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COMPARATIVE STUDY OF A CONSTRUCTION FIREPLACE WITHOUT AND WITH A HOTFIREDOOR ENCLOSURE.

File number: 23/32300955 ENGLISH VERSION

Reference of the petitioner:

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Date:
22nd November, 2023

Digitally signed by
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Date at which the sample was received: 17/03/2023

Date at which the test was performed: Start: 02/05/2023 End: 06/05/2023

1.- OBJECT OF THE TEST

Determination of the performance, emissions and surrounding temperature performance, for a brick chimney without and with an enclosure based on the standards :

- UNE-EN 13240:2002
- UNE-EN 13240:2002/A2:2005
- UNE-EN 13240:2002/AC:2006
- UNE-EN 13240:2002/A2:2005/AC:2007

2.- CHARACTERISTICS OF THE SAMPLE

A Horfiredoor enclosure system was received, consisting of a front door and a grill for collecting ashes; and an open fire brick fireplace fed with wood with the following characteristics:

- Net weight: 152 Kg
- Fuel: Wood
- Interior width: 81 cm
- Interior height: 125 cm
- Depth: 50 cm

Photograph 1: Fireplace without enclosure

Photo 2: Fireplace with Hotfiredoor system

Internal code assigned by the laboratory: 23/15247

3.- TEST DESCRIPTION

Three consecutive tests are carried out on an open fireplace and this same one applying the Hotfiredoor enclosure to the fireplace. The tests will be carried out based on the set of standards UNE-EN 13240 and UNE-EN 16510-1 and the following characteristics are determined:

- Temperature on the front and side walls at a distance of 50 cm from the open fireplace.
- Temperature on the ceiling at a distance of 150 cm from the chimney opening.
- Performance at nominal thermal power
- Emissions and particles at nominal thermal power

4. SPECIFICATION AND TEST RESULTS

4.1- Fuel used:

The fuels used are wood pellets with the following characteristics:

Test Fuel	Moisture (%)	Ash (%)	Volatile materials (%)	H (%)	C (%)	S (%)	Hu (kJ/kg)
Beech	12	0,5	85,2	6,3	49,1	0,0001	16163

Beech wood length: 300 mm

Beech fuel analyzed by Centro de Investigación Elías Masaveu S.A. with report no. E035956/22 and CARTIF Foundation with report no. IE-LAE-I-30597-22 corresponding fuel validation 2022650.

4.2.- Information and test results:

- Open

Test fuel: 3 logs of 30 cm length

	Unit	Test 1 (1)	Test 2 (2)	Test 3 (3)	Average
Consumed fuel load	kg	2,96	2,28	2,32	2,52
Average smoke temperature	ºC	106	73	84	87
Duration	h	0,71	1,26	0,96	0,98
Flue draught	Pa	11,92	12,63	12,47	12,34
CO	%	0,04	0,04	0,04	0,04
CO_2	%	0,87	0,52	0,66	0,68
O_2	%	20,32	20,69	20,55	20,52
Ambient room temperature	ºC	24,26	24,67	24,39	24,44
Maximum temperature trihedron floor	ºC	44	44	43	43
Maximum temperature left wall	ºC	35	31	31	32
Maximum temperature right wall	ºC	66	71	63	67
Maximum temperature rear wall	ºC	43	47	49	46
Maximum temperature ceiling	ºC	36	44	43	41
Maximum temperature frontal wall	ºC	60	55	58	57
Losses through specific heat in the flue gases (qa)	%	66,09	62,33	63,03	63,82
Losses through latent heat in the flue gases (qb)	%	3,39	5,53	4,43	4,45
Losses through combustible constituents in the residues (qr)	%	0,50	0,50	0,50	0,50
Efficiency	%	30	32	32	31
Nominal heat output	kW	5,7	2,6	3,5	3,9
Emission of CO at 13% O_2	%	0,51	1,15	0,77	0,81
Emission of NOx at 13% O_2	mg/m^3	8,55	18,74	12,59	13,29
Emission of OGC at 13% O_2	mg/m^3	127,80	329,96	274,86	244,21
Emission of PM_{HF} at 13% O_2	mg/m^3	900,44	431,86	1000,09	777,46
Flue gas mass flow	g/s	150,62	104,53	112,36	122,50

