuel wood pellets with the designation:

“Balance K / Type HP 02”

3 Equipment submitted for testing and documents supplied

Hapero Energietechnik GmbH supplied a boiler with the designation

“Balance K / Typ HP 02”

The client provided the following documents:

- Operating instructions
- Installation instructions
- Identification plate
- Technical drawings

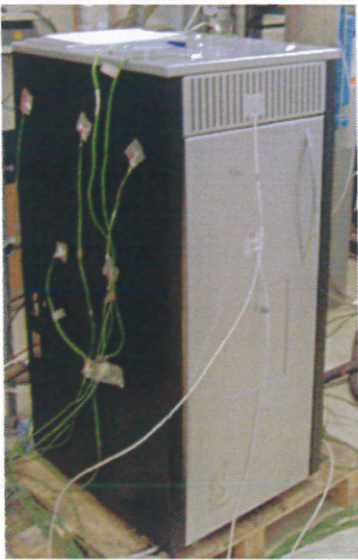
4 Product description (equipment to be tested)

4.1 Construction and function

The wood pellets boiler “Balance K / Type HP 02” is equipped with a fuel hopper, screw conveyer, combustion chamber with a fuel pot, electrical ignition and water heat exchanger. The combustion chamber door has a flushed glass window to avoid deposits.

The integrated stoking device feeds the pellets into the fuel pot via an electronic controlled screw conveyer. The required combustion air is sucked by the flue gas fan via the air inlet. Hot combustion gases are led through the heat exchanger to the flue gas exit.

4.2 Technical data of the boiler tested¹ on the test-bench

Name of device		Balance K / Typ HP 02
Photo of the tested boiler		
Parameters		
Fuel		Wood pellets (ÖNORM 7135)
Nominal heat output	[kW]	15
Heat power range	[kW]	4 – 15
Max. boiler operation pressure	[bar]	3
Max. boiler temperature	[°C]	85
Min. boiler inlet temperature	[°C]	30
Dimensions		
Weight	[kg]	158
Height	[mm]	1118
Base	[m ²]	0,324
Water amount	[l]	32
Connection outlet/inlet	[inch]	3/4"
Flue gas tube connection	[mm]	80
Electric links	[V/Hz]	230/50
Electrical power input	Start	[W] 280
	Operation	[W] 38

¹ Information provided by the manufacturer

5 Test procedure

“Balance K/Typ HP 02” was tested on the test-bench as specified in ÖNORM EN 303-5 also a safety test according to ÖNORM EN 303-5 was carried out.

6 Measuring system

The test-bench was constructed in accordance with the requirements of ÖNORM EN 303-5. The test-bench is shown together with the measurement devices in scheme in Figure 1.

A small amount of flue gas was taken out of the exit stream for analysis. The first step was to remove the dust from the sample gas using a heated filter made from ceramics. The sample gas was then transported along a pipe heated to approximately 180° C to the next preparation stages. The majority of the water was removed from the gas by cooling to about 5 ° C. After these preparatory stages the gas was fed to several analysis equipments (O₂, CO₂, CO and NO). The flame ionisation detector (C_xH_y) was supplied with sample gas through a separate heated pipe (180° C) equipped with a filter.

The dust measurement was carried out discontinuously according to the gravimetric principle. To determine the dust concentration content a small gas stream was sampled from the flue gas. A filter collected the particulate matter of the sample gas stream. The sample gas stream was dried (drying tower) and its volume was metered with a gas meter. The evaluation is carried out according to ÖNORM EN 303-5.

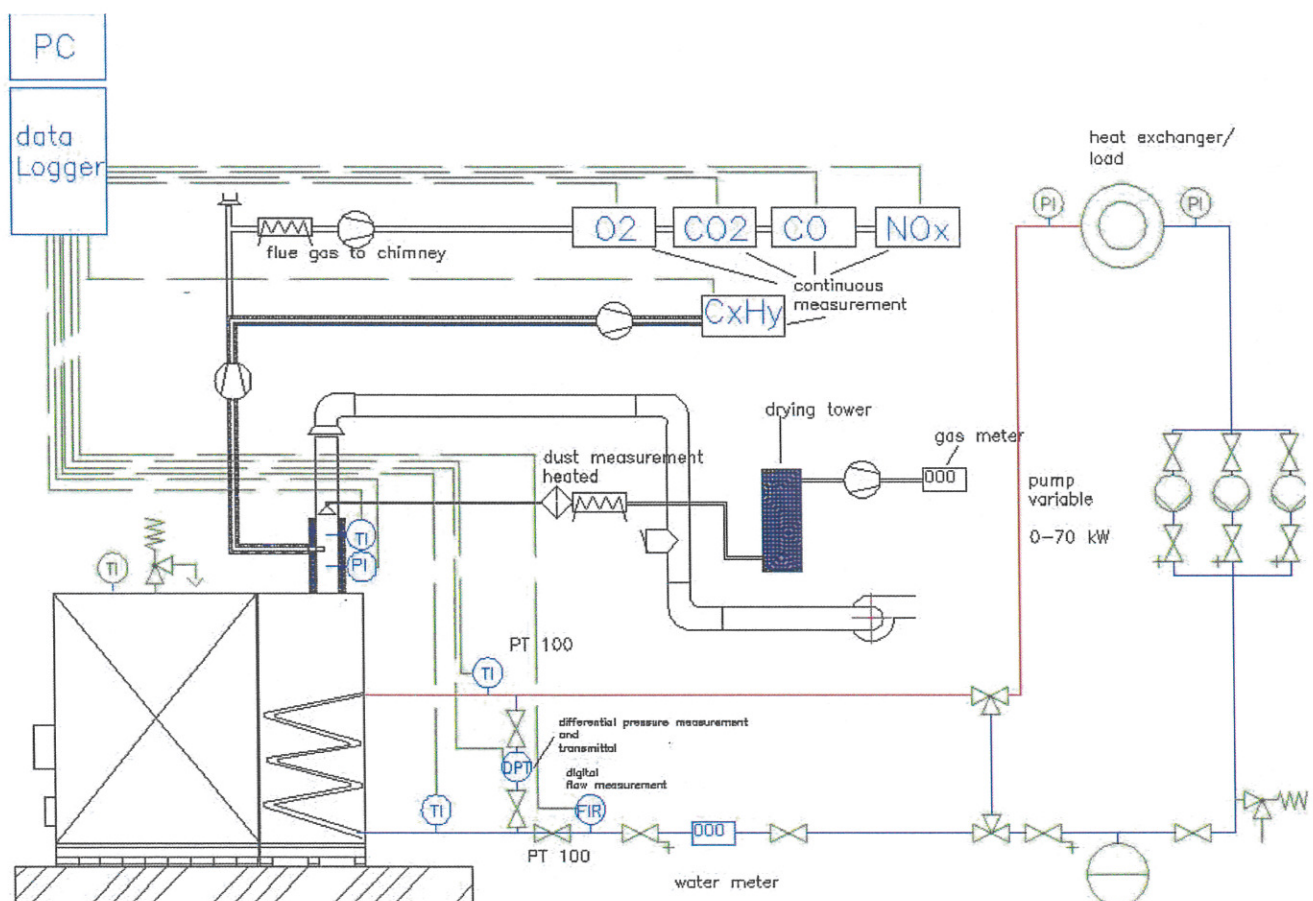


Figure 1: Scheme of the test-bench

7 Measuring equipment and measuring procedures

The measuring equipment and procedures used are listed below.

