

Wood burning stoves and indoor air quality.

Abstract

In December 2020, following a report issued by Sheffield University <https://www.mdpi.com/2073-4433/11/12/1326?s=09>, there was a lot of publicity in the press regarding the detrimental effect that wood burning stoves have on indoor air quality, particularly when refuelling, quoting levels of 27 - 195 micrograms per M3. This is contrary to logic and the experience we and our customers have had.

The research is flawed and seems to be the victim of confirmation bias, as it takes no account of other activities taking place in the house, occupation of the living room, the effect a lit stove or fireplace has on the movement of air in the house, how the stove was being operated, or the quality and installation of the stoves tested.

Flaws and assumptions

- Properly made wood burning stoves work on negative pressure, if a hole is drilled in the side of a stove air is drawn in, smoke does not come out. This can be easily demonstrated by opening the door ajar and holding a smoking joss stick near it. When lit, a stove can pull all the air out of the room every hour, this air is replaced from the other rooms in the house, including any particulates which may already be present.
- When the stove is not lit these particulates from other sources will not be sucked into the living room so will not be detected by the analyser, thereby leading to the incorrect assumption that the stove must be the source of the particulates.
- Most of the measurements were taken between 18:00 and 22:00, the same times which cooking and other domestic activities are being carried out.
- Analysers were not placed elsewhere in the house, such as the kitchen, to verify background levels.
- When the stove is lit the living room will be occupied which in itself leads to a significant rise in airborne particulates.
- There is no information at all on which stoves were tested and the build quality, how they had been installed, if they comply with Ecodesign or whether the stoves were being used correctly.

Objective

To remove the above factors and carry out more research into how wood burning stoves affect indoor air quality and how this compares to other everyday activities in the home.

Equipment

Monitor	Tempot M2000 air quality monitor, zeroed and calibrated
Stove	Burley Model 9308 Brampton, 8kW
Room type	Conventional living room, dimensions 8M x 5M x 2.6M, monitor in centre of room, door open Kitchen, dimensions 4M x 3.7M x 2.4M, monitor on work surface, door closed, 1 x passive air vent
Location	Isolated country location, outside influencing factors can be disregarded
Time	12:00, no other occupation or activity taking place in house
Weather	Pressure 1001mb, wind SW 7mph, overcast, 5 degrees C.

Method

The stove was laid with one firelighter, 300g of kindling (larch) and 1.6kg of wood (oak) and the background pm2.5 particulate level allowed to settle to 7.

Note - once the background level had stabilised, sitting on the sofa raised the PM2.5 measurement from 7 to 16 due to disturbance of particulates from the cushions, this was allowed to reduce before the start of the tests.

<u>Time (minutes)</u>	<u>Activity</u>	<u>Level of pm2.5</u>
0:00	Stove lit	7 (background)
1:20	Door put on latch to draw	26
6:00	Door closed	17
12:00		15
18:00		13
24:00		11
30:00		10
36:00		9
42:00		7
48:00		7
54:00		8
60:00	Refuelled with 1.8kg log	6
66:00		5
72:00		6
90:00		4
105:00	Refuelled with 1.8kg log	4
120:00		4

Actual stove and location of tests



Other activities for comparison

- Lighting a match in the living room 12 PM2.5, falling to 8 over 20 minutes.
- Blowing out 1 candle (lit by a gas lighter) 44 PM2.5, falling to 12 over 10 minutes.
- Making toast in the kitchen. Figures below.
Note - When the toast was burnt even a little the analyser exceeded its limit of 1000.

<u>Time (minutes)</u>	<u>Level of PM2.5</u>
0:00	Toaster turned on 5 (background),
2:00	Toaster off at 2:20 5
4:00	120
6:00	65
8:00	60
10:00	50
12:00	54
14:00	53
16:00	53
18:00	53
20:00	51
25:00	46
30:00	43
40:00	37
120:00	21

