



Laboratory measurement of gaseous emissions from wood pellets and wood chips

IOHA 2015

Mike Hemingway

Introduction

- Since 2002 there have been at least nine fatalities world wide caused by carbon monoxide poisoning following entry into wood pellet storage areas.
- Domestic, commercial and industrial use of wood pellet boilers is now increasing in the UK.
- There is concern that the risks, particularly the release of carbon monoxide and absorption of oxygen during storage, are not understood.
- There are similar concerns over the use of wood chips.

Site Measurements

- No significant concentrations of CO, CO₂, CH₄ were detected.
- Each site had a reasonably high ventilation rate
 - 1.7 air changes.hr⁻¹ to 20 air changes.hr⁻¹.
- Very little microbiological contamination of pellets
 - not detected Sites 2 & 4; fungi 125 cfu.g⁻¹, Site 7).
- Higher microbiological contamination of wood chips
 - bacteria 1.8×10^7 cfu.g⁻¹.

Wood pellet and wood chip fuel

Pellets



Chips



Methodology

- Samples and real-time instruments sealed in 60 l drums
 - CO, CO₂, O₂, volatile organic carbons (VOC) and flammable gases
- Two series of tests
 - To minimise headspace and maximise potential gas emissions
 - Increase headspace to reduce anomalies
- Additional test on dried woodchip

Sample details

Test	Sample	Wood Type	Particle Size	Wood Mass ¹
Series 1	Woodchip	90% Larch and Spruce, some Scots Pine and very small amount of Silver Birch. Felled 8 to 20 months before use.	5-70 mm pieces	8.9 kg
	Wood Pellet	Pure pressed sawdust.	6.5 mm diameter, 5-25 mm long rods	28.2 kg ²
Series 2	Woodchip	"Almost entirely Spruce, less than 36 hours old."	5 to 70 mm pieces	3.6 kg ³
				3.0 kg ⁴