7.1 Oxygen / carbon dioxide / carbon monoxide

Manufacturer/type	: Emerson Process Management AG / MLT 3 IR IR PO ₂
Measuring principle	: Paramagnetic (O ₂) Infrared (CO ₂ , CO)
Measuring ranges	: 0-25 und 0-100 % O ₂ 0-20 und 0-100 % CO ₂ 0-500 und 0-5000 ppm CO
Measured value output	: 0 to ± 20 mA respectively. 0 to ± 10 VDC
Calibration gas	: Air 14.96 % CO ₂ in N ₂ 1465 ppm CO in N ₂
Zero gas	: N ₂
Accuracy of measurement	: Lower detection limit 1% of the upper range value Margin of error 1 %

7.2 Nitrogen oxides

Manufacturer/type	: Maihak UNOR 6N
Measuring principle	: Infrared
Measuring range	: 0-500/0-1500 ppm NO
Measured value output	: 0-1 V, 4-20 mA (analog)
Calibration gas	: 98.7 ppm NO in Nitrogen
Zero gas	: Nitrogen
Accuracy of measurement	: Lower detection limit 2 % of the upper range value Margin of error 1 %

7.3 Organic gaseous hydrocarbons

Manufacturer/type	: Testa 123
Measuring principle	: Flame ionisation detector (FID)
Measuring range	: 10, 100, 1000, 10000, ppm (is switched automatically)
Measured value output	: 0-10 V, 0-20 mA
Combustion gas	: Hydrogen 5.0
Combustion air	: Air free from hydro-carbons
Calibration gas	: 7.89 ppm propane in nitrogen
Zero gas	: Air free from hydro-carbons
Accuracy of measurement	: Lower detection limit 1% of the upper range value Margin of error 1 %

7.4 Dust

Manufacturer	: Ströhlein
Measuring principle	: Gravimetric
Sampling probe	: Simple probe according to VDI 2066 (made from corrosion-resistant steel with smooth inner walls)
Dust collection	: Stainless steel sleeves with quartz wool located in the probe
Measurement of gas volume	: Gas meter (bellows gas meter)
Suction equipment	: Vacuum pump with 4 m ³ /h rated suction. The partial gas volume stream removed by suction can be adjusted by a bypass regulator
Filter conditioning	: Drying chamber (105 °C, app. 12 hours), desiccators (app. 1 hour)
Accuracy of measurement	: +/- 5 mg/Nm ³
Lower detection limit	: 2 mg/Nm ³

7.5 Gas temperature

The gas temperature was measured with a type K NiCr-Ni thermocouple.

7.6 Pressure measurement

The pressure was measured using pressure-measuring equipment manufactured by Special Instruments, type Digima LPU, with a measuring range from 0 to 200 Pa.

7.7 Atmospheric humidity

Atmospheric humidity was measured continuously using a data logger manufactured by Testo, type 175-H2.

7.8 Recording equipment

The data obtained from the measurements was recorded electronically using a PC (Pentium) and the National Instruments "Field Point" data recording system.

8 Combustion data and test results

9 Fuel

Designation	Wood pellets	
Type	Spruce	
Dimensions		
Diameter	[mm]	6
Length	[mm]	ca. 20

Elementary analysis¹

c	[%]	47,11
h	[%]	5,56
n	[%]	0,10
s	[%]	0,01
a ²	[%]	0,21
o	[%]	40,02
w ²	[%]	6,98

Calculated values³

O ₂ demand	(V _{O2,min})	[m ³ /kg]	0,91
Air demand	(V _{L,min})	[m ³ /kg]	4,32
Flue gas volume, dry	(V _{A,tr,min})	[m ³ /kg]	4,30
Water vapor	(V _w)	[m ³ /kg]	0,71
Flue gas volume, wet	(V _{A,f,min})	[m ³ /kg]	5,01
CO ₂ , maximum		[%]	20,47
Net calorific value	(H _u)	[kJ/kg]	17255

¹ Elementary analysis Vienna University of Technology, Institute of Chemical Engineering

² Determined in accordance with DIN 51718 and DIN 51719

³ All information on volumes related to 0° C and 1013 mbar.

9.1 Test results

Test run		Full load	Partial load
Date of testing		06.05.2009	05.05.2009
Settings during test runs			
Test period	[min]	370	371
Fuel quantity	[kg]	18,2	5,2
Total fuel capacity	[kW]	14,1	4,1
Fuel conversion	[kg/h]	2,9	0,9
Average negative pressure in the flue gas draught	[Pa]	10,9	5,5
Environmental conditions			
Air pressure	[mbar]	989,6	993,3
Atmospheric humidity	[%]	48,3	30,6
Ambient temperature	[°C]	20,3	20,3
Average boiler surface temperatures			
Boiler surface	[°C]	25,1	23,7
Boiler left	[°C]	26,4	25,8
Boiler right	[°C]	24,5	23,8
Boiler front	[°C]	26,2	25,3
Boiler back	[°C]	26,4	26,2
Boiler base	[°C]	26,0	22,1
Fuel hopper	[°C]	25,6	28,6
Operating data			
Air ratio (λ)	[-]	1,7	2,5
Flue gas volume, dry	[Nm ³ /kg]	7,3	10,7
Flue gas volume, wet	[Nm ³ /kg]	8,0	11,4
Flue gas flow	[Nm ³ /h]	23,5	9,8
Flue gas mass flow rate	[g/s]	7,9	3,5
Average flue gas temperature	[°C]	85,1	63,6
c_{pav} steam	[kJ/Nm ³ K]	1,50	1,50
c_{pav} dry flue gas	[kJ/Nm ³ K]	1,32	1,31
Sensible heat loss in flue gas	[kJ/Nm ³ K]	725,1	676,0
	[kJ/Nm ³ K]	4,2	3,9
Loss through CO in flue gas	[kJ/kg]	4,9	13,2
	[%]	0,0	0,1
Heat losses due to combustible constituents in the residue	[kJ/kg]	13,8	31,7
	[%]	0,1	0,8
Loss through radiation, convection and conduction	[W]	151,1	142,7
	[%]	1,0	3,5
Thermal efficiency indirect	[%]	94,6	91,8
Thermal output indirect	[kW]	13,4	3,8
Thermal water output			
Average inlet water temperature	[°C]	59,9	62,3
Average outlet water temperature	[°C]	70,1	74,0
Average water volume flow	[m ³ /h]	1,152	0,284
Thermal output	[kW]	13,5	3,8
Thermal efficiency	[%]	95,7	92,8

