

Report on
Type testing of the pellets boiler
“HP 04 / K Flash”
of the company “Hapero Energietechnik GmbH”



Order number	PL-12034/3-E-P
Person responsible for testing	E. Padouvas L. Kleemann
Number of pages	14
Number of pages in appendix	6

Report written	on: 29.02.2012 of: E. Padouvas	Report approved	on: 09.03.2012 of: H. Hofbauer
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This report is the translation of the original German report with the order number PL-11055-P from 29.04.2011

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1 The Client

Firma 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:

"HP 04 / K Flash"

3 Equipment submitted for testing and documents supplied

Hapero Energietechnik GmbH supplied a boiler with the designation "HP 04 / K Flash".

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 "HP 04 / K Flash" (35 kW) 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.

The ash is transported mechanically into the ash chamber.

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

Name of device	HP 04 / K Flash	
Photo of the tested boiler		
Parameters		
Fuel		Wood pellets (ÖNORM 7135)
Nominal heat output	[kW]	35
Heat power range	[kW]	7,6 – 35
Max. boiler operation pressure	[bar]	3
Max. boiler temperature	[°C]	83
Min. boiler inlet temperature	[°C]	25
Dimensions		
Weight	[kg]	285
Height	[mm]	1118
Base	[m²]	0,324
Water amount	[l]	32
Connection outlet/inlet	[inch]	5/4"
Flue gas tube connection	[mm]	130
Electric links	[V/Hz/A]	230/50/16
Electrical power input	Start	[W]
	Operation	[W]
		257
		47

¹ Information provided by the manufacturer

5 Test procedure

"HP 04 / K Flash" 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 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.

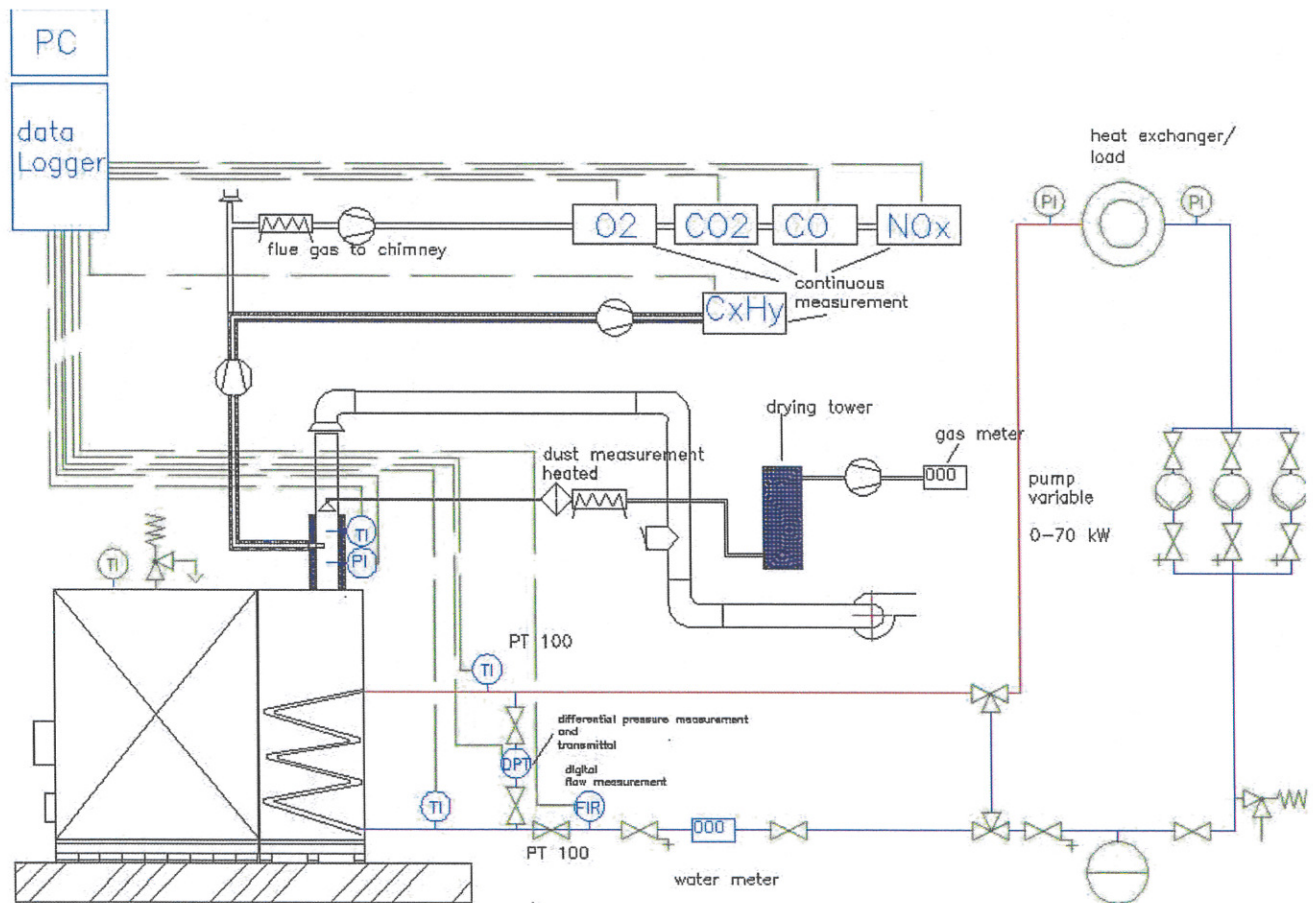


Figure 1: Scheme of the test-bench

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 14,98 % CO ₂ in Nitrogen 1448 ppm CO in Nitrogen 98,43 ppm NO in Nitrogen
Zero gas	: Nitrogen
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	: 7.94 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

8.1 Fuel

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

Elementary analysis¹

Carbon content	c	[%]	47,56
Hydrogen content	h	[%]	5,44
Nitrogen content	n	[%]	0,11
Sulphur content	s	[%]	0,01
Ash content	a ²	[%]	0,31
Oxygen content	o	[%]	40,25
Water content	w ²	[%]	6,32

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]	0,69
Flue gas volume, wet	(V _{A,f,min})	[m ³ /kg]	4,99
CO ₂ , maximum		[%]	20,63
Net calorific value	(H _u)	[kJ/kg]	17719

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.

