

Appendices belonging to this report:

- a) Main drawing no. S0490
- b) Photos of the biofuel boiler, 21 pieces
- c) Operating and installation instructions, 4th edition, 1-2-2005
- d) Technical information and date plate

The appendices are kept separately.

1 Remarks

None.

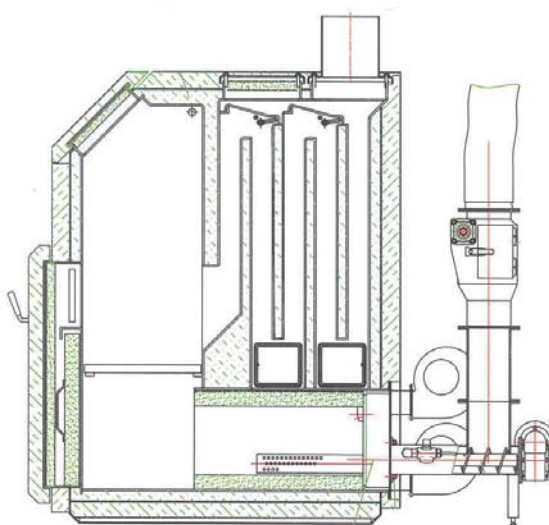
2 Description of the biofuel boiler

KSM 975-95 Auto is a compact, automatically fired boiler for firing with finely divided solid fuel. The fuel is transported via a rotary valve from external storage hopper to the combustion chamber where the combustion takes place during the air supply.

The boiler's control system changes automatically between three burn rate stages, a cooling stage (0) and an idle stage. Current measurements and controls are carried out of the boiler temperature and oxygen content of the flue gas.

The boiler is a welded steel sheet boiler with a convection part consisting of 5 vertical tubes without flue gas baffle plates. The total heat transfer area is approx. 9 m².

The biofuel boiler is provided with an automatic sprinkler and a rotary valve and drop chute to prevent back-burning when the fuel is fed to the burner.



Settings on biofuel boiler during testing:

Boiler thermostat (nominal): 90 °C
Boiler thermostat (minimum load): 76 °C
Set point for O₂: 9.0%
Reduction of O₂ set point in step 3: 3.1%
Pause time, auger: 31-32 sec.
Air inlet: 70 x 90 mm

Main dimensions, total biofuel boiler:

Length: 1925 mm
Height: 1650 mm
Width: 825 mm
Weight: Approx. 1250 kg

Feeding system:

Type: External hopper with rotary valve and drop chute
Fuel auger drive motor (el):: 0.55 kW
Fuel feed duct: 92 x 92 mm

Burner:

Type: Duct burner lined with fireproof stones
Width: 285 mm
Height: 235 mm
Depth: 580 mm
Fan engine 1: 230 V, 176 W
Fan engine 2: 230 V, 67 W
Primary air: 3 pieces of nozzles with 3 holes, ø8.5 mm
Secondary air: 2 pieces of nozzles with 30 holes ø8.5 mm

Boiler:

Type: Welded steel sheet boiler
Length: 1275 mm
Weight: 1180 kg
Water content: 290 l
Water side connection, inlet: 5/4"
Water side connection, return: 5/4"

Safety equipment:

Temperature controller, type: Electronic
Safety thermostat, type: STB
Safety heat exchanger, type: Wound spiral
Valve for safety circuit: SYR
Fire extinguishing equipment: Thermostatic sprinkler

3 Test equipment

Test rig and equipment are constructed in accordance with EN 303-5 and EN 304.

Rack 3			
Instrument	Type	Traceability	No.
Data acquisition unit	HP 34970A	DANAK 200	270-A-1509
Pc	Amitech Pentium	-	270-A-1579
CO/CO ₂ /O ₂ analyzer	H & B Uras 14	-	270-A-1501
Pressure gauge	Autotran 700	ELAB	270-A-1578
Heated hose	Winkler	-	270-A-1495
Probe	M & C	-	270-A-1479
Flue gas temperature sensor	Type K	ELAB	270-A-1528
Ambient temperature sensor	Type K	ELAB	270-A-1527

Test rig 4			
Instrument	Type	Traceability	No.
Water flow meter	0-11 m ³ /h	DANAK 200	270-A-1760
Water temperature sensor	Pt100 (inlet)	DANAK 200	270-A-1306
Water temperature sensor	Pt100 (return)	DANAK 200	270-A-1307
Gas meter	IGA AC-5M	IGA	270-A-1474