Test run		Full load	Partial load
Date of testing		06.05.2009	05.05.2009
Emissions, measured			
Oxygen	[Vol%]	8,3	12,2
Carbon dioxide	[Vol%]	12,1	8,2
Carbon monoxide	[ppm]	54	98
Nitrogen oxides as NO ₂	[ppm]	104	63
Organic hydro-carbons	[ppm]	3	3
Dust measurement 1	[mg/Nm ³]	28	15
Dust measurement 2	[mg/Nm ³]	31	15
Dust measurement 3	[mg/Nm ³]	24	16
Dust measurement 4	[mg/Nm ³]	30	13
Dust measurement 5	[mg/Nm ³]	30	16
Dust measurement 6	[mg/Nm ³]	30	16
Emissions, referred to 10 Vol-% O₂ and standard reference conditions			
Carbon monoxide	[mg/Nm ³]	58	153
Nitrogen oxides as NO ₂	[mg/Nm ³]	168	147
Organic hydro-carbons	[mg/Nm ³]	4	5
Dust measurement 1	[mg/Nm ³]	23	18
Dust measurement 2	[mg/Nm ³]	25	17
Dust measurement 3	[mg/Nm ³]	19	18
Dust measurement 4	[mg/Nm ³]	23	14
Dust measurement 5	[mg/Nm ³]	23	18
Dust measurement 6	[mg/Nm ³]	24	17
Emissions, referred to 13 Vol-% O₂ and standard reference conditions			
Carbon monoxide	[mg/Nm ³]	42	111
Nitrogen oxides as NO ₂	[mg/Nm ³]	134	118
Organic hydro-carbons	[mg/Nm ³]	3	4
Dust measurement 1	[mg/Nm ³]	19	14
Dust measurement 2	[mg/Nm ³]	20	14
Dust measurement 3	[mg/Nm ³]	15	14
Dust measurement 4	[mg/Nm ³]	19	11
Dust measurement 5	[mg/Nm ³]	18	15
Dust measurement 6	[mg/Nm ³]	19	14
Emissions, referred to energy content of fuel			
Carbon monoxide	[mg/MJ]	28	73
Nitrogen oxides as NO ₂	[mg/MJ]	88	77
Organic hydro-carbons	[mg/MJ]	2	3
Dust measurement 1	[mg/MJ]	12	9
Dust measurement 2	[mg/MJ]	13	9
Dust measurement 3	[mg/MJ]	10	9
Dust measurement 4	[mg/MJ]	12	7
Dust measurement 5	[mg/MJ]	12	10
Dust measurement 6	[mg/MJ]	12	9
Oxygen reference for dust measurement			
Dust measurement 1	[Vol%]	9,0	12,6
Dust measurement 2	[Vol%]	8,6	12,5
Dust measurement 3	[Vol%]	8,3	12,0
Dust measurement 4	[Vol%]	8,2	11,8
Dust measurement 5	[Vol%]	7,7	12,2
Dust measurement 6	[Vol%]	8,2	11,9

10 Examination of the design and safety related aspects

Requirements	Tested according to	Confirmed
<i>Venting</i> Venting is provided. During the test no boiling sound were perceived.	4.1.5.1	Yes
<i>Cleaning of heating surfaces</i> In the manual cleaning and inspection of the heating surfaces are described.	4.1.5.2	Yes
<i>Inspection of the flame</i> Inspection can be carried out via carefully opening of the door.	4.1.5.3	Yes
<i>Water tightness</i> There are no holes for screws and similar components, which are used for the attachment of removable parts, which enter into spaces, through which water flows.	4.1.5.4	Yes
<i>Replacement parts</i> Replacement parts are marked that the installation is mandatory correct.	4.1.5.5	Yes
<i>Water side connection</i> Connections are designed according to international standards. Nozzles: G 3/4"	4.1.5.6	Yes
<i>Thermal insulation</i> The thermal insulation is according to common standards.	4.1.5.8	Yes
<i>Water side resistance of the boiler</i>	4.1.5.9	Yes (9.5)
<i>Leakage of the combustion system</i> In the combustion chamber is a negative pressure.	4.1.5.10	Yes
<i>Temperature control and limiting devices for open vented systems</i>	4.1.5.11.1	n.a.
<i>Temperature control and limiting devices for closed vented systems</i> The firing system is rapidly disconnectable. See 9.6.	4.1.5.11.2	Yes
<i>Devices for dissipating excess heat up to a maximum of 100 kW</i>	4.1.5.11.4	n.a.
<i>Storage hopper</i> The fuel is conveyed from the storage hopper via screw conveyer.	4.1.5.12	Ja
<i>Ash chamber</i> The capacity of the ash chamber is 7 l and is adequate for a combustion period of 12 hours at nominal output.	4.1.5.13	Yes

n.a. ... not applicable

Requirements	Tested according to	Confirmed
<i>Manual stoking</i>	4.1.5.14.1	n.a.
<i>Automatic stoking</i> The fuel is conveyed from the storage hopper via a downspout into the burner. The maximum measured boiler temperature (full load) Downspout wall: 35,4 °C Screw conveyor casing: 30,3 °C	4.1.5.14.2	Yes
<i>Heating boiler accessories</i>	4.1.5.15	Yes

n.a. ... not applicable

10.1 Installation instructions

The content of the installation instructions were evaluated according to the requirements of ÖNORM EN 303-5. The requirements of the standard are met.

10.2 Operating instructions

The content of the operating manual were evaluated according to the requirements of ÖNORM EN 303-5. The requirements of the standard are met.

10.3 Marking

The submitted description of the identification plate meets the requirements of ÖNORM EN 303-5.

10.4 Examination of the design

No defects were observed during the examination of the stove's design (materials, lay-out and workmanship) according to the requirements of ÖNORM EN 303-5 as well as during the testing.

10.5 Water side resistance of the boiler

The water side resistances are determined for those flows which correspond to the nominal heat output with two temperature differences of 10 K and 20 K between the water outlet and water inlet connections of the boiler

Temperature difference [K]	Differential pressure [mbar]
10	20
20	20

10.6 Function check of the temperature controller and safety temperature limiter

10.6.1 Reduction of the heat consumption to 40%

The firing was adjusted to achieve the related heat output of a boiler temperature of 71° C. The temperature controller was adjusted to a maximal boiler temperature of 85° C. The output was reduced to 40 % at the beginning of the test.