8.2 Test results

Test run		Full load	Partial load
Date of testing		23.03.2011	22.03.2011
Settings during test runs			
Test period	[min]	385	379
Fuel quantity	[kg]	49,0	10,7
Total fuel capacity	[kW]	37,6	8,3
Fuel conversion	[kg/h]	7,6	1,7
Average negative pressure in the flue gas draught	[Pa]	11,8	11,6
Environmental conditions			
Air pressure	[mbar]	1005,5	1008,7
Atmospheric humidity	[%]	22,2	17,9
Ambient temperature	[°C]	24,1	23,1
Average boiler surface temperatures			
Boiler cover	[°C]	26,8	24,7
Boiler surface left	[°C]	26,2	24,3
Boiler surface right	[°C]	27,8	26,4
Boiler surface front	[°C]	27,4	24,8
Boiler surface back	[°C]	28,5	27,6
Boiler base	[°C]	25,3	21,6
Fuel hopper	[°C]	24,3	21,1
Operating data			
Air ratio (Lamda)	[-]	1,8	2,7
Flue gas volume, dry	[Nm ³ /kg]	7,6	11,6
Flue gas volume, wet	[Nm ³ /kg]	8,3	12,3
Flue gas flow	[Nm ³ /h]	63,1	20,8
Flue gas mass flow rate	[g/s]	21,0	7,2
Average Flue gas temperature	[°C]	81,4	55,1
c _{p,av} water vapour	[kJ/Nm ³ K]	1,50	1,50
c _{p,av} dry flue gas	[kJ/Nm ³ K]	1,31	1,31
Loss of sensible heat in the flue gas	[kJ/Nm ³ K]	661,4	535,2
	[kJ/Nm ³ K]	3,7	3,0
Loss through CO in the flue gas	[kJ/kg]	6,4	16,3
	[%]	0,0	0,1
Heat losses due to combustible constituents in the residue	[kJ/kg]	11,3	108,8
	[%]	0,1	0,6
Loss through radiation, convection and conduction	[W]	141,7	98,4
	[%]	0,4	1,2
Combustion efficiency	[%]	95,8	95,1
Water heating output			
Temperature of inlet water	[°C]	54,9	55,7
Temperature of outlet water	[°C]	71,5	72,3
Water flow	[m ³ /h]	1,876	0,408
Water heating output	[kW]	35,9	7,8
Thermal efficiency	[%]	95,4	93,9

Date of testing		Full load	Partial load
Test run		23.03.2011	22.03.2011
Emissions, measured			
Oxygen	[Vol%]	8,7	12,9
Carbon dioxide	[Vol%]	11,7	7,7
Carbon monoxide	[ppm]	67	112
Nitrogen oxides as NO	[ppm]	104	40
Organic hydro-carbons	[ppm]	1	1
Dust measurement 1	[mg/Nm ³]	20	14
Dust measurement 2	[mg/Nm ³]	22	16
Dust measurement 3	[mg/Nm ³]	20	18
Dust measurement 4	[mg/Nm ³]	17	14
Dust measurement 5	[mg/Nm ³]	16	17
Dust measurement 6	[mg/Nm ³]	19	18
Emissionen, bezogen auf 10 Vol-% O₂ und Normzustand			
Carbon monoxide	[mg/Nm ³]	68	173
Nitrogen oxides as NO ₂	[mg/Nm ³]	173	103
Organic hydro-carbons	[mg/Nm ³]	1	2
Dust measurement 1	[mg/Nm ³]	16	19
Dust measurement 2	[mg/Nm ³]	18	21
Dust measurement 3	[mg/Nm ³]	16	23
Dust measurement 4	[mg/Nm ³]	14	17
Dust measurement 5	[mg/Nm ³]	12	20
Dust measurement 6	[mg/Nm ³]	15	21
Emissionen, bezogen auf 13 Vol-% O₂ und Normzustand			
Carbon monoxide	[mg/Nm ³]	54	138
Nitrogen oxides as NO ₂	[mg/Nm ³]	138	82
Organic hydro-carbons	[mg/Nm ³]	1	2
Dust measurement 1	[mg/Nm ³]	13	15
Dust measurement 2	[mg/Nm ³]	15	17
Dust measurement 3	[mg/Nm ³]	13	18
Dust measurement 4	[mg/Nm ³]	11	14
Dust measurement 5	[mg/Nm ³]	10	16
Dust measurement 6	[mg/Nm ³]	12	17
Emissionen, bezogen auf den Energieinhalt des Brennstoffes			
Carbon monoxide	[mg/MJ]	35	88
Nitrogen oxides as NO ₂	[mg/MJ]	88	53
Organic hydro-carbons	[mg/MJ]	1	1
Dust measurement 1	[mg/MJ]	8	10
Dust measurement 2	[mg/MJ]	9	11
Dust measurement 3	[mg/MJ]	8	12
Dust measurement 4	[mg/MJ]	7	9
Dust measurement 5	[mg/MJ]	6	10
Dust measurement 6	[mg/MJ]	8	11
Oxygen reference for dust measurement			
Dust measurement 1	[Vol%]	8,8	13,5
Dust measurement 2	[Vol%]	9,1	13,4
Dust measurement 3	[Vol%]	8,7	13,1
Dust measurement 4	[Vol%]	8,8	12,9
Dust measurement 5	[Vol%]	8,3	12,4
Dust measurement 6	[Vol%]	8,5	12,3

9 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 1/2"	4.1.5.6	Yes
<i>Connections for control and indicating equipment, and safety thermostat</i>	4.1.5.7	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.

n.a. ... not applicable

Requirements	Tested according to	Confirmed
<i>Storage hopper</i> The fuel is conveyed from the storage hopper via screw conveyer.	4.1.5.12	Yes
<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
<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.	4.1.5.14.2	Yes
<i>Heating boiler accessories</i>	4.1.5.15	Yes

n.a. ... not applicable

9.1 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.