Other equipment			
Instrument	Type	Traceability	No.
NO analyzer	H&B Radas 2	-	270-A-1502
Converter	H&B CGO-K	-	270-A-1503
FID analyzer	M&A Thermo-Fid	-	270-A-1751
Heated hose	Winkler	-	270-A-1753
Probe	M & C	-	270-A-1752
Adiabatic calorimeter	-	IVC, Kemi	-
Span gas, CH ₄	Alpha-gaz	Hede Nielsen	270-A-1729-1
Span gas, CO/CO ₂	Alpha-gaz	Hede Nielsen	270-A-1727-3
Span gas, NO/SO ₂	Alpha-gaz	Hede Nielsen	270-A-1725-1
Zero gas, N ₂	Alpha-gaz	Hede Nielsen	270-A-1731-1
Data acquisition software	DAQ ver. 1	-	-
Dust measuring equipment	Ströhlein	-	270-A-1330
Surface thermometer	Technoterm 5500	DANAK 200	270-A-976
Water gauge	ELAB	-	270-A-1759
Scale (dust)	Mettler PC 440	ELAB	270-A-947
Scale (humidity)	Mettler PJ6	ELAB	270-A-997
Scale (boiler)	Sauter E/40-E2100	ELAB	270-A-0551
Scale (fuel)	Sauter 60 kg	ELAB	270-A-484

4 Requirements on construction etc.

	Reference paragraph in EN 303-5	Requirement met
4.1 General requirements		
Safety during normal operation	4.1.1	Yes
4.2 Requirements on documentation		
Drawings	4.1.2.1	Yes
Quality manual	4.1.2.2	Yes
Data plate	7.1-7.2	Yes
Technical information	8.1	Yes
Operating instructions	8.2	Yes
4.3 Requirements on welded steel sheet boilers		
Execution of welding work	4.1.3.1	*
Welding seams and materials	4.1.3.2	*
Parts of steel subject to pressure	4.1.3.3	*
Minimum wall thickness and tolerances	4.1.3.4	*
4.4 Requirements on safety and design		
Venting etc.	4.1.5.1	Yes
Cleaning of heating surfaces	4.1.5.2	Yes
Inspection of the flame	4.1.5.3	Yes
Water tightness	4.1.5.4	Yes
Replacement and spare parts	4.1.5.5	Yes
Water side connections	4.1.5.6	Yes
Thermostat pockets	4.1.5.7	Yes
Thermal insulation	4.1.5.8	Yes
Leakages in flue gas system	4.1.5.10	Yes
Requirement on temperature control at open expansion	4.1.5.11.1	Yes
Requirement on temperature control at closed expansion	4.1.5.11.2	Yes
Storage hopper	4.1.5.12	Yes (external)
Ash chamber	4.1.5.13	Yes
Safety during automatic fuel supply	4.1.5.14.2	Yes
Accessories/fittings	4.1.5.15	Yes
Electrical safety	4.1.5.16	*

* Not included in this report. Please refer to the manufacturer's EU declaration of conformity.

5 Test results

5.1 Water resistance

Equivalent temperature difference at nominal output	Water flow	Drop of pressure
20 K	4.25 m ³ /h	23 mbars
10 K (calculated drop of pressure)	8.50 m ³ /h	94 mbars

5.2 Leakage test

Since the boiler operates with a negative pressure in the combustion chamber, there are no requirements on leakage flow.

5.3 Surface temperatures

	Measured temperature	Tolerated limit
Boiler doors etc., average of 5 measurements	45 °C	+ 100 K
Boiler's underside, average of 5 measurements	31 °C	+ 65 K
Handles being touched during operation		
Metal and similar materials	60 °C	+ 35 K
Porcelain and similar materials	-	+ 45 K
Plastic and similar materials	-	+ 60 K
Boiler's average surface temperature		
Average of 1 spot measurements	28 °C	-
Ambient temperature	21 °C	-

5.4 Function check

The biofuel boiler can partly be disconnected, cf. DS/EN 303.5 paragraph 4.1.5.11.2 b), and therefore the safety equipment includes a temperature controller, a safety thermostat with manual reset device and a device for disposal of the boiler's residual heat.

The boiler's thermostats have been tested according to DS/EN 303-5, paragraph 5.13. The device for disposal of residual heat/excess of heat has been tested according to paragraph 5.14.

	Measured temperature	Tolerated limit
Temperature controller	99 °C	100 °C
Safety thermostat	105 °C	110 °C
Device for disposal of the boiler's residual heat	103 °C	110 °C
Temperature on cold water supply	11 °C	10-15°C
Pressure on cold water supply	2 bars	2 bars

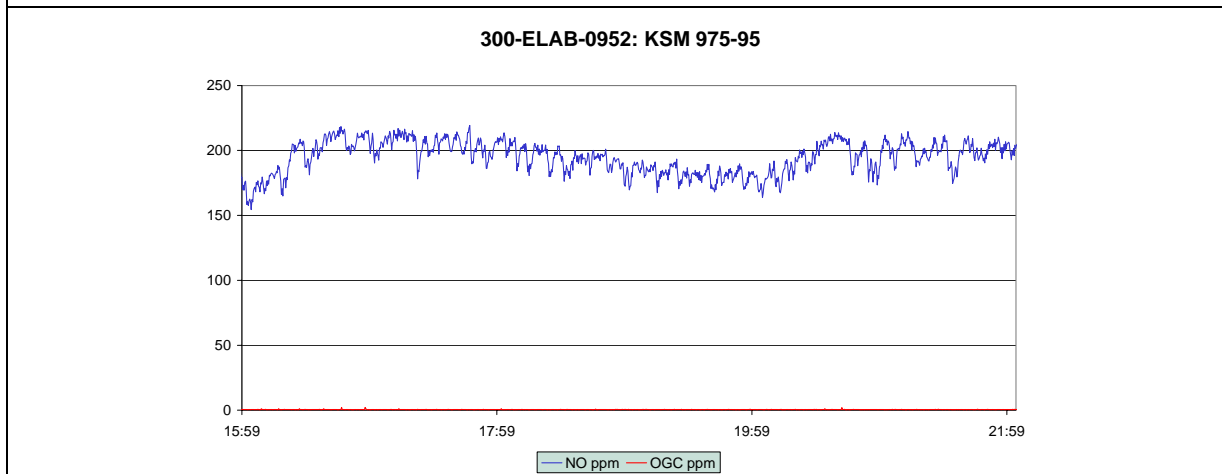
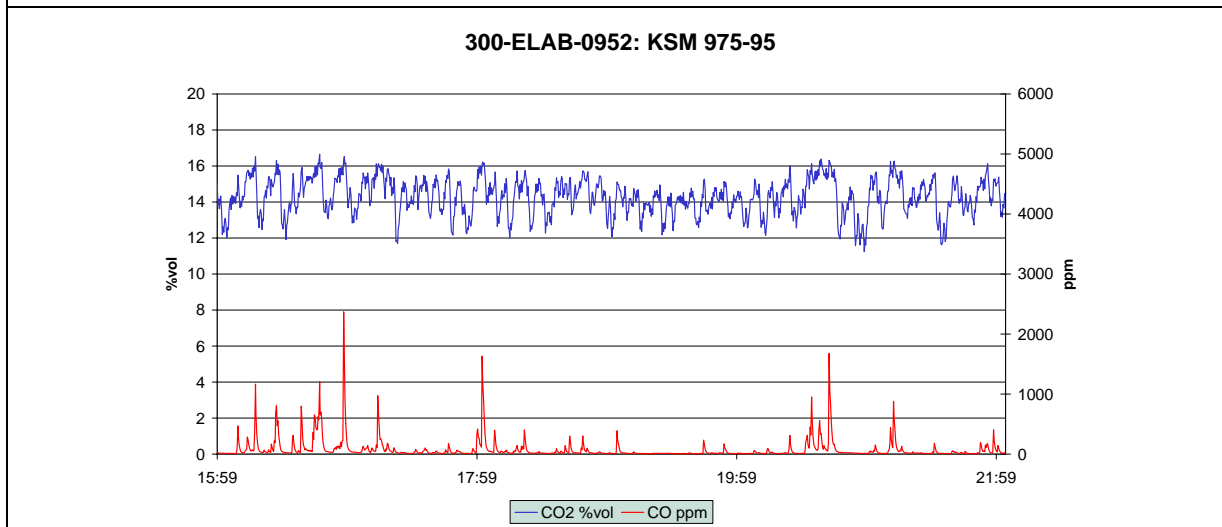
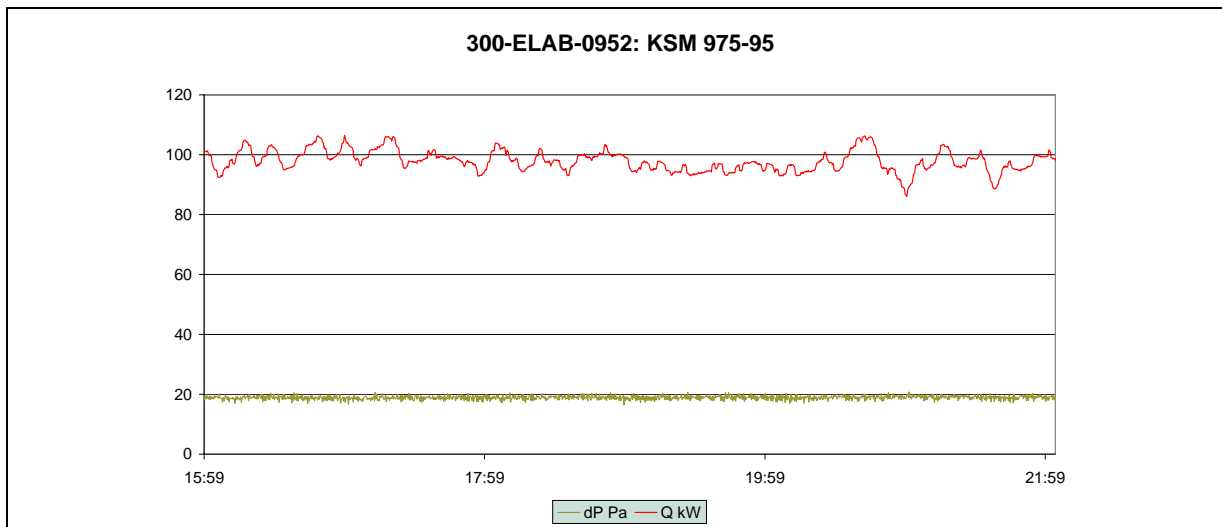
5.5 Pressure testing of boiler shell

The necessary tests, cf. DS/EN 303-5 paragraph 5.4, is carried out by the manufacturer.

5.6 Test results at nominal output

Measurement	Result	Requirement
Return temperature	59.93 °C	
Inlet temperature	78.61 °C	
Water flow rate	4.61 m ³ /h	
Heat output	98.48 kW	
Duration	6.07 h	
Fuel consumption	21.69 kg/h	
Water content	7.2 %	
Calorific value	17711 J/g	
Heat input	106.70 kW	
Efficiency	92.3 %	79 (Class 3) 84 (Austria)
Ambient temperature	21 °C	
Flue gas temperature	149 °C	
Chimney draught	19 Pa	
Flue gas volume flow	227.5 m ³ /h	
Flue gas mass flow	191.7 kg/h	40 (Max.)
CO ₂	14.3 % _{vol}	
Dust measured	40 mg/m _n ³	
Dust at 10% O ₂	28 mg/m _n ³	150 (Class 3)
Dust at 13% O ₂	21 mg/m _n ³	150 (Germany)
Dust emission	14 mg/MJ	60 (Austria)
CO measured	0.0080 % _{vol}	
CO at 10% O ₂	0.0059 % _{vol}	
CO at 10% O ₂	73 mg/m _n ³	2500 (Class 3)
CO at 13% O ₂	0.0533 g/m _n ³	2 (Germany)
CO at 13% O ₂	53 mg/m _n ³	2000 (Switzerland)
CO emission	34 mg/MJ	500 (Austria)
NO _x (NO ₂) at 10% O ₂	0.0143 % _{vol}	
NO _x (NO ₂) at 10% O ₂	293 mg/m _n ³	
NO _x emission (NO ₂)	136 mg/MJ	150 (Austria)
OGC (CH ₄) at 10% O ₂	0.0000 % _{vol}	
OGC (C) at 10% O ₂	0 mg/m _n ³	80 (Class 3)
OGC emission (C)	0 mg/MJ	40 (Austria)

All emission values are stated on the basis of dry flue gas.



5.7 Test results at lowest output

Measurement	Result	Requirement
Return temperature	59.82 °C	
Inlet temperature	74.44 °C	
Water flow rate	1.68 m ³ /h	
Heat output	28.02 kW	
Duration	13.53 h	
Fuel consumption	6.10 kg/h	
Water content	7.1 %	
Calorific value	17589 J/g	
Heat input	29.82 kW	
Efficiency	94.0 %	(Class 3) 83 (Austria)
Ambient temperature	20 °C	
Flue gas temperature	80 °C	
Chimney draught	11 Pa	
Flue gas volume flow	79.2 m ³ /h	
Flue gas mass flow	79.4 kg/h	39 (Max.)
CO ₂	9.3 % _{vol}	
CO measured	0.0056 % _{vol}	
CO at 10% O ₂	0.0064 % _{vol}	
CO at 10% O ₂	79 mg/m _n ³	2500 (Class 3)
CO at 13% O ₂	0.0578 g/m _n ³	2 (Germany)
CO at 13% O ₂	58 mg/m _n ³	2000 (Switzerland)
CO emission	37 mg/MJ	750 (Austria)
NO _x (NO ₂) at 10% O ₂	0.0108 % _{vol}	
NO _x (NO ₂) at 10% O ₂	222 mg/m _n ³	
NO _x emission (NO ₂)	104 mg/MJ	150 (Austria)
OGC (CH ₄) at 10% O ₂	0.0003 % _{vol}	
OGC (C) at 10% O ₂	1 mg/m _n ³	80 (Class 3)
OGC emission (C)	1 mg/MJ	40 (Austria)

All emission values are stated on the basis of dry flue gas.