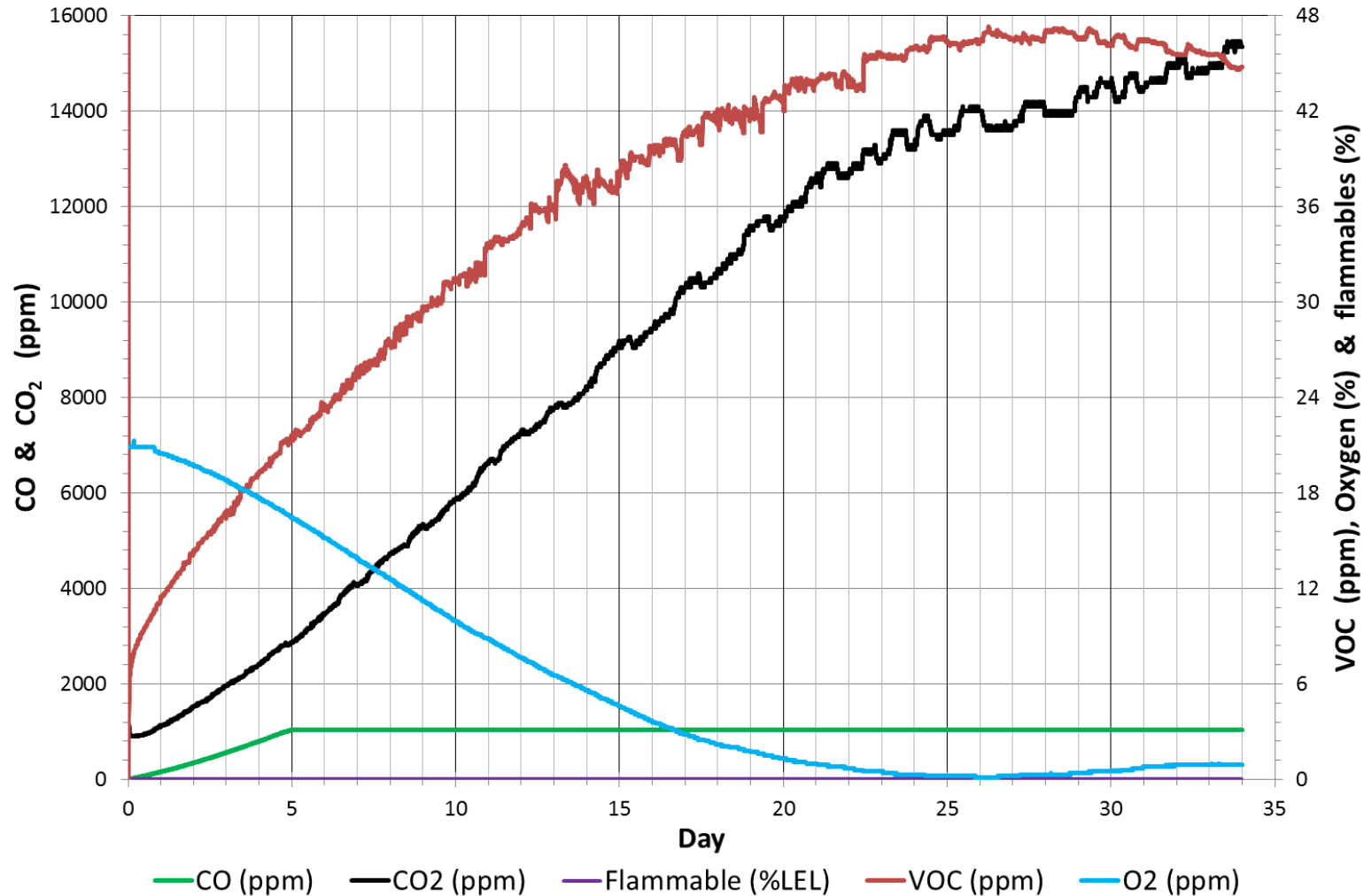
1 - Approximate mass

2 – Wood pellet Mean moisture content = 9.0%