9.2 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.

9.3 Marking

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

9.4 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.

9.5 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	40
20	38

9.6 Function check of the temperature controller and safety temperature limiter

9.6.1 *Reduction of the heat consumption to 40%*

The firing was adjusted to achieve the related heat output of a boiler temperature of 72° C. The temperature controller was adjusted to a maximal boiler temperature of 75° C. The output was reduced to 40 % at the beginning of the test.

Immediately the controller reduced the output and after 5 minutes the boiler continued with partial load. After another 5 minutes the output was reduced, the boiler temperature increased and after 6 minutes the boiler is shut down of the temperature of 83° C. The maximum boiler temperature was 90° C (limit 100° C).

9.6.2 *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 72,5° C. At the beginning of the test, the heat consumption is shut down. After app. 3 minutes the safety temperature limiter shuts down the firing at 90° C. The boiler temperature increased after 14 minutes to a maximum of 97,1° C (set temperature ≤ 110 °C)

10 Summary and assessment of the measurements

Hapero Energietechnik GmbH supplied the boiler appliance "HP 04 / K Flash" 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.

1 Full load

Partial load (app. 30%)

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

10.1 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.

10.2 Output

The rated output of 35 kW by the manufacturer is recognized as correct.

10.3 Energy efficiency assessment

The following Table indicates the boiler's energy efficiency.

	Efficiency [%]
	HP 04 / K Flash
Full load	95,4
Partial load	93,9
EN 303-5 ($67+6\log Q_N$)	76,3
According to Art. 15a B-VG ($68,3+7,7\log Q_N$)	80,2

10.4 Emissions assessment

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

		Test results "HP 04 / K Flash"			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	68	54	35	3000	500 ¹
	Partial load	173	138	88		
NO _x	Full load	173	138	88	-	150
	Partial load	103	82	53	-	
OGC (Org. C)	Full load	<3	<3	<3	100	40
	Partial load	<3	<3	<3		
Dust ²	Full load	15	12	8	150	60
	Partial load	20	16	10		

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

Am Blouk

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[Signature]

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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-11055-P
Marking	HP 04

Date of test:	23.03.2011
Fuel:	Wood pellets

Elementary analysis		
Carbon content	[%]	47,56
Hydrogen content	[%]	5,44
Nitrogen content	[%]	0,11
Sulphur content	[%]	0,01
Ash content	[%]	0,31
Oxygen content	[%]	40,25
Water content	[%]	6,32

Load	[min]	Full Load
Start	[hh:mm]	09:20
End	[hh:mm]	15:44
Combustion time	[min]	385
Fuel quantity	[kg]	49,0
Thermal output from fuel	[kW]	37,6
Conversion	[kg/h]	7,6
Average negative pressure in the interceptor	[Pa]	11,8

Air ratio (Lamda)	[-]	1,8
Flue gas volume, dry	[Nm ³ /kg]	7,6
Flue gas volume, wet	[Nm ³ /kg]	8,3
Flue gas flow	[Nm ³ /h]	63,1
Flue gas mass flow rate	[g/s]	21,0
$c_{p,av}$ 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]	661,4
	[%]	3,7
Loss through CO in the flue gas	[kJ/kg]	6,4
	[%]	0,0
Heat losses due to combustible constituents in	[kJ/kg]	11,3
	[%]	0,1
Loss through radiation, convection and conduction	[kJ/kg]	141,7
	[%]	0,4
Combustion efficiency	[%]	95,8

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]	0,69
Flue gas volume, wet	[m ³ /kg]	4,99
CO ₂ maximum	[%]	20,63
Net calorific value	[kJ/kg]	17719

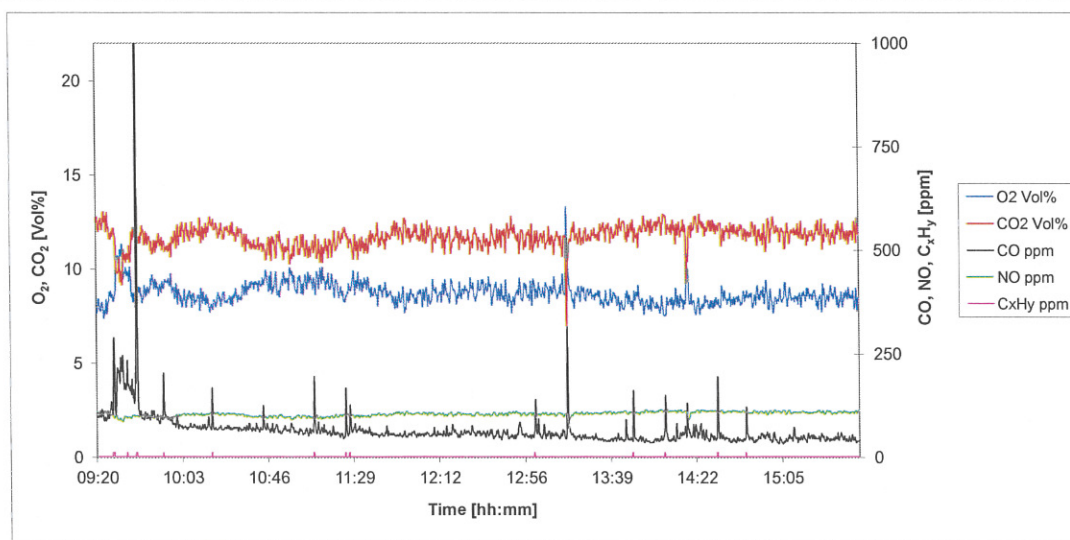
Ambient conditions		
Atmospheric Pressure	[%]	1005,5
Atmospheric humidity	[%]	22,2
Room temp.	[°C]	24,1

Flue gas temperature in measurement section		
Maximum	[°C]	93,3
Average	[°C]	81,4

Average boiler surface temperatures		
Boiler cover	[°C]	26,8
Boiler surface left	[°C]	26,2
Boiler surface right	[°C]	27,8
Boiler surface front	[°C]	27,4
Boiler surface back	[°C]	28,5
Boiler base	[°C]	25,3
Fuel hopper	[°C]	24,3
Door handle		n.a.