Actual toast to show amount of cooking



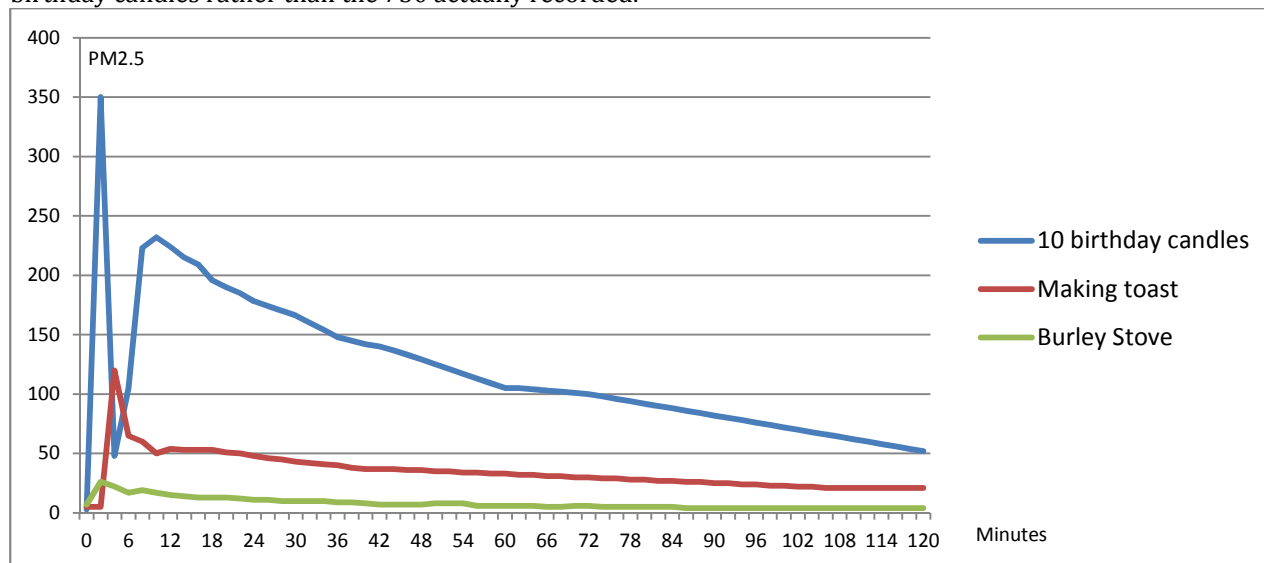
- Blowing out 10 candles on a birthday cake in the kitchen (lit with a match). Figures below.

<u>Time (minutes)</u>	<u>Level of PM2.5</u>
0:00 (background)	3
1:00 Candles blown out	730
2:00	62
3:00	54
4:00	48
5:00	133
6:00	105
7:00	166
8:00	223
9:00	233
10:00	232

<u>Time (minutes)</u>	<u>Level of PM2.5</u>
12:00	224
14:00	215
16:00	209
18:00	196
20:00	190
25:00	178
30:00	166
40:00	142
60:00	105
90:00	82
120:00	52

Graph of comparisons

Note – in order to maintain a readable scale on the graph, a PM2.5 level of 350 was entered for the birthday candles rather than the 730 actually recorded.



Summary of tests

When removing other contributing factors, the correct use of the stove over a two hour period had very little effect on the level of PM2.5, approximately the same as lighting one candle with a match and blowing it out again. Making toast in a kitchen created a level of PM2.5's 7.8 times higher than using a wood burning stove, and lighting 10 candles on a birthday cake and blowing them out created a level 29.5 times higher. All tests were carried out for 120 minutes, at the end of this period however the level of PM2.5 from making toast and the ten birthday candles were still well in excess of ambient, 10 times greater in the case of the candles and still double the safe WHO limit.

Conclusion

The WHO advised limit for continuous exposure to PM2.5's over 24 hours is 25 and the limit for continuous exposure over an entire year is 10. The level of PM2.5's during this test when using the Burley wood burning stove was significantly below both these levels and quickly stabilised at the ambient background level after lighting.

Had the air quality measurement been taken in the living room when the stove was burning at the same time as when the toast was made in the kitchen, or the birthday candles blown out, these particulates would have been drawn into living room with the air flow, seriously corrupting the reading.

The conclusion from these tests is that a properly designed, installed and operated Burley stove has little or no effect on indoor air quality.

Common sense when lighting, using and refuelling your wood burning stove

- Only use dry wood and kindling.
- Do not use your stove with the door open
- After lighting the stove, close the door just leaving a small gap to prevent any smoke coming out.
- Refuel when the logs have burned down to mostly embers, not when logs are still burning vigorously.
- When refuelling, open the door slowly, allowing the pressure to equalize.
- Have the correct fuel ready for refuelling, don't open the door and then go looking logs.

Created by Burley Appliances, manufactures of the World's most efficient and clean burning stoves.
Research carried out using Burley stoves, results will vary between manufacturers. www.burley.co.uk