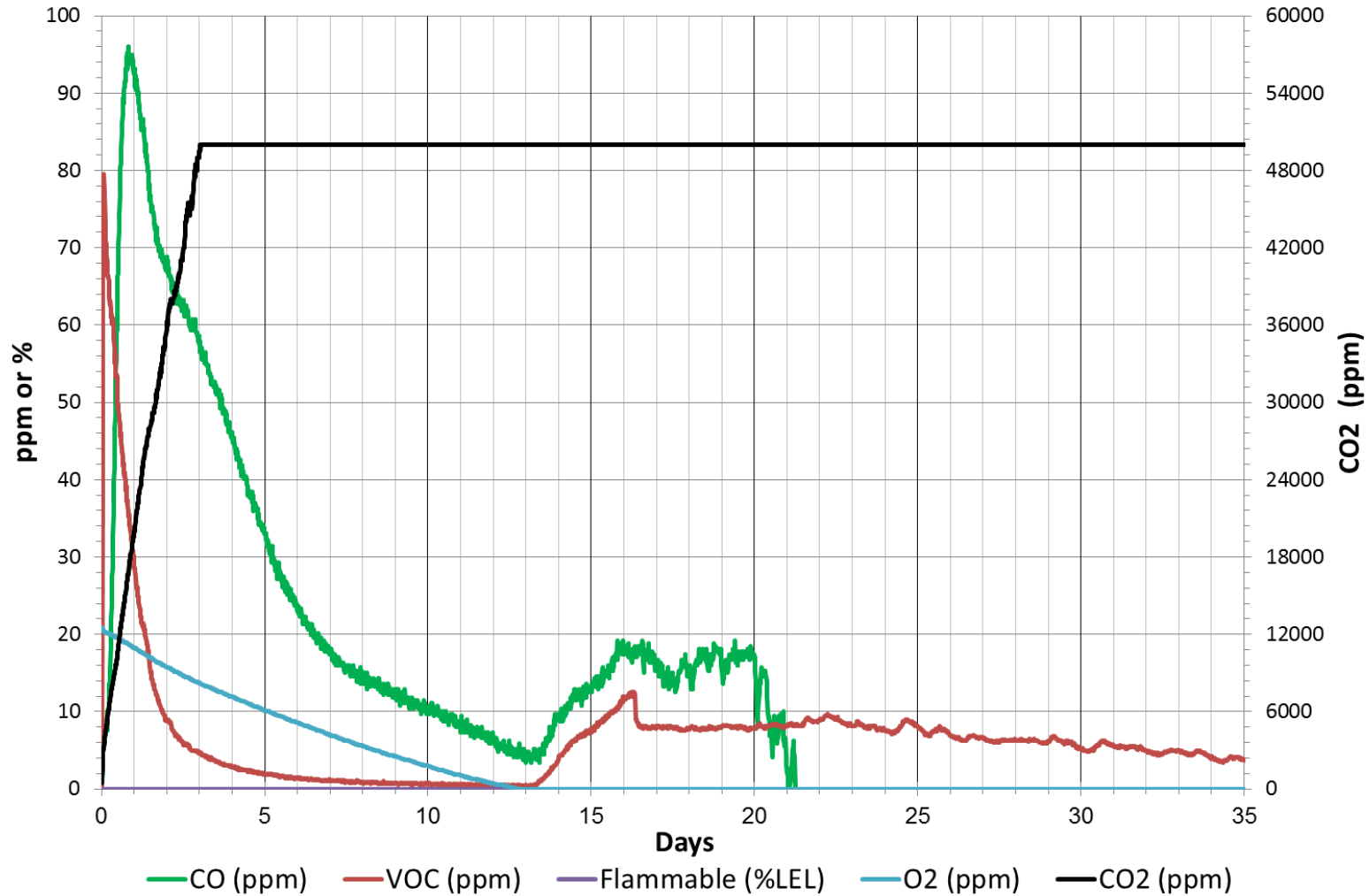
3 – Undried woodchip mean moisture content = 26.1%