Water heating output		
Temperature of inlet water	[°C]	54,9
Temperature of outlet water	[°C]	71,5
Water flow	[m ³ /h]	1,9
Water heating output	[kW]	35,9
Thermal efficiency	[%]	95,4

Emissions, measured					Dust					
O ₂	CO ₂	CO	NO	C _x H _y	09:46 - 10:46	10:50 - 11:50	11:55 - 12:56	13:00 - 14:00	14:03 - 15:03	15:05 16:00
[%]	[%]	[ppm]	[ppm]	[ppm]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]
8,7	11,7	67	104	1	20	22	20	17	16	19
					O ₂ in %					
					8,8	9,1	8,7	8,8	8,3	8,5
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]
	68	173	1	16	18	16	14	12	15	
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]
	54	138	1	13	15	13	11	10	12	
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]
	35	88	1	8	9	8	7	6	8	



Order number:	PL-11055-P
Marking	HP 04

Date of test:	22.03.2011
Fuel:	Wood pellets

Elementary analysis		
Carbon content	[%]	47,56
Hydrogen content	[%]	5,44
Nitrogen content	[%]	0,11
Sulphur content	[%]	0,01
Ash content	[%]	0,31
Oxygen content	[%]	40,25
Water content	[%]	6,32

Load	[min]	Partial Load
Start	[hh:mm]	09:45
End	[hh:mm]	16:04
Combustion time	[min]	379
Fuel quantity	[kg]	10,7
Thermal output from fuel	[kW]	8,3
Conversion	[kg/h]	1,7
Average negative pressure in the interceptor	[Pa]	11,6

Air ratio (Lamda)	[-]	2,7
Flue gas volume, dry	[Nm ³ /kg]	11,6
Flue gas volume, wet	[Nm ³ /kg]	12,3
Flue gas flow	[Nm ³ /h]	20,8
Flue gas mass flow rate	[g/s]	7,2
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]	535,2
	[%]	3,0
Loss through CO in the flue gas	[kJ/kg]	16,3
	[%]	0,1
Heat losses due to combustible constituents in	[kJ/kg]	108,8
	[%]	0,6
Loss through radiation, convection and conduction	[kJ/kg]	98,4
	[%]	1,2
Combustion efficiency	[%]	95,1

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]	0,69
Flue gas volume, wet	[m ³ /kg]	4,99
CO ₂ maximum	[%]	20,63
Net calorific value	[kJ/kg]	17719

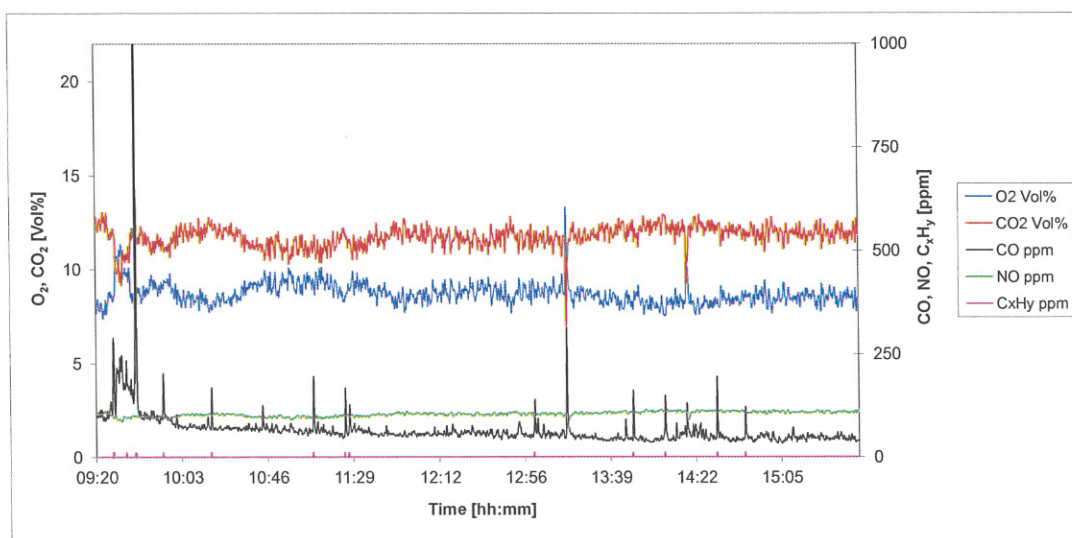
Ambient conditions		
Atmospheric Pressure	[%]	1008,7
Atmospheric humidity	[%]	17,9
Room temp.	[°C]	23,1