Immediately the controller reduced the output and after 24 minutes the boiler continued with partial load.

10.6.2 Shut down of the heat consumption

The boiler has no discharge safety device. The test for the emergency shut down is carried out with the loss of the heat consumption and the simulation of a blackout.

For the test with loss of heat consumption, the firing was adjusted to achieve the related heat output of an inlet temperature of 71.5° C. At the beginning of the test, the heat consumption is shut down. After app. 5 minutes the safety temperature limiter shuts down the firing at 85° C. The boiler temperature increased after 22 minutes to a maximum of 98.7° C (set temperature ≤ 110 °C).

11 Summary and assessment of the measurements

Hapero Energietechnik GmbH supplied the boiler appliance "Balance K / Typ HP 02" for testing of heat engineering as specified in the requirements of the EN 303-5 and the agreements pursuant to Article 15a of the Federal Constitution Act on "protective measures related to small scale combustion equipment" and "energy saving":

Wood pellets according to ÖNORM M 7135, were used as fuel.

Following tests were carried out.

Full load

Partial load (app. 30%)

Based on the tests conducted and the documents supplied, the following statements can be made:

11.1 Technical documentation

The submitted technical documentation meets the requirements according to the EN 303-5 and the Article 15a B-VG of the Federal Constitution Act on "protective measures related to small scale combustion equipment" and "energy saving" for the fuel wood pellets.

11.2 Output

The rated output of 14.5 kW by the manufacturer is recognized as correct.

11.3 Energy efficiency assessment

The following Table indicates the boiler's energy efficiency.

	Efficiency [%]
	Balance K / Type HP 02
Full load	95,7
Partial load	92,8
EN 303-5 ($67+6\log Q_N$)	73,9
According to Art. 15a B-VG ($68,3+7,7\log Q_N$)	77,1

11.4 Emissions assessment

The measured emissions are summarized in the following Table. The specified emission limits are also indicated.

		Test results "Balance K / Type HP 02"			Emission limits	
		[mg/Nm ³] at 10 % O ₂ according EN 303-5	[mg/Nm ³] at 13 % O ₂	[mg/MJ]	EN 303-5 class 3 [mg/Nm ³] at 10 % O ₂	15a BVG [mg/MJ]
CO	Full load	58	42	28	5000	500 ¹
	Partial load	153	111	73		
NO _x	Full load	168	134	88	-	150
	Partial load	147	118	77	-	
OGC (Org. C)	Full load	4	3	<3	150	40
	Partial load	5	4	3		
Dust ²	Full load	23	18	12	150	60
	Partial load	17	14	9		

The requirements of the EN 303-5 are met.

The requirements related to the emissions under the agreement in accordance with Article 15a of the Federal Constitution Act on "protective measures related to small scale combustion equipment" are met.

The requirements related to the energy efficiency under the agreement pursuant to Article 15a of the Federal Constitution Act on "energy saving" are met.

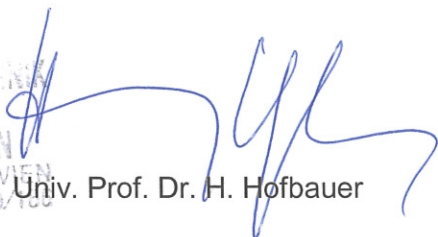
Person responsible for testing

Supervisor



Dipl. Ing. E. Padouvas

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¹ At partial load of 30% of the nominal heat output the emission limits can be exceeded by 50%

² Mean value of six single measurements, out of which each is below the emission limit.

Appendix

1. Data sheets	2 Pages
2. Technical drawings	3 Pages
3. Marking	1 Page

Order number:	PL-09075-P
Marking	09075/1

Date of test:	06.05.2009
Fuel:	Wood pellets

Elementary analysis		
Carbon content	[%]	47,11
Hydrogen content	[%]	5,56
Nitrogen content	[%]	0,10
Sulphur content	[%]	0,01
Ash content	[%]	0,21
Oxygen content	[%]	40,02
Water content	[%]	6,98

Calculated values		
O ₂ -demand	[m ³ /kg]	0,91
Air consumption	[m ³ /kg]	4,32
Flue gas volume, dry	[m ³ /kg]	4,30
Water vapour	[m ³ /kg]	0,71
Flue gas volume, wet	[m ³ /kg]	5,01
CO ₂ maximum	[%]	20,47
Net calorific value	[kJ/kg]	17255

Load	[min]	Full Load
Start	[hh:mm]	10:25
End	[hh:mm]	16:35
Combustion time	[min]	370
Fuel quantity	[kg]	18,2
Thermal output from fuel	[kW]	14,1
Conversion	[kg/h]	2,9
Average negative pressure in the interceptor	[Pa]	10,9

Ambient conditions		
Atmospheric Pressure	[%]	989,6
Atmospheric humidity	[%]	48,3
Room temp.	[°C]	20,3

Flue gas temperature		
Maximum	[°C]	85,7
Average	[°C]	85,1

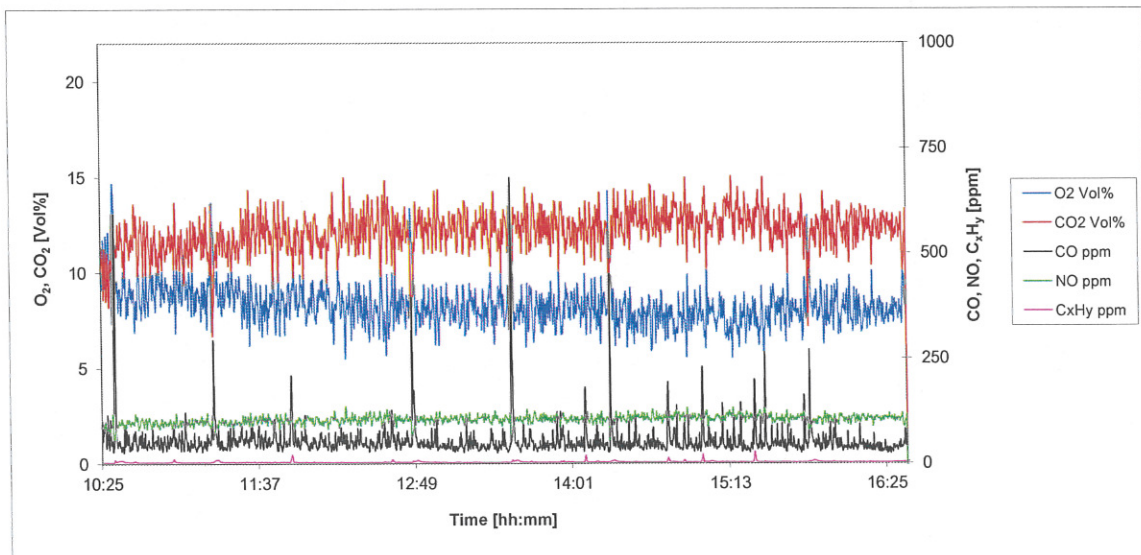
Air ratio (Lamda)	[-]	1,7
Flue gas volume, dry	[Nm ³ /kg]	7,3
Flue gas volume, wet	[Nm ³ /kg]	8,0
Flue gas flow	[Nm ³ /h]	23,5
Flue gas mass flow rate	[g/s]	7,9
c _{p,av} water vapour	[kJ/Nm ³ K]	1,50
c _{p,av} dry flue gas	[kJ/Nm ³ K]	1,32
Loss of sensible heat in the flue gas	[kJ/kg]	725,1
	[%]	4,2
Loss through CO in the flue gas	[kJ/kg]	4,9
	[%]	0,0
Heat losses due to combustible constituents in	[kJ/kg]	13,8
	[%]	0,1
Loss through radiation, convection and conduction	[kJ/kg]	151,1
	[%]	1,1
Combustion efficiency	[%]	94,6