4 – Dried woodchip mean moisture content = 12.6%

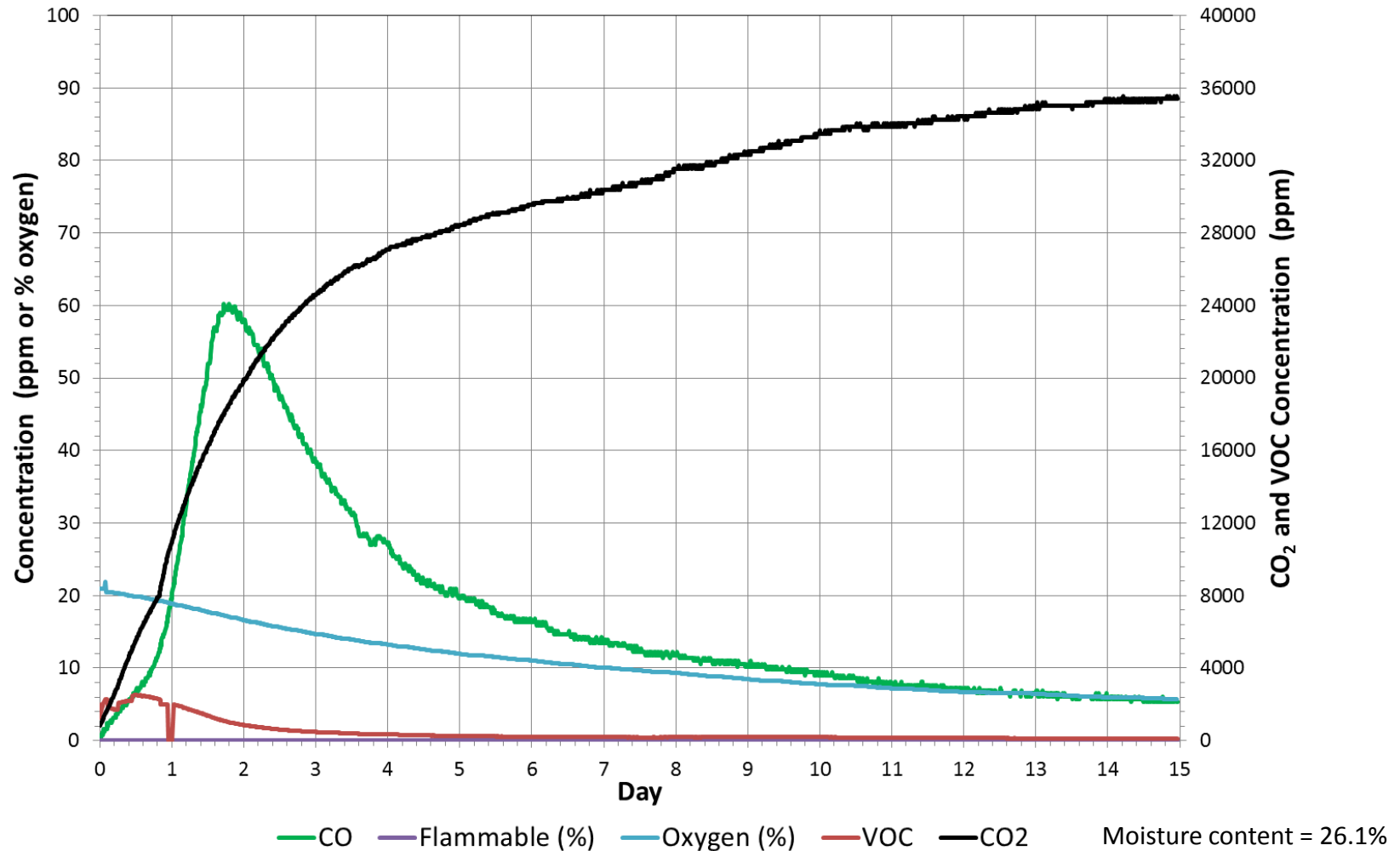
Gaseous emissions from wood pellets



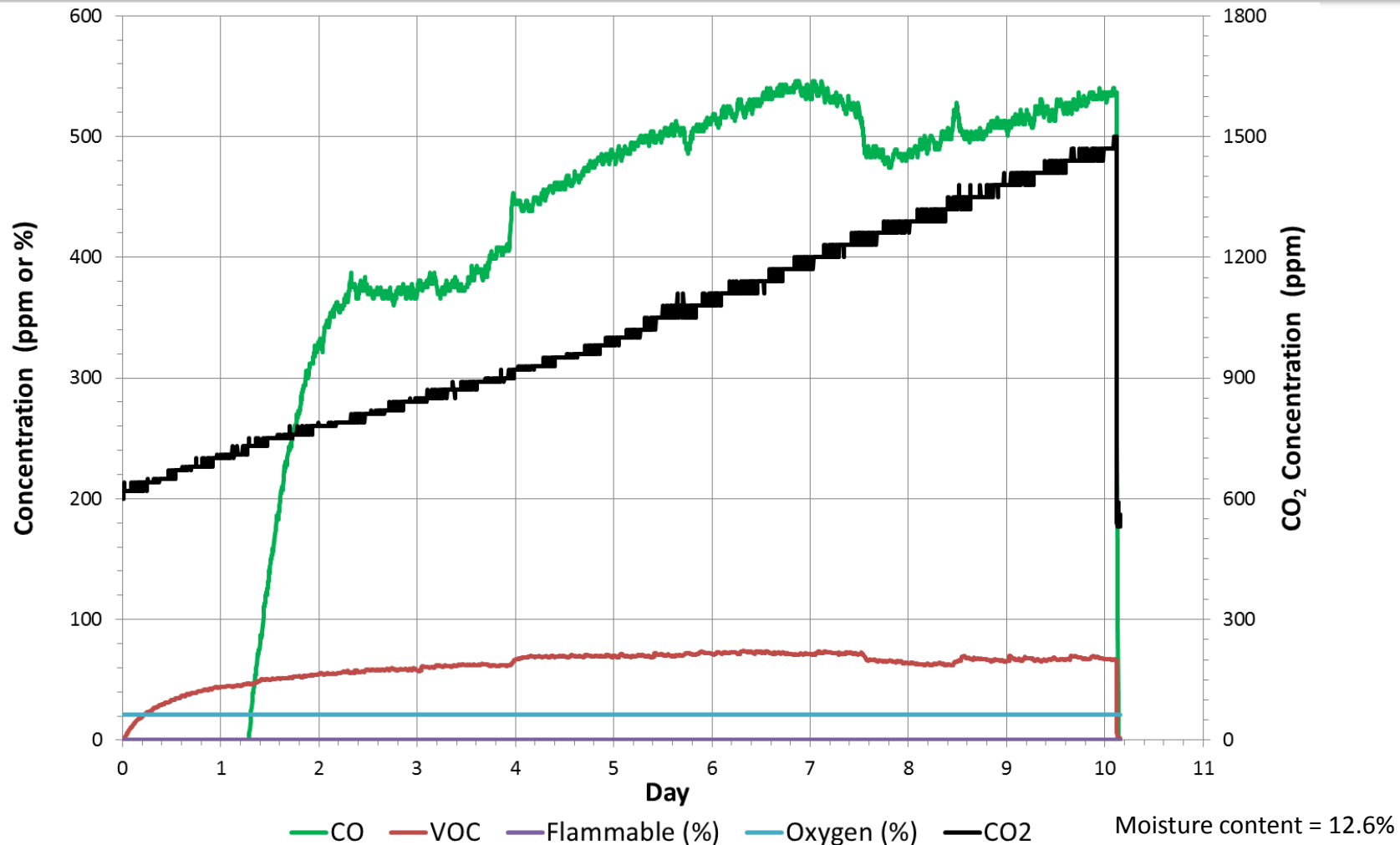
Gaseous emissions from woodchip - 1



Gaseous emissions from woodchip - 2



Gaseous emissions from dried woodchip



Gaseous emission factors

- Emissions factor = mass of gas emitted per kilogram of woodchip or pellet.
- Can be used to:
 - Compare different tests,
 - provide a first estimate of the minimum ventilation required to prevent significant build up of toxic gases.

Type	CO		CO ₂		O ₂ reduction	
	C _g (ppm)	f (mg.kg ⁻¹)	C _g (ppm)	f (mg.kg ⁻¹)	C _g (%)	f (mg.kg ⁻¹)
Wood pellets	>1042	>1.6	15,470	21.8	20.9	295
Woodchip - 1	≈96	≈0.6	>50,000	>319	20.8	1328
Woodchip - 2	60	1.1	35,570	650	5.7	1042
Woodchip - dried	543	11.4	1500	31.5	0.0	-

Conclusions

- Tests confirmed that these wood pellets were capable of producing large gaseous emissions of carbon monoxide and carbon dioxide, and depleting oxygen.
- The gaseous emissions from wood pellets were as expected and were similar to those found elsewhere – chemical decomposition.
- The gaseous emissions from woodchip were significantly different from those from wood pellets because the CO and VOC concentration quickly reached a maximum before falling to a relatively low level – biological decomposition.
- The amounts emitted and absorbed will likely vary with different types of woodchip or wood pellets and different storage conditions.

Acknowledgements

- This work was funded by the Health and Safety Executive (HSE). Opinions and conclusions expressed do not necessarily reflect HSE policy.
- HSL is grateful for the assistance of those companies who participated in this project and for the input received from HSE's Confined Spaces Network.
- The collection of samples were carried out by the field based staff of HSL.

Recommended controls

- Prevention of dangerous gas levels accumulating (including low oxygen) by ventilation.
- Recognition as a confined space, i.e. restricting access to authorised workers with the necessary training.
- Having a safe system of work, including supervision, air quality checks, etc.
- Giving consideration to areas where escaped gases may accumulate.