Flue gas temperature		
Maximum	[°C]	67,1
Average	[°C]	55,1

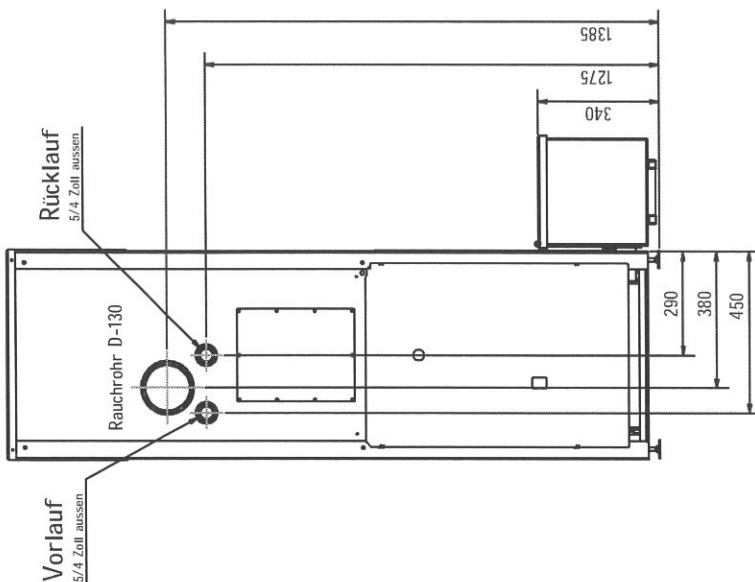
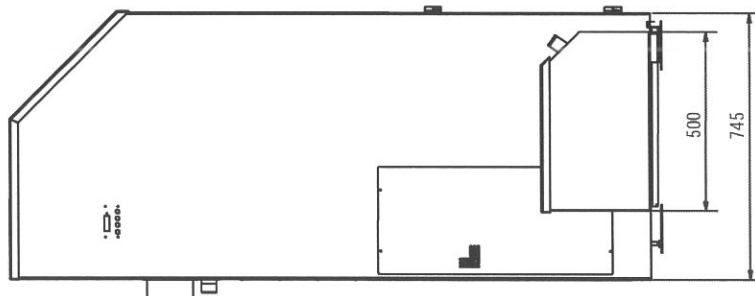
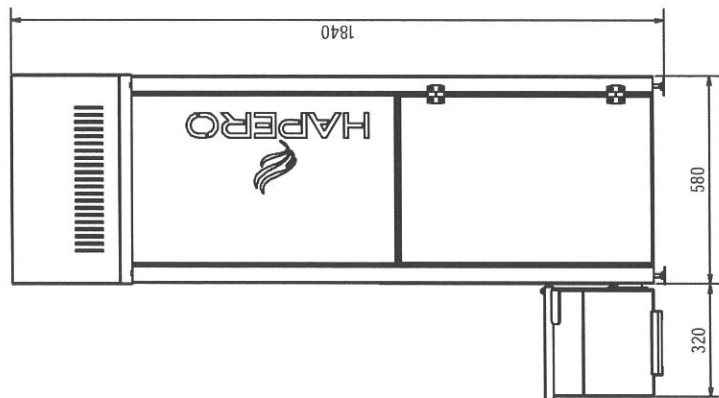
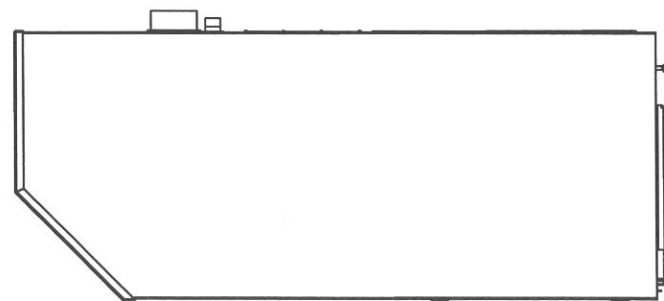
Average boiler surface temperatures		
Boiler cover	[°C]	24,7
Boiler surface left	[°C]	24,3
Boiler surface right	[°C]	26,4
Boiler surface front	[°C]	24,8
Boiler surface back	[°C]	27,6
Boiler base	[°C]	21,6
Fuel hopper	[°C]	21,1
Door handle		n.a.

Water heating output		
Temperature of inlet water	[°C]	55,7
Temperature of outlet water	[°C]	72,3
Water flow	[m ³ /h]	0,4
Water heating output	[kW]	7,8
Thermal efficiency	[%]	93,9

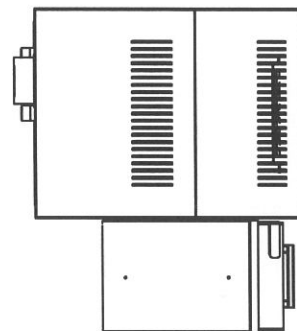
Emissions, measured					Dust measured					
O ₂	CO ₂	CO	NO	C _x H _y	09:46 - 10:46	10:50 - 11:50	11:55 - 12:56	13:00 - 14:00	14:03 - 15:03	15:05 16:00
[%]	[%]	[ppm]	[ppm]	[ppm]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]	[mg/Nm ³]
12,9	7,7	112	40	1	14	16	18	14	17	18
					O ₂ in %					
					13,5	13,4	13,1	12,9	12,4	12,3
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]
	173	103	2	19	21	23	17	20	21	
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]
	138	82	2	15	17	18	14	16	17	
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]
	88	53	1	10	11	12	9	10	11	



Diese Zeichnung unterliegt dem Urheberrecht!
Sie darf ohne unsere Genehmigung weder vervielfältigt,
noch dritten Personen zugänglich gemacht werden.



INSTITUT FÜR VERFAHRENTECHNIK
UMWELTECHNIK UND
TECHN. BIONNISCHAFTEIN
A-1060 WIEN, GETREIDEMARKT 9/103



Pelletofen: Typenbezeichnung HP-04 / Einwurffheizung / 3-zügiger Wärmetauscher
Nennwärmeleistung: 35 kW
Maximal zulässiger Betriebsdruck: 3 bar
Prüfdruck des Wasserkreislaufes: 6 bar
Schweißnahtform: Kehln- und Stumpnaht
Werkstoff: Stahl / Wandstärke - 3 / 4 / 5mm / Qualität - S 235 JR
Maximal zulässige Betriebstemperatur des Wasserkreises: 80°C