Average boiler surface temperatures		
Boiler cover	[°C]	25,1
Boiler surface left	[°C]	26,4
Boiler surface right	[°C]	24,5
Boiler surface front	[°C]	26,9
Boiler surface back	[°C]	26,4
Boiler base	[°C]	26,0
Fuel hopper	[°C]	25,6
Door handle		n.a.

Water heating output		
Temperature of inlet water	[°C]	59,9
Temperature of outlet water	[°C]	70,1
Water flow	[m ³ /h]	1,2
Water heating output	[kW]	13,5
Thermal efficiency	[%]	95,7

n.a. ... not applicable

Emissions, measured					Dust measured					
O ₂	CO ₂	CO	NO	C _x H _y	10:40 - 11:10	11:40 - 12:11	12:40 - 13:10	14:00 - 14:30	14:55 - 15:25	15:50 - 16:23
[%]	[%]	[ppm]	[ppm]	[ppm]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]
8,3	12,1	54	104	3	28	31	24	30	30	30
					O ₂ in %					
					9,0	8,6	8,3	8,2	7,7	8,2
Emissions, related to 10 vol % O ₂ and standard reference conditions										
	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]
	58	168	4	23	25	19	23	23	23	24
Emissions, related to 13 vol % O ₂ and standard reference conditions										
	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]
	42	134	3	19	20	15	19	18	18	19
Emissions related to the energy content of the fuel										
	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]
	28	88	2	12	13	10	12	12	12	12



Order number:	PL-09075-P
Marking	09075/1

Date of test:	06.05.2009
Fuel:	Wood pellets

Elementary analysis		
Carbon content	[%]	47,11
Hydrogen content	[%]	5,56
Nitrogen content	[%]	0,10
Sulphur content	[%]	0,01
Ash content	[%]	0,21
Oxygen content	[%]	40,02
Water content	[%]	6,98

Load	[min]	Partial Load
Start	[hh:mm]	14:09
End	[hh:mm]	20:20
Combustion time	[min]	371
Fuel quantity	[kg]	5,3
Thermal output from fuel	[kW]	4,1
Conversion	[kg/h]	0,9
Average negative pressure in the interceptor	[Pa]	5,5

Air ratio (Lamda)	[-]	2,5
Flue gas volume, dry	[Nm ³ /kg]	10,7
Flue gas volume, wet	[Nm ³ /kg]	11,4
Flue gas flow	[Nm ³ /h]	9,8
Flue gas mass flow rate	[g/s]	3,5
c _{p,av} water vapour	[kJ/Nm ³ K]	1,50
c _{p,av} dry flue gas	[kJ/Nm ³ K]	1,31
Loss of sensible heat in the flue gas	[kJ/kg]	676,0
	[%]	3,9
Loss through CO in the flue gas	[kJ/kg]	13,2
	[%]	0,1
Heat losses due to combustible constituents in	[kJ/kg]	31,7
	[%]	0,8
Loss through radiation, convection and conduction	[kJ/kg]	142,7
	[%]	3,5
Combustion efficiency	[%]	91,8

Calculated values		
O ₂ -demand	[m ³ /kg]	0,91
Air consumption	[m ³ /kg]	4,32
Flue gas volume, dry	[m ³ /kg]	4,30
Water vapour	[m ³ /kg]	0,71
Flue gas volume, wet	[m ³ /kg]	5,01
CO ₂ maximum	[%]	20,47
Net calorific value	[kJ/kg]	17255

Ambient conditions		
Atmospheric Pressure	[%]	993,3
Atmospheric humidity	[%]	30,6
Room temp.	[°C]	20,3

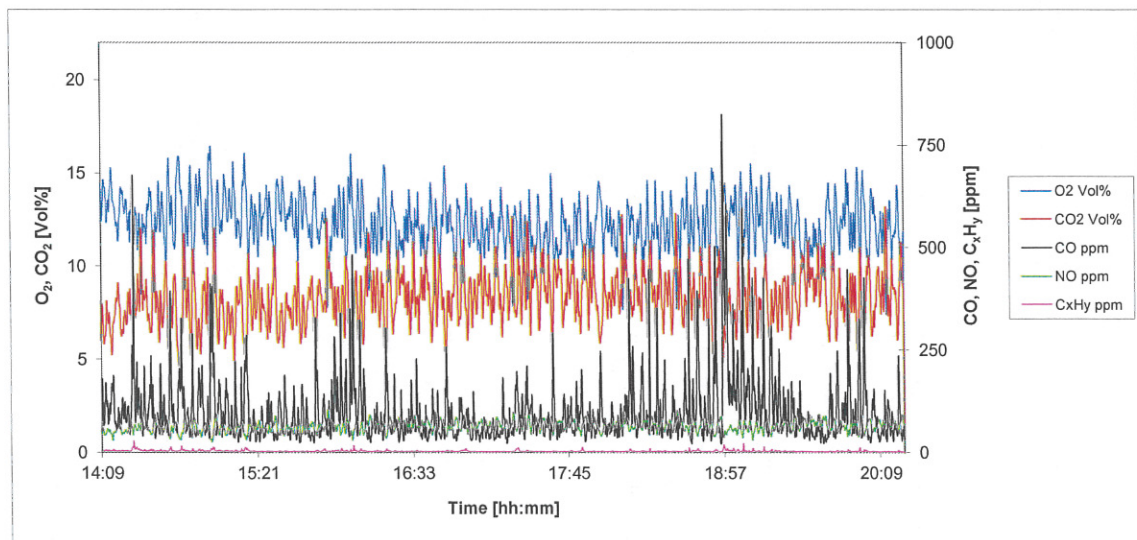
Flue gas temperature in measurement section		
Maximum	[°C]	65,1
Average	[°C]	63,6

Average boiler surface temperatures		
Boiler cover	[°C]	23,7
Boiler surface left	[°C]	25,8
Boiler surface right	[°C]	23,8
Boiler surface front	[°C]	25,3
Boiler surface back	[°C]	26,2
Boiler base	[°C]	22,1
Fuel hopper	[°C]	28,6
Door handle		n.a.

