UNIVERSITY OF ZAGREB
Faculty of mechanical engineering and naval architecture
Laboratory for thermodynamics and heat transfer equipment
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ISPITNO IZVJEŠĆE Br. 10/23

TEST REPORT No.

Objekt mjerenja: *Object of measurements:*	Štednjak na kruto gorivo *Residential cooker fired by solid fuel*
Oznaka tipa: *Type designation:*	**C**
Verzije: *Versions:*	**25, 35**
Naručitelj: *Customer:*	Senko Ltd. Vladimira Nazora 22, Štefanec 40000 Čakovec
Proizvođač: *Manufacturer:*	Senko Ltd. Vladimira Nazora 22, Štefanec 40000 Čakovec
Ispitano prema: *Tested according to:*	HRN EN 16510-1:2023 (EN 16510-1:2022) HRN EN 16510-2-3:2023 (EN 16510-2-3:2022)

	Datum izdavanja *Issue date*	Odgovorna osoba *Authorized person*	Voditelj laboratorija *Head of the laboratory*
M.P. SVEUČILIŠTE U ZAGREBU FAKULTET STROJARSTVA I BRODOGRADNJE Zagreb, Ivana Lučića 5	31.05.2023.	dr. sc. Ivan Horvat	prof. dr. sc. Damir Dović

1. Summary

Customer	SENKO Ltd., Vladimira Nazora 22, Štefanec, 40000 Čakovec
Subject of test	Residential cooker fired by solid fuel according to HRN EN 16510-1:2023 (EN 16510-1:2022) and HRN EN 16510-2-3:2023 (EN 16510-2-3:2022)
Appliance	Residential cooker fired by solid fuel
Type	**C-25, C-35**
Manufacturer	SENKO Ltd., Vladimira Nazora 22, Štefanec, 40000 Čakovec
Intended use	Cooking, Baking and Space heating
Fuel	Wood briquettes (test), Wood logs

C-25	Unit	Value	Limit according to				
			HRN EN[1]	HRN EN[2]	DIN plus	2. Stufe der 1.BlmSchV	2015/1185 (EU)
Total nominal heat output	kW	16.8	-	-	-	-	-
Water heat output	kW	4.3	-	-	-	-	-
Efficiency	%	81.02	-	> 60	-	> 75	-
CO – at O_2 = 13%	mg/Nm^3	896	1 500	12 500	-	1 500	1 500
OGC – at O_2 = 13%	mg/Nm^3	43.1	120	-	120	-	120
NO_X – at O_2 = 13%	mg/Nm^3	140	200	-	200	-	200
Dust – at O_2 = 13%	mg/Nm^3	28.6	40	-	-	40	40
Distance to combustible materials	Minimum distances at mm: - rear = 200 - sides = 200 - above = 1000 - front = 800						

1 HRN EN 16510-1:2023 (EN 16510-1:2022), HRN EN 16510-2-3:2023 (EN 16510-2-3:2022)
2 HRN EN 12815:2014/A1:2008/Ispr.2:2008 (EN 12815:2001/A1:2004/AC:2007)

	Unit	Value	Limit according to 2015/1185 (EU)
Seasonal space heating efficiency	%	71.02	> 65

	Unit	Value	Energy efficiency class 2015/1186 (EU)
Energy efficiency index (EEI)	%	107.48	A+

Voditelj laboratorija
Head of the laboratory

prof. dr. sc. Damir Dović

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Zagreb, Ivana Lučića 5

2. Product specifications

Residential cookers fired by solid fuel **C-25/35** manufactured by Senko Ltd. are residential cookers fired by wood briquettes and wood logs with grate and ash pan. Cookers are made of stainless-steel sheets and castings of quality gray cast iron. The combustion chamber is partially lined with chamotte bricks. Cookers are intended for cooking, baking and household space heating. Cookers are fitted with a boiler. There is secondary air is on the side. The primary air inlet is located in the lower back part, connection is Ø120 mm. Chimney connection is located at the rear and back side.

Cookers are declared as being equipped with thermal discharge control: yes ☐ no ☒

Detailed description is provided in the instructions for installation and operation which forms integral part of the source materials.

