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Off-gassing of charred pellets during storage

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OFF-GASSING OF CHARRED PELLETS DURING STORAGE

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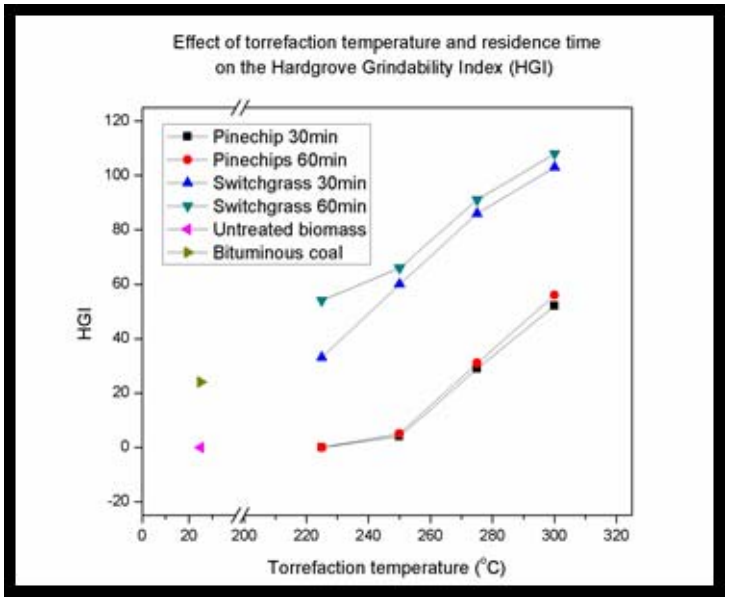