(1) **The flame starts 5 minutes after applying the load**
(2) **The flame starts 15 minutes after applying the load**
(3) **The flame starts 20 minutes after applying the load**

- with Hotfiredoor

Test fuel: 3 logs of 30 cm length

	Unit	Test 1	Test 2	Test 3	Average
Consumed fuel load	kg	3,19	3,47	3,37	3,34
Average smoke temperature	ºC	255	328	327	303
Duration	h	0,77	0,57	0,62	0,65
Flue draught	Pa	11,97	11,94	11,58	11,83
CO	%	0,24	0,18	0,20	0,21
CO_2	%	6,14	9,37	8,49	8,00
O_2	%	14,30	10,50	11,44	12,08
Ambient room temperature	ºC	21,18	23,36	24,82	23,12
Maximum temperature trihedron floor	ºC	21	35	43	33
Maximum temperature left wall	ºC	42	62	66	57
Maximum temperature right wall	ºC	68	85	97	83
Maximum temperature rear wall	ºC	79	122	127	109
Maximum temperature ceiling	ºC	48	44	54	49
Maximum temperature frontal wall	ºC	59	74	81	71
Losses through specific heat in the flue gases (qa)	%	28,63	26,47	28,50	27,87
Losses through latent heat in the flue gases (qb)	%	2,59	1,28	1,55	1,81
Losses through combustible constituents in the residues (qr)	%	0,50	0,50	0,50	0,50
Efficiency	%	68	72	69	70
Nominal heat output	kW	12,7	17,4	17,1	15,7
Emission of CO at 13% O_2	%	0,29	0,14	0,16	0,20
Emission of NOx at 13% O_2	mg/m^3	30,26	18,80	0,68	16,58
Emission of OGC at 13% O_2	mg/m^3	54,68	16,54	17,48	29,57
Emission of PM_{HF} at 13% O_2	mg/m^3	50,46	120,26	87,39	86,03
Flue gas mass flow	g/s	20,63	17,98	20,04	19,55

5.- SUMMARY OF RESULTS

The results obtained during the laboratory tests have been:

	Unit	Open	with Hotfiredoor	Difference
Consumed fuel load	kg	2,52	3,34	0,82
Average smoke temperature	ºC	87	303	216
Duration	h	0,98	0,65	0,33
Flue draught	Pa	12,34	11,83	0,51
CO	%	0,04	0,21	0,17
CO_2	%	0,68	8,00	7,32
O_2	%	20,52	12,08	8,44
Ambient room temperature	ºC	24,44	23,12	1,32
Maximum temperature trihedron floor	ºC	43	33	10
Maximum temperature left wall	ºC	32	57	24,7
Maximum temperature right wall	ºC	67	83	16
Maximum temperature rear wall	ºC	46	109	63
Maximum temperature ceiling	ºC	41	49	8
Maximum temperature frontal wall	ºC	57	71	14
Losses through specific heat in the flue gases (qa)	%	63,82	27,87	35,95
Losses through latent heat in the flue gases (qb)	%	4,45	1,81	2,64
Losses through combustible constituents in the residues (qr)	%	0,50	0,50	0,50
Efficiency	%	31	70	39
Nominal heat output	kW	3,9	15,7	11,8
Emission of CO at 13% O_2	%	0,81	0,20	61
Emission of NOx at 13% O_2	mg/m^3	13,29	16,58	3,29
Emission of OGC at 13% O_2	mg/m^3	244,21	29,57	214,64
Emission of PM_{HF} at 13% O_2	mg/m^3	1431,95	86,03	1345,92
Flue gas mass flow	g/s	122,50	19,55	102,95

6.- OBSERVATIONS

After carrying out the tests with the same load, with the fireplace without door and with the Hotfiredoor system, it is observed that the load consumed in the open system is lower than that consumed with the closed system because part of the load has not finished burning.