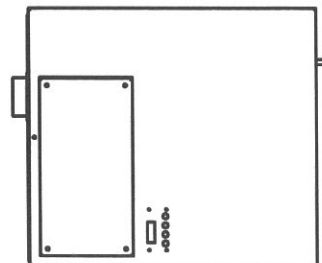
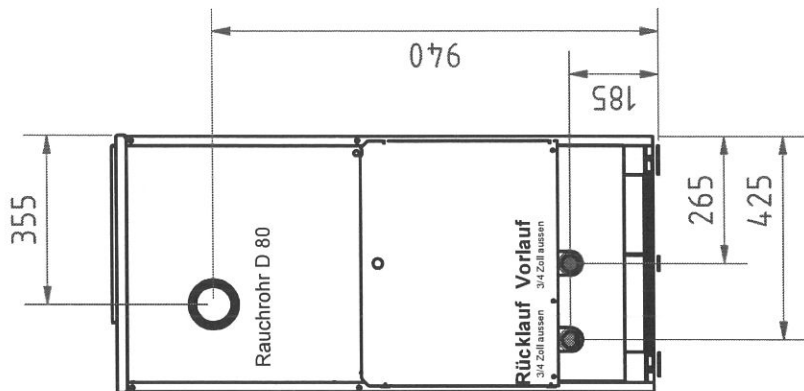
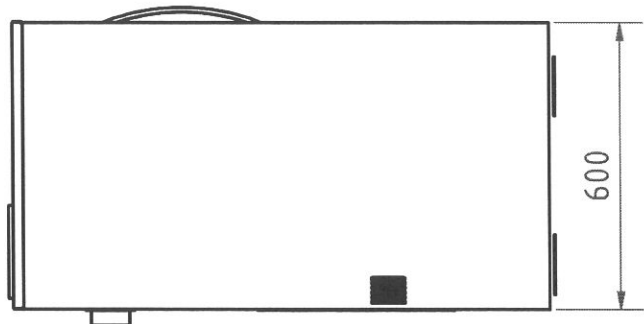
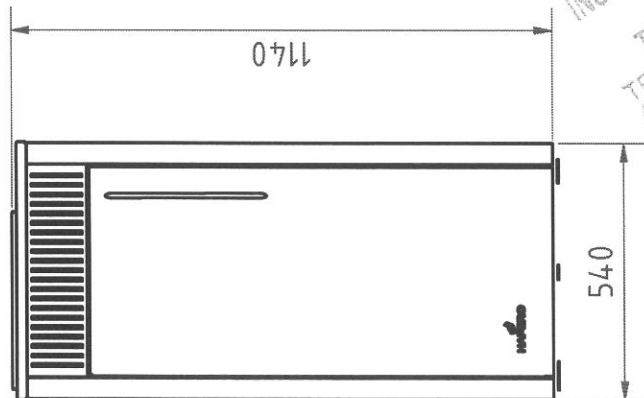
Water heating output		
Temperature of inlet water	[°C]	62,3
Temperature of outlet water	[°C]	74,0
Water flow	[m ³ /h]	0,3
Water heating output	[kW]	3,8
Thermal efficiency	[%]	92,8

n.a. ... not applicable

Emissions, measured					Dust					
O ₂	CO ₂	CO	NO	C _x H _y	14:27 - 14:58	15:30 - 16:00	16:30 - 17:00	17:30 - 18:00	18:30 - 19:00	19:32 - 20:02
[%]	[%]	[ppm]	[ppm]	[ppm]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]
12,2	8,2	98	63	3	15	15	16	13	16	16
					O ₂ in %					
					12,6	12,5	12,0	11,8	12,2	11,9
Emissions, related to 10 vol % O ₂ and standard reference conditions										
	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]
	153	147	5	18	17	18	14	18	17	
Emissions, related to 13 vol % O ₂ and standard reference conditions										
	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]
	111	118	4	14	14	14	11	15	14	
Emissions related to the energy content of the fuel										
	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]	[mg/MJ]
	73	77	3	9	9	9	7	10	9	