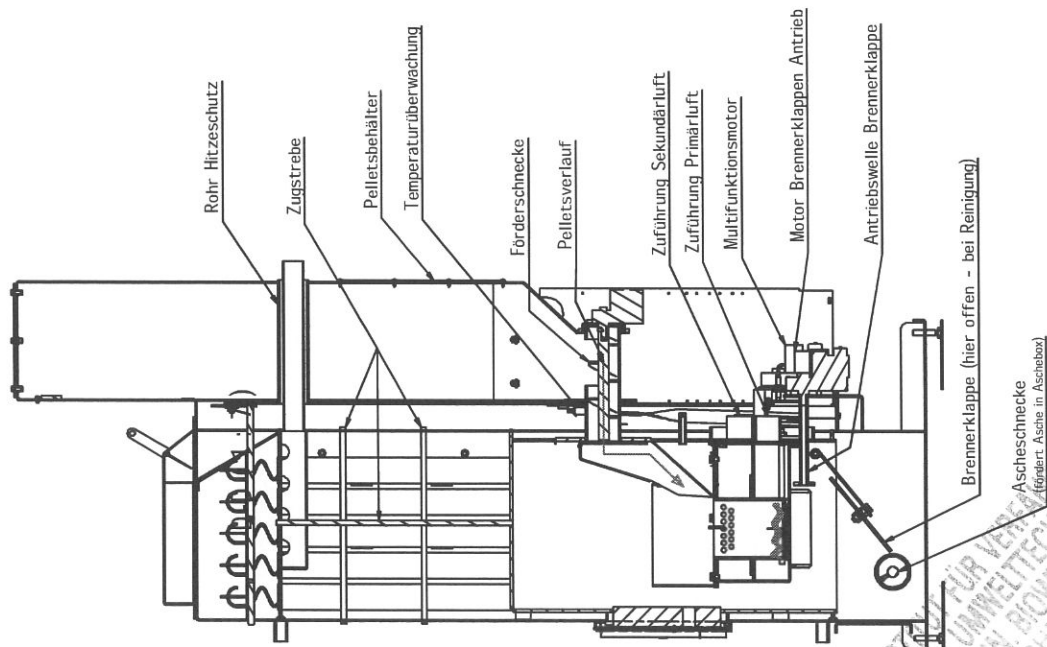


Toleranzen nach
DIN 7168 mittel
Erstellt am 27.08.2010
Konstrukteur P.R.
Gewicht ca. k.A.
Funktions- und Prüfm.
Hilfsmasse ()
Werkstoff -
Oberfläche -
Maßstab: 1 : 10
Index

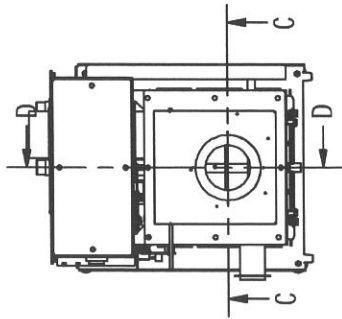
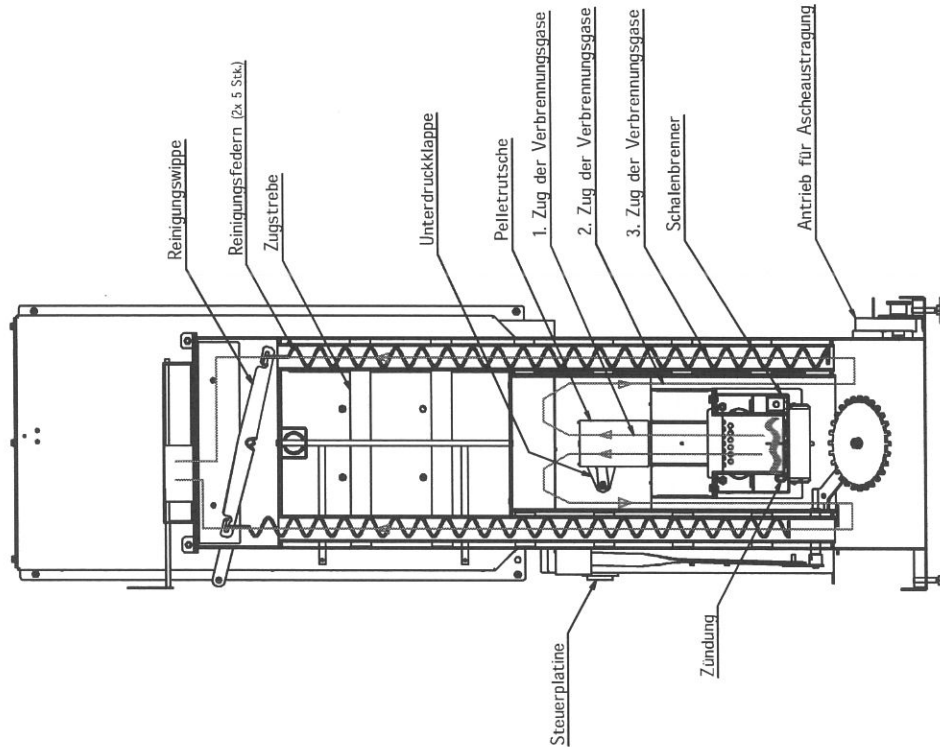
Änderung
Datum
Benennung
HP-04 Abmessungen
Zeichnungsnummer HP-04 Abmessungen
alte Zeich.-Nr.
A2

Diese Zeichnung unterliegt dem Urheberrecht!
 Sie darf ohne unsere Genehmigung weder vervielfältigt,
 noch dritten Personen zugänglich gemacht werden.