The duration of the test, although a little longer in the open system, the performance and heating power of this are lower compared to the closed Hotfiredoor system, with the efficiency being 31% and heating power of 4 kW in the open system and 70% and 16 kW in closed system with Hotfiredoor. This is due to a better combustion of the load where the calorific value of the wood is better used and which can be contrasted with the emissions of gases and polluting particles, where the open system has a very unfavourable behaviour based on the criteria of Ecodesing, especially in particles, compared to the closed system with Hotfiredoor.

Regarding the temperature in the stove envelope, a higher temperature in all directions is observed with the closed Hotfiredoor system, except for the base, possibly due to the use of a grate that separates the bottom of the chimney with direct contact with the embers and prevents heat transfer in that direction.

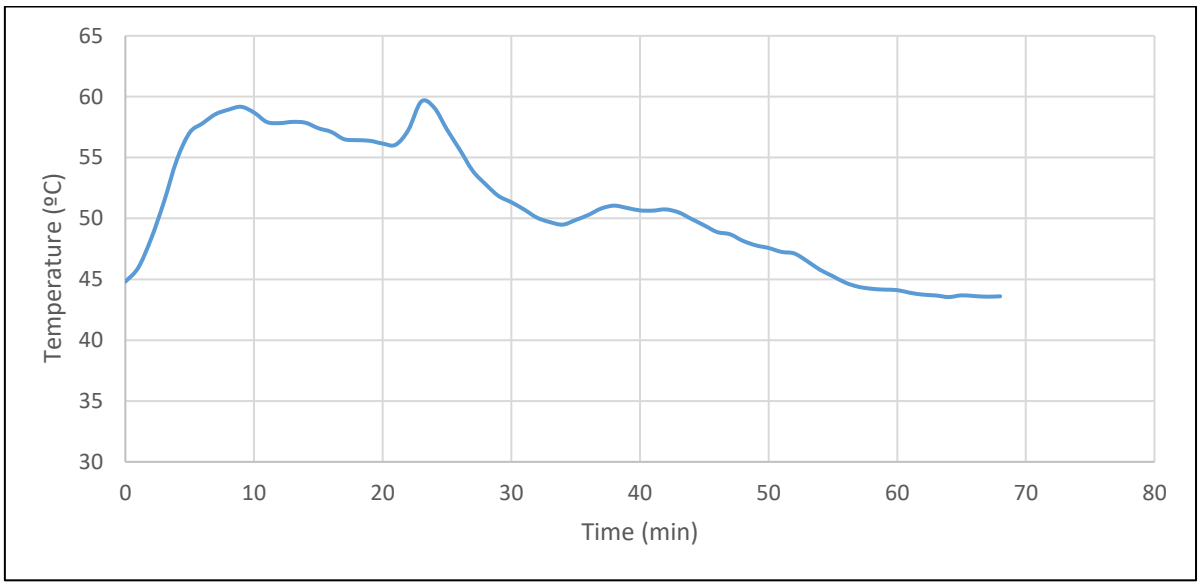
Other observations during the test are about ignition where the open system takes between 5-20 minutes to catch fire and where the system smokes outside the system, while the closed system with Hotfiredoor ignites as soon as the load is placed and the door is closed by making better use of the air entering the chimney and passing through the embers and the load of new wood.