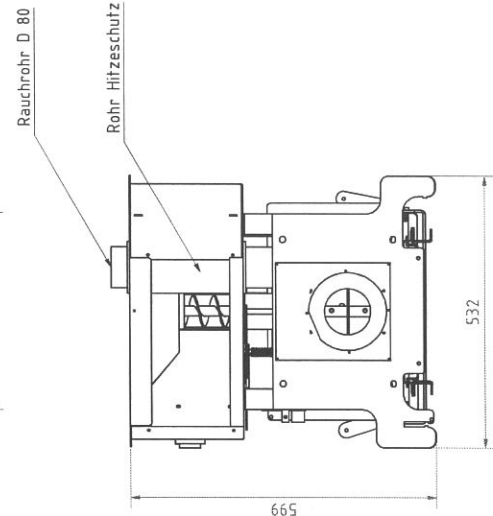
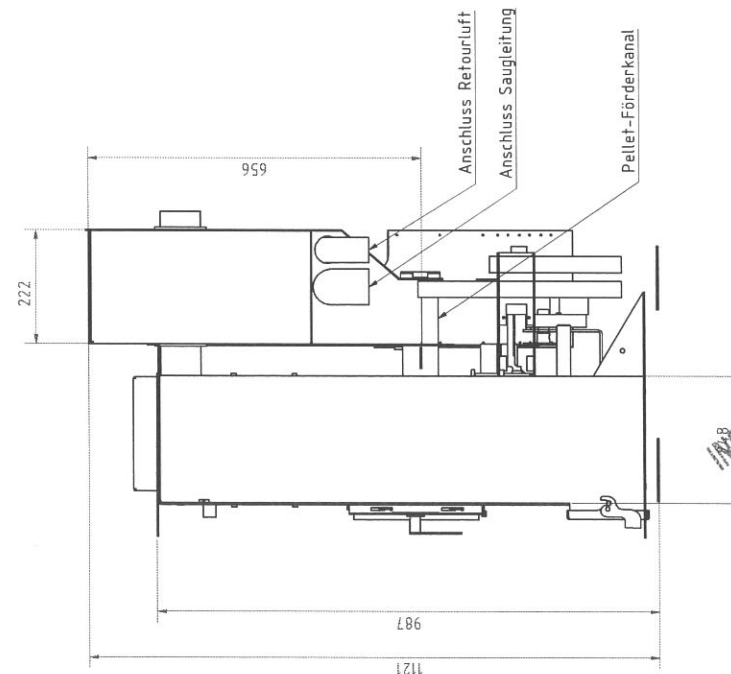
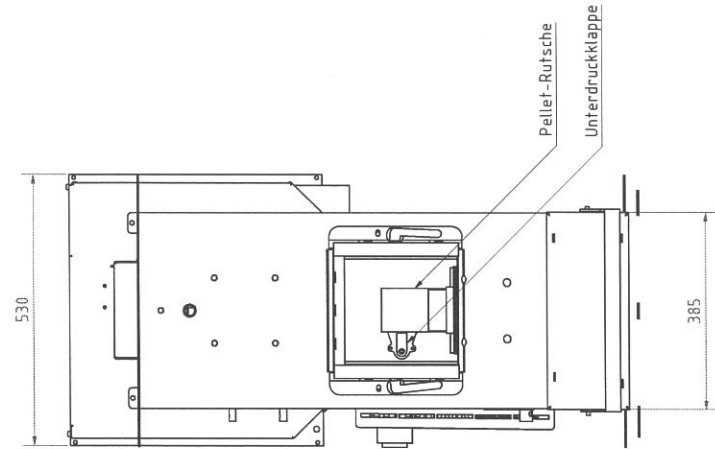
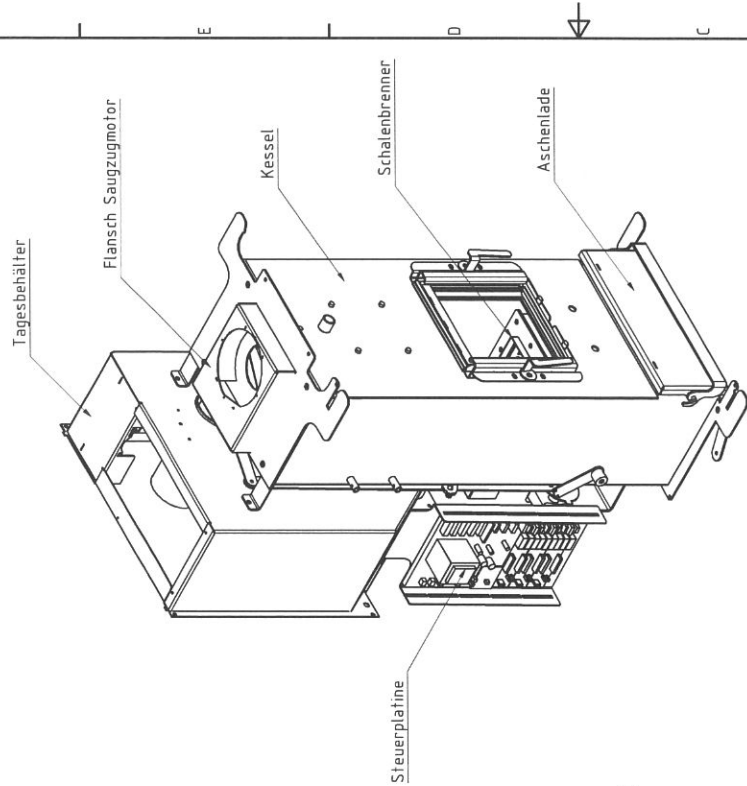
Datenblatt - BALANCE Holzpelletsofen (Version: Keller)



HAPERO

ENERGIETECHNIK GMBH

Geprüft nach.....	EN 303-5
Wirkungsgrad	> 95 %
Leistung	14,9 kW
Gewicht	160 kg
Rauchrohranschluss	Durchmesser 80 mm
Stromverbrauch - Standby	7 Watt
Stromverbrauch - mittlere Leistung	38 Watt
Anschluss Absicherung	16 Ampere
Thermische Ablaufsicherung	nicht erforderlich
Wasserinhalt	29 Liter
Pellet - Vorratsbehälter	30 kg
Isolierung	Glaswolle 80 - 100mm
Brennraumtür	aus Stahl (isoliert)
Verkleidung	geschlossen



		Toleranzen nach DIN 7168 mittel		Funktionen- und Prüfm. 			
Kanten		Gewicht ca.		Hilfsmasse ()		Projektion DIN 6	
Datum		Name		Werkstoff		Oberfläche	
Skizziert: 19.02.2009 Rehl.Paul							
Zeichnungsart		Zeichnungsart					
Norm		Norm					
Datum eingetragt		Baugruppe				Blatt von	
Unterschrift/Initialen		Unterschrift/Initialen				3	
						A2	

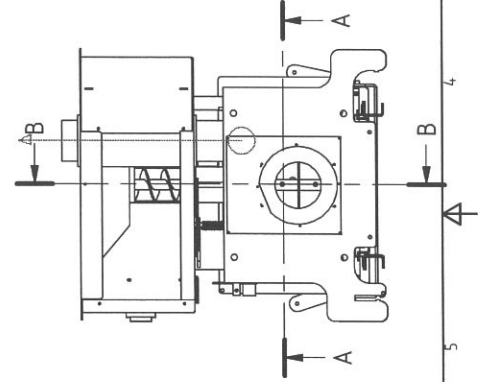
INSTITUT FÜR VERFAHRENSTECHNIK
 UMWELTECHNIK UND
 TECHN. BIOLOGIE UND
 TECHNISCHE UNIVERSITÄT WIEN
 A-1000 WIEN, GETREIDEMARKT 9/10

Technical drawing of a pellet stove showing internal components and airflow paths. The drawing includes the following labels:

- Pellets-Tagesbehälter
- Schnecke (Pelletszuführung)
- Zuführung Sekundärluft
- Zuführung Primärluft
- Multifunktionsantrieb
- Zündrohr mit Zündstab
- Pelletsrufsche
- Dichtplatte
- Pelletsfangring
- Brenner (eckig)
- Brennerrost
- Entfälsche Klappe
- Aschenlade

Das Diagramm zeigt einen Querschnitt durch einen Pelletkessel. Die Beschriftungen sind wie folgt:

- Reinigungsklappe
- Wärmetauscherrohr
- Wärmetauscherplatte
- 3. Zug der Verbrennungsgase
- 2. Zug der Verbrennungsgase
- 1. Zug der Verbrennungsgase
- Pellets
- Schalenbrenner
- Unterdruckklappe
- Pelletsrutsche
- Steuerplatine
- Zündung