Type	Main dimensions (mm)			Nominal heat output (kW)*	Fuel consumption (kg/hour)*	Flue gas connector diameter (mm)	Operating draught (Pa)
	Height	Width	Depth				
C-25	850	1 000	640	16.8/4.8	4.54	130	12
C-35	850	1 000	780	23/8	5.86	150	12

* Declared by the manufacturer

Note: Design of variants C-25 and C-35 have different outer main dimensions, while the stove is the same.

3. Sample tested

The product sample indicated in the following table was used for inspection, testing and evaluation:

Type	**Date**	**Sample Reg. No.**
C-25	18.05.2023. 23.05.2023. 24.05.2023.	prototype at the producer

Place of testing:	at the FSB-LTTU Laboratory ☐	at the manufacturer ☒	at the customer ☐	other:

4. List of employed technical documentation

	Employed documentation:
1.	Instructions for installation and operation
2.	Assembly engineering drawings

5. Detailed test results

5.1 Measuring and testing equipment

No.	Name	Manufacturer/Type	Serial number	Calibration certificate
1.	Thermocouple*	T/K type	-	Calibration certificate C-4225 / 21-07
2.	Multichannel test set up for temperature measurement*	Agilent/3491A	MY44008250	Calibration certificate C-4225 / 21-07
3.	Industrial scale**	Ohaus/CH30R11	-	2013-219-01
4.	Combustion analyzer	MRU/NOVA 2000	010277	Calibration certificate No. E36/2020
5.	Differential pressure sensor	Ahlborn FD A602-S2K	08080490	2-0061/14-05
6.	Contact temperature sensor	Ahlborn ZA 9020-FS	FPA32PH	Calibration certificate C-4225 / 21-07
7.	Stick meter	-	-	-
8.	Ultrasonic meter**	Siemens UH50-A36C-HR06-F	65 760 067	-

* Calibration done according to DKD-R 5-1:2018
** Calibration done according to the internal procedure

5.2 Thermal output, energy efficiency and emission of combustion products test

Testing method: HRN EN 16510-1:2023

Sample tested: C-25

Measuring equipment used: 1, 2, 3, 4, 5, 7, 8

Test results – Nominal heat output

Date of testing:	18.05.2023.	t_{ok} = 20 °C	RH = 57%

Variables measured and calculated:	Unit	Tests			Limit according to			
		1	2	Avg	HRN EN[1]	HRN EN[2]	DIN plus	2. Stufe der 1.BlmSchV
Fuel consumption	kg/hour	4.486	4.608	4.547				
Achieved input	kW	20.50	21.06	20.78				
Combustion air temperature	°C	19.1	20.5	19.8				
Chimney draught	Pa	12	12	12				
Average combustion product temperature	°C	206.3	203.3	204.8				
CO_2	%	8.06	7.27	7.66				
CO – measured	%	0.0736	0.0756	0.0746				
CO – at O_2 = 13%	%	0.0670	0.0763	0.0716		1.0		
CO – at O_2 = 13%	mg/Nm^3	838	953	896	1 500	12 500		1 500
CO – at O_2 = 0%	mg/MJ	553	629	591				
OGC – at O_2 = 13%	mg/Nm^3	32.3	53.8	43.1	120		120	
OGC – at O_2 = 0%	mg/MJ	21.3	35.5	28.4				
NO_X – at O_2 = 13%	mg/Nm^3	120	160	140	200		200	
NO_X – at O_2 = 0%	mg/MJ	79	106	92				
Dust – at O_2 = 13%	mg/Nm^3	26.2	30.9	28.6	40			40
Dust – at O_2 = 0%	mg/MJ	17.3	20.4	18.8				
Flue gas sensible heat loss	%	17.24	18.45	17.85				
Flue gas chemical heat loss	%	0.59	0.67	0.63				
Heat loss of combustible constituents in the residue	%	0.50	0.50	0.50				
Efficiency	%	81.66	80.38	81.02		>60		>75
Uncertainty (Efficiency)	%	1.5						
Total heat output	kW	16.7	16.9	16.8				
Water heat output	kW	4.8	3.8	4.3				
Rated total heat output	kW	16.8						