ANNEX

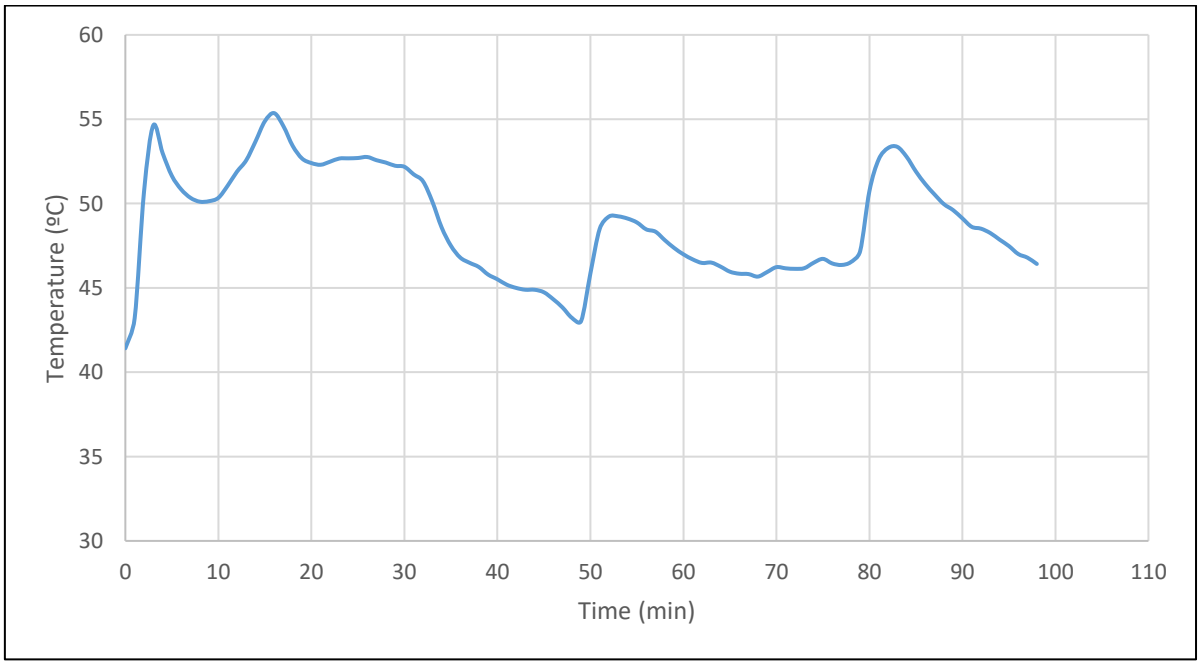
Graphics:

The temperature profile of the different tests 50 cm from the front of the stove is attached.