Pelletsofen: Typenbezeichnung HP-02 / Entwurfsleistung / 3-zügiger Wärmetauscher Nennwärmeleistung: 14,9 kW/h Maximal zulässiger Betriebsdruck: 3 Bar Prüfdruck des Wasserkreislaufes: 6 Bar Schweißnahtformen: Kehl- und Stumpfnaht Werkstoff – Stahl, Wandstärke – 3 / 4 / 5 mm, Qualität – S 235 JRG2 Maximal zulässige Betriebstemperatur des Wasserkreislaufes: 80°C

 HAPERO HERBETHEIM GMBH	Toleranzen nach DIN 7186 mittel		Funktionen- und Prüfm. ☐ Maßstab:	
	Kanten	Gewicht ca.	Projektion DIN 6 Oberfläche	
Datum 20.03.2009		Name Rolf-Paul		1 A2
Gezeichnet Kontrolliert Norm		Bauteilname Baugruppenzeichnung Baugruppenzusatz		
Zeichnungsart Baugruppenzeichnung		Zeichnungsnummer alle Zeich-Nr.		gezeichnet am

Balance - Keller

Type: HP 02 / K

Hersteller: Hapero Energietechnik GmbH (AUSTRIA)

Manufacturer: <http://www.hapero.com>



office@hapero.com

Seriennummer: 04.12.00184.2020 40A

Serialnumber:



KENNUNG

Automatischer Holzpelletskessel:

Automatic wood pellet boiler,

Automatisk træpillefyr, Chaudière automatique à granulés de bois,

Caldaia a pellets automatica,



Wärmeleistung: 3,8 - 14,5 kW
Nominal output, 13-50 BTU
Varmeydelse, Puissance nominale, Potenza nominale,

Kesselklasse: 3
Boiler class, 3
Kedelklasse, Chaudière de classe, Classe caldaia,

Max. Betriebsdruck: 3 bar
Maximum operating pressure, 3 bar
Max driftryk, Pression de service maximum, Pressione massima ammessa,

Max. Kesseltemperatur: 85°C
Maximum boiler temperature, 185°F
Max kedeltryk, Température maximale de chaudière, Massima temperatura di caldaia,

Wasserinhalt: 32 Liter
Water capacity, 32 Liter
Vandinhold, Contenance en eau, Contenuto d'acqua,

Stromanschluss: 230 V / 1400 W
Electricity supply, 50 Hz / >= 13 A
Strømtilslutning, Raccordement électrique, Allacciamento elettrico,

Vor Inbetriebnahme des Pelletskessels ist die Bedienungsanleitung vollinhaltlich zur Kenntnis zu nehmen.
Before commencement of operation the manual should be read over carefully.
Før igangsætning af kedlen skal monteringsvejledning læses og overholdes.
Prière de lire attentivement la notice technique d'utilisation avant la mise en service.
Leggere attentamente il libretto di istruzioni prima della messa in funzione della caldaia

Balance - Keller

Type: HP 02 / K

Hersteller: Hapero Energietechnik GmbH (AUSTRIA)

Manufacturer: <http://www.hapero.com>



office@hapero.com

Seriennummer: 04.12.00182.2020 40A

Serialnumber:



KENNUNG

Automatischer Holzpelletskessel:

Automatic wood pellet boiler,

Automatisk træpillefyr, Chaudière automatique à granulés de bois,

Caldaia a pellets automatica,



Wärmeleistung: 3,8 - 14,5 kW
Nominal output, 13-50 BTU
Varmeydelse, Puissance nominale, Potenza nominale,

Kesselklasse: 3
Boiler class, 3
Kedelklasse, Chaudière de classe, Classe caldaia,

Max. Betriebsdruck: 3 bar
Maximum operating pressure, 3 bar
Max driftryk, Pression de service maximum, Pressione massima ammessa,

Max. Kesseltemperatur: 85°C
Maximum boiler temperature, 185°F
Max kedeltryk, Température maximale de chaudière, Massima temperatura di caldaia,

Wasserinhalt: 32 Liter
Water capacity, 32 Liter
Vandinhold, Contenance en eau, Contenuto d'acqua,

Stromanschluss: 230 V / 1400 W
Electricity supply, 50 Hz / >= 13 A
Strømtilslutning, Raccordement électrique, Allacciamento elettrico,

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Leggere attentamente il libretto di istruzioni prima della messa in funzione della caldaia

Balance - Keller

Type: HP 02 / K

Hersteller: Hapero Energietechnik GmbH (AUSTRIA)

Manufacturer: <http://www.hapero.com>



office@hapero.com

Seriennummer: 04.12.00185.2020 40A

Serialnumber:



KENNUNG

Automatischer Holzpelletskessel:

Automatic wood pellet boiler,

Automatisk træpillefyr, Chaudière automatique à granulés de bois,

Caldaia a pellets automatica,



Wärmeleistung: 3,8 - 14,5 kW
Nominal output, 13-50 BTU
Varmeydelse, Puissance nominale, Potenza nominale,

Kesselklasse: 3
Boiler class, 3
Kedelklasse, Chaudière de classe, Classe caldaia,

Max. Betriebsdruck: 3 bar
Maximum operating pressure, 3 bar
Max driftryk, Pression de service maximum, Pressione massima ammessa,

Max. Kesseltemperatur: 85°C
Maximum boiler temperature, 185°F
Max kedeltryk, Température maximale de chaudière, Massima temperatura di caldaia,

Wasserinhalt: 32 Liter
Water capacity, 32 Liter
Vandinhold, Contenance en eau, Contenuto d'acqua,

Stromanschluss: 230 V / 1400 W
Electricity supply, 50 Hz / >= 13 A
Strømtilslutning, Raccordement électrique, Allacciamento elettrico,

Vor Inbetriebnahme des Pelletskessels ist die Bedienungsanleitung vollinhaltlich zur Kenntnis zu nehmen.
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Balance - Keller

Type: HP 02 / K

Hersteller: Hapero Energietechnik GmbH (AUSTRIA)

Manufacturer: <http://www.hapero.com>



office@hapero.com

Seriennummer: 04.12.00183.2020 40A

Serialnumber:



KENNUNG

Automatischer Holzpelletskessel:

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Automatisk træpillefyr, Chaudière automatique à granulés de bois,

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Wärmeleistung: 3,8 - 14,5 kW
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Wasserinhalt: 32 Liter
Water capacity, 32 Liter
Vandinhold, Contenance en eau, Contenuto d'acqua,

Stromanschluss: 230 V / 1400 W
Electricity supply, 50 Hz / >= 13 A
Strømtilslutning, Raccordement électrique, Allacciamento elettrico,

Vor Inbetriebnahme des Pelletskessels ist die Bedienungsanleitung vollinhaltlich zur Kenntnis zu nehmen.
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