[1] HRN EN 16510-1:2023 (EN 16510-1:2022), HRN EN 16510-2-3:2023 (EN 16510-2-3:2022)
[2] HRN EN 12815:2014/A1:2008/Ispr.2:2008 (EN 12815:2001/A1:2004/AC:2007)

Note: The OGC, NOx and dust results are obtained from Laboratory Međimurje ZAING d.o.o., Emission measurement report of pollutants in the air from the prototype heating device, Report number: IV-01-0094-23-0847-A

Evaluation:

CO emissions → Compliance – The measurement result is below the specification limit when the measurement uncertainty is taken into account

OGC emissions → Compliance – The measurement result is below the specification limit when the measurement uncertainty is taken into account

NO_X emissions → Compliance – The measurement result is below the specification limit when the measurement uncertainty is taken into account

Dust emissions → Compliance – The measurement result is below the specification limit when the measurement uncertainty is taken into account

Efficiency → Compliance – The measurement result is above the specification limit when the measurement uncertainty is taken into account

Measurement uncertainty: Specified with the measurement results

"The above-specified extended measurement uncertainties are calculated as a factor of the measurement uncertainty and the extension coefficient, k=2, corresponding to the coverage certainty of 95% for standard classification. The standard uncertainty was determined in accordance with Document EA 4/02 M."

Variables measured and calculated:		**Value**	**Limit 2015/1185 (EU)**
Seasonal space heating efficiency	%	71.02	> 65
CO	[mg/m^3]	896	1 500
OGC	[mg/m^3]	43.1	120
NO_x	[mg/m^3]	140	200
Dust	[mg/m^3]	28.6	40

Evaluation:

Seasonal space heating efficiency → Compliance – The measurement result is above the specification limit when the measurement uncertainty is taken into account

CO emissions → Compliance – The measurement result is below the specification limit when the measurement uncertainty is taken into account

OGC emissions → Compliance – The measurement result is below the specification limit when the measurement uncertainty is taken into account

NO_X emissions → Compliance – The measurement result is below the specification limit when the measurement uncertainty is taken into account

Dust emissions → Compliance – The measurement result is below the specification limit when the measurement uncertainty is taken into account

Variables calculated:		**Value**	**Energy efficiency class 2015/1186 (EU)**
Energy efficiency index (EEI)	%	107.48	A+

Fuel analysis

Wood briquettes			
Analytical indicator	Symbol	Unit	Value
Calorific value	Q_i	MJ/kg	16,45
All water in original condition	W^r_t	% by weight	9,3
Ash	A	% by weight	0,5
Carbon	C	% by weight	45,9
Hydrogen	H	% by weight	5,2
Nitrogen	N	% by weight	0,14
Sulphur	S	% by weight	0,011

Note: The results are obtained from Laboratory HEP - Proizvodnja d.o.o., Centralni kemijsko-tehnološki laboratorij, LABORATORIJSKI IZVJEŠTAJ br. 456/22

Tested by: dr. sc. Ivan Horvat Date: 25.05.2023. Signed:

Reviewed by: prof. dr. sc. Damir Dović Date: 26.05.2023. Signed:

5.3 Temperature rise of the operating components

Testing method:	HRN EN 16510-1:2023
Sample tested:	C-25
Measuring equipment used:	1, 2, 3, 6

Test results – Nominal heat output

Date of testing:	18.05.2023.	t_{ok} = 20 °C	RH = 57 %

Measured point	Material	Temperature rise, K	Note
Front door handle	metal	49	≤ 35 K
Operating knob (primary air)	metal	111	≤ 35 K
Oven door handle	metal	48	> 35 K

Note: The highest value is indicated in the table.
*The use of protecting gloves is prescribed.

Test evaluation: Compliance

Measurement uncertainty: 0,5 K

"The above-specified extended measurement uncertainties are calculated as a factor of the measurement uncertainty and the extension coefficient, k=2, corresponding to the coverage certainty of 95% for standard classification. The standard uncertainty was determined in accordance with Document EA 4/02 M."