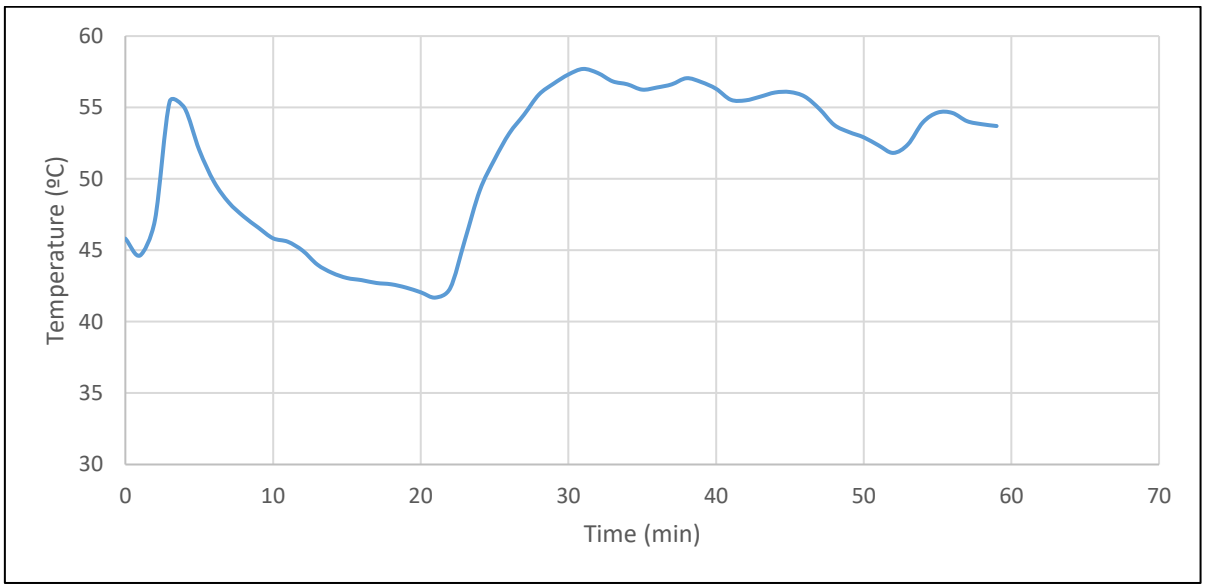
Open system test: 1



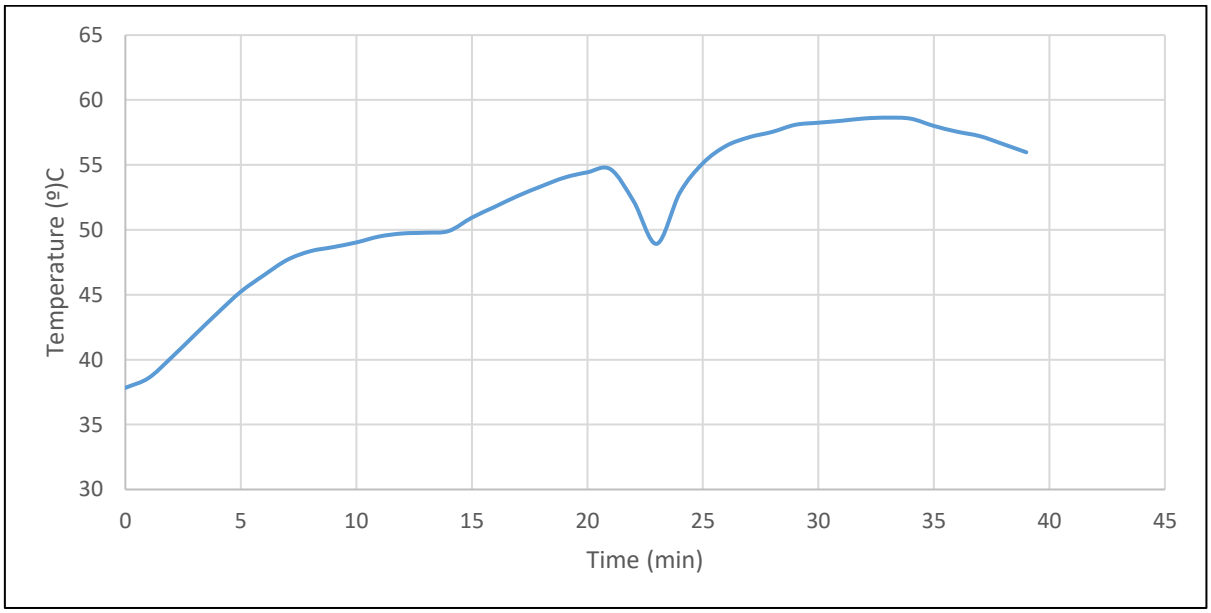
Open system test: 2



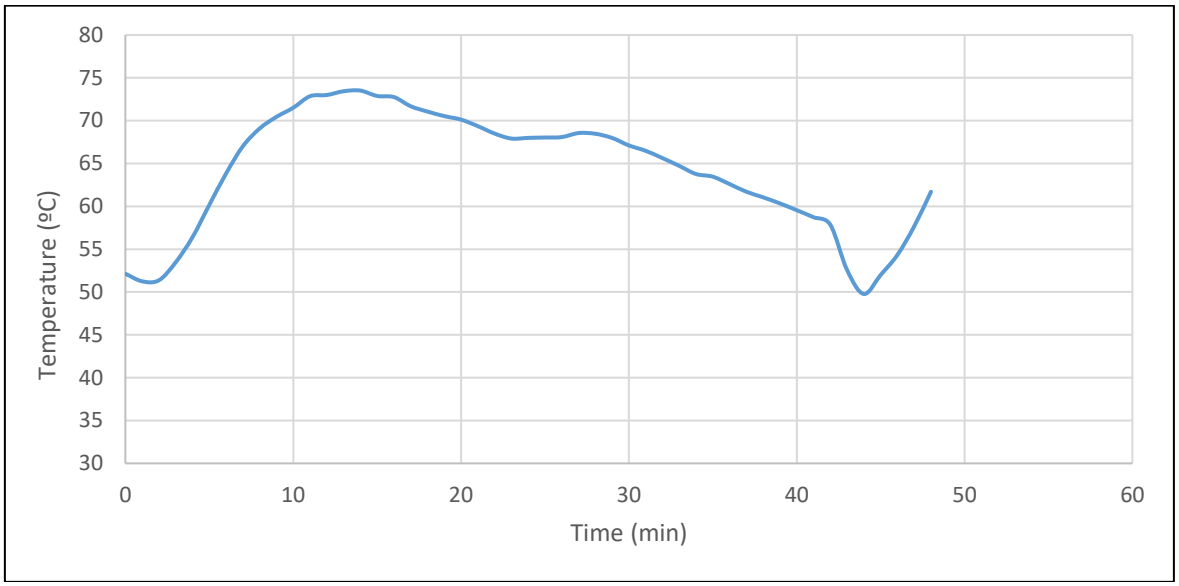
Open system test: 3



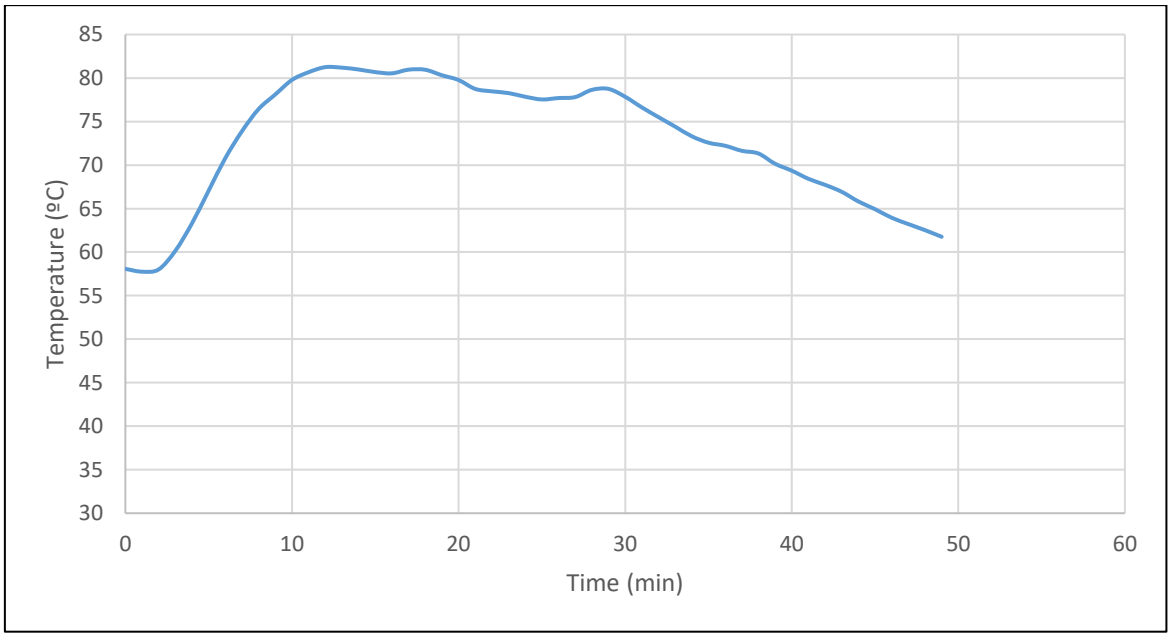
Hotfiredoor system test: 1



Hotfiredoor system test: 2



Hotfiredoor system test: 3



Photographs:

Photograph 4: Open system test at minute 5 in the first test.

Photograph 5: Closed system test at minute 1 in the first test.