Schnitt D:



Schnitt C:



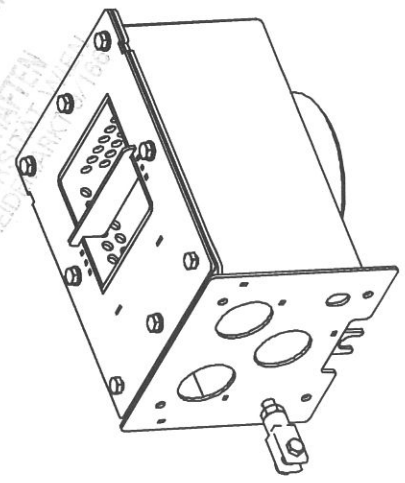
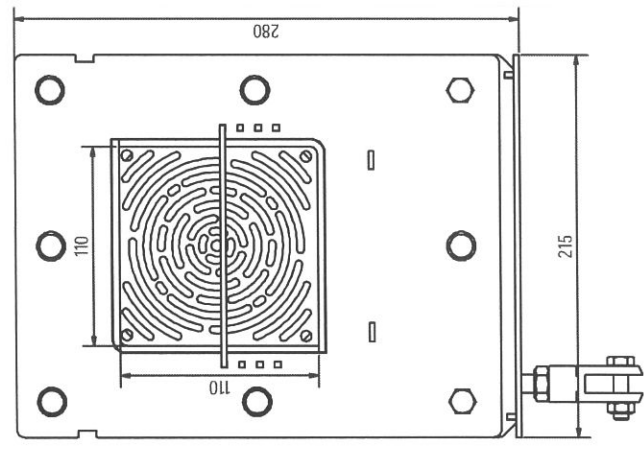
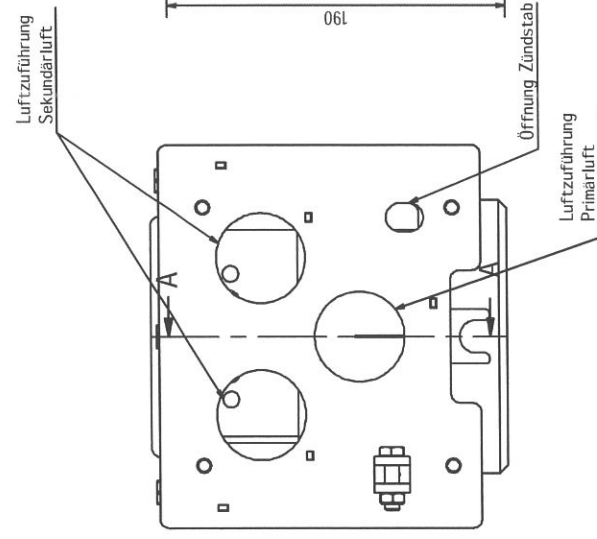
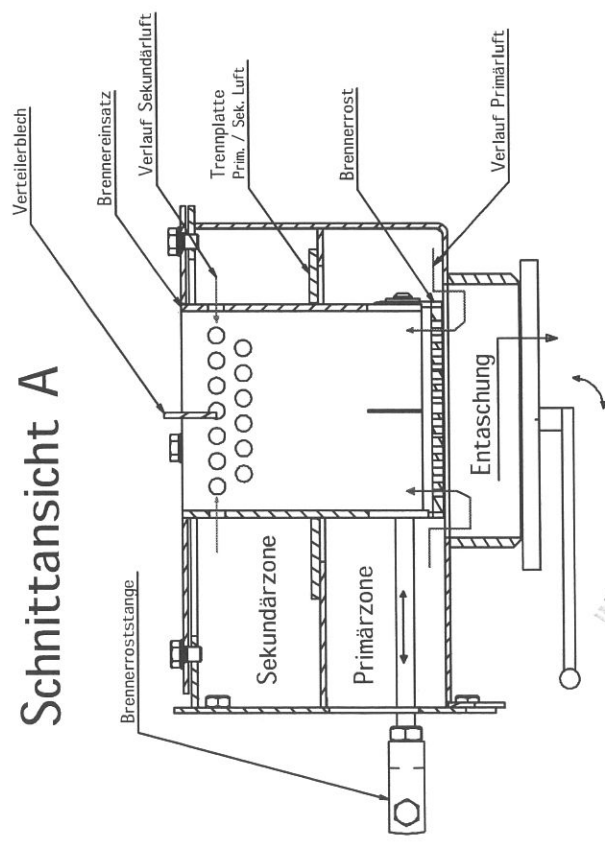
HAPERO TECHNIK UND SERVICE		Toleranzen nach DIN 7168 mittel		Funktions- und Prüfm. Hilfsmasse ()		Maßstab: 1 : 7	
		Erstellt am 27.06.2010	Konstrukteur P.R.	Werkstoff -	Profil -	Proj. Blatt -	Proj. Blatt -
Index	Änderung	Gewicht ca.	K.A.	Datum	Bemerkung HP-04 Schnittdarstellung		
					Zeichnungsnummer HP-04 Verlauf/Brennmaterial		
					alte Zeich.-Nr.		
					Blatt von A2		

Pelletofen: Typenbezeichnung HP-04 / Einwurfheizung / 3-zugiger Wärmetauscher
Nennwärmeleistung: 35 kW
Maximal zulässiger Betriebsdruck: 3 bar
Prüfdruck des Wasserkreislaufes: 6 bar
Schweißnahtform: Kehrl- und Stumpfnaht
Werkstoff: Stahl / Wandstärke - 3 / 4 / 5mm / Qualität - S 235 JR
Maximal zulässige Betriebstemperatur des Wasserkreislaufes: 80°C

INSTITUT FÜR VERFAHRENTECHNIK
 UMWELTECHNIK UND
 TECHN. BIOINGENIEURWESEN
 TECHNISCHE UNIVERSITÄT WIEN
 ALBERT-LEIBNIZ-STRASSE 25
 1040 WIEN, GEBIEDERMARKT 8

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noch dritten Personen zugänglich gemacht werden.

Schnittansicht A



Pelletofen: Typenbezeichnung HP-04 / Einwurffheizung / 3-zugiger Wärmetauscher		Nennwärmeleistung: 35 kW	
Maximal zulässiger Betriebsdruck: 3 bar		Prüfdruck des Wasserkreislaufes: 6 bar	
Schweißnahtform: Kehrl- und Stumpfnaht		Werkstoff: Stahl / Wandstärke - 3 / 4 / 5 mm / Qualität - S 235 JR	
Maximal zulässige Betriebstemperatur des Wasserkreislaufes: 80 °C		Funktions- und Prüfm.:	
Toleranzen nach DIN 7168 mittel		Hilfsmasse ()	
Erstellt am 24.09.2010		Werkstoff	
Konstrukteur P. R.		Maßstab: 1 : 2	
Gewicht ca. k.A.		Regelung	
Änderung		Oberfläche	
Datum		-	
Index		Benennung	
		HP-04 Ansicht Brenner (35 kW)	
		Blattvor 1	
		Zeichnungsnummer HP-04 Brenner 35kW	
		alte Zeich-Nr.	
		A2	

Flash max. output 35 kW

Type: HP 04 / K Flash

Hersteller: Hapero Energietechnik GmbH (AUSTRIA)

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



office@hapero.com

Seriennummer:

Serialnumber: 04.12.00027.2045



KENNUNG



Automatischer Holzpelletskessel:

Automatic wood pellet boiler,

Automatisk træpillefyr, Chaudière automatique à granulés de bois,

Caldaia a pellets automatica,

Wärmeleistung:

Nominal output,

Varmeydelse, Puissance nominale, Potenza nominale,

7,6 - 35 kW

25-121 BTU

Kesselklasse:

Boiler class,

Kedelklasse, Chaudière de classe, Classe caldaia,

3

Max. Betriebsdruck:

Maximum operating pressure,

Max drifttryk, Pression de service maximum, Pressione massima ammessa,

3 bar

Max. Kesseltemperatur:

Maximum boiler temperature,

Max kedeltryk, Température maximale de chaudière, Massima temperatura di caldaia,

85° C

185° F

Wasserinhalt:

Water capacity,

Vandinhold, Contenance en eau, Contenuto d'acqua,

60 Liter

Stromanschluss:

Electricity supply,

Strømtilslutning, Raccordement électrique, Allacciamento elettrico,

230 V / 1400 W

50 HZ / >= 13 A

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.

Prrière 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

Flash max. output 35 kW

Type: HP 04 / K Flash

Hersteller: Hapero Energietechnik GmbH (AUSTRIA)

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



office@hapero.com

Seriennummer:

Serialnumber: 04.12.00025.2045



KENNUNG



Automatischer Holzpelletskessel:

Automatic wood pellet boiler,

Automatisk træpillefyr, Chaudière automatique à granulés de bois,

Caldaia a pellets automatica,

Wärmeleistung:

Nominal output,

Varmeydelse, Puissance nominale, Potenza nominale,

7,6 - 35 kW

25-121 BTU

Kesselklasse:

Boiler class,

Kedelklasse, Chaudière de classe, Classe caldaia,

3

Max. Betriebsdruck:

Maximum operating pressure,

Max drifttryk, Pression de service maximum, Pressione massima ammessa,

3 bar

Max. Kesseltemperatur:

Maximum boiler temperature,

Max kedeltryk, Température maximale de chaudière, Massima temperatura di caldaia,

85° C

185° F

Wasserinhalt:

Water capacity,

Vandinhold, Contenance en eau, Contenuto d'acqua,

60 Liter

Stromanschluss:

Electricity supply,

Strømtilslutning, Raccordement électrique, Allacciamento elettrico,

230 V / 1400 W

50 HZ / >= 13 A

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

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Prrière 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

Flash max. output 35 kW

Type: HP 04 / K Flash

Hersteller: Hapero Energietechnik GmbH (AUSTRIA)

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



office@hapero.com

Seriennummer:

Serialnumber: 04.12.00028.2045



KENNUNG



Automatischer Holzpelletskessel:

Automatic wood pellet boiler,

Automatisk træpillefyr, Chaudière automatique à granulés de bois,

Caldaia a pellets automatica,

Wärmeleistung:

Nominal output,

Varmeydelse, Puissance nominale, Potenza nominale,

7,6 - 35 kW

25-121 BTU

Kesselklasse:

Boiler class,

Kedelklasse, Chaudière de classe, Classe caldaia,

3

Max. Betriebsdruck:

Maximum operating pressure,

Max drifttryk, Pression de service maximum, Pressione massima ammessa,

3 bar

Max. Kesseltemperatur:

Maximum boiler temperature,

Max kedeltryk, Température maximale de chaudière, Massima temperatura di caldaia,

85° C

185° F

Wasserinhalt:

Water capacity,

Vandinhold, Contenance en eau, Contenuto d'acqua,

60 Liter

Stromanschluss:

Electricity supply,

Strømtilslutning, Raccordement électrique, Allacciamento elettrico,

230 V / 1400 W

50 HZ / >= 13 A

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.

Prrière 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

Flash max. output 35 kW

Type: HP 04 / K Flash

Hersteller: Hapero Energietechnik GmbH (AUSTRIA)

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



office@hapero.com

Seriennummer:

Serialnumber: 04.12.00026.2045



KENNUNG



Automatischer Holzpelletskessel:

Automatic wood pellet boiler,

Automatisk træpillefyr, Chaudière automatique à granulés de bois,

Caldaia a pellets automatica,

Wärmeleistung:

Nominal output,

Varmeydelse, Puissance nominale, Potenza nominale,

7,6 - 35 kW

25-121 BTU

Kesselklasse:

Boiler class,

Kedelklasse, Chaudière de classe, Classe caldaia,

3

Max. Betriebsdruck:

Maximum operating pressure,

Max drifttryk, Pression de service maximum, Pressione massima ammessa,

3 bar

Max. Kesseltemperatur:

Maximum boiler temperature,

Max kedeltryk, Température maximale de chaudière, Massima temperatura di caldaia,

85° C

185° F

Wasserinhalt:

Water capacity,

Vandinhold, Contenance en eau, Contenuto d'acqua,

60 Liter

Stromanschluss:

Electricity supply,

Strømtilslutning, Raccordement électrique, Allacciamento elettrico,

230 V / 1400 W

50 HZ / >= 13 A

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.

Prrière 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