Tested by: dr. sc. Ivan Horvat Date: 25.05.2023. Signed:

Reviewed by: prof. dr. sc. Damir Dović Date: 26.05.2023. Signed:

5.4 Hot plate boiling test

Testing method:	HRN EN 16510-2-3:2023
Sample tested:	C-25
Measuring equipment used:	1, 2, 3

Test results – Nominal heat output

Date of testing:	23.05.2023.	t_{ok} = 24 °C	RH = 43 %

Variables measured	Unit	Test 1	Test 2	Avg	Note
Mass of the water	g	2000	2000	2000	
Water temperature at the start of the boiling test	°C	17.1	18.3	17.7	
Time when the temperature is increased by 75 K	min	11	10	10.5	<15

Test evaluation: Compliance – The measurement result is below the specification limit when the measurement uncertainty is taken into account

Measurement uncertainty: 10 g / 0,2 K / 0,5 min

"The above-specified extended measurement uncertainties are calculated as a factor of the measurement uncertainty and the extension coefficient, k=2, corresponding to the coverage certainty of 95% for standard classification. The standard uncertainty was determined in accordance with Document EA 4/02 M."

Tested by: dr. sc. Ivan Horvat Date: 25.05.2023. Signed:

Reviewed by: prof. dr. sc. Damir Dović Date: 26.05.2023. Signed:

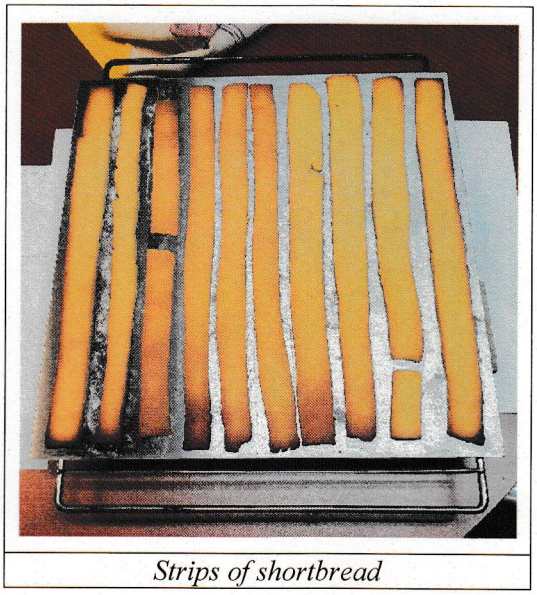
5.5 Oven heating test

Testing method:	HRN EN 16510-2-3:2023
Sample tested:	C-25
Measuring equipment used:	1, 2

Test results

Date of testing:	24.05.2023.	t_{ok} = 21°C	RH = 56%

Variables measured	Unit	Test
Achieved oven temperature	213°C	Browning chart index 3



Strips of shortbread

Test evaluation: Compliance

Measurement uncertainty: 0,2 K

"The above-specified extended measurement uncertainties are calculated as a factor of the measurement uncertainty and the extension coefficient, k=2, corresponding to the coverage certainty of 95% for standard classification. The standard uncertainty was determined in accordance with Document EA 4/02 M."

Tested by: dr. sc. Ivan Horvat Date: 25.05.2023. Signed:

Reviewed by: prof. dr. sc. Damir Dović Date: 26.05.2023. Signed:

5.6 Oven shelf test

Testing method:	HRN EN 16510-2-3:2023
Sample tested:	C-25
Measuring equipment used:	-

Test results

Not applicable, door opens sideways

Tested by: dr. sc. Ivan Horvat Date: 24.03.2022. Signed:

Reviewed by: prof. dr. sc. Damir Dović Date: 26.05.2022. Signed:

List of referenced documents

- HRN EN 16510-1:2023 (EN 16510-1:2022)
- HRN EN 16510-2-3:2023 (EN 16510-2-3:2022)
- Emission measurement report of pollutants in the air from the prototype heating device, Report number: IV-01-0094-23-0847-A, Međimurje ZAING d.o.o.
- LABORATORIJSKI IZVJEŠTAJ br. 456/22, Centralni kemijsko-tehnološku laboratorij, HEP Proizvodnja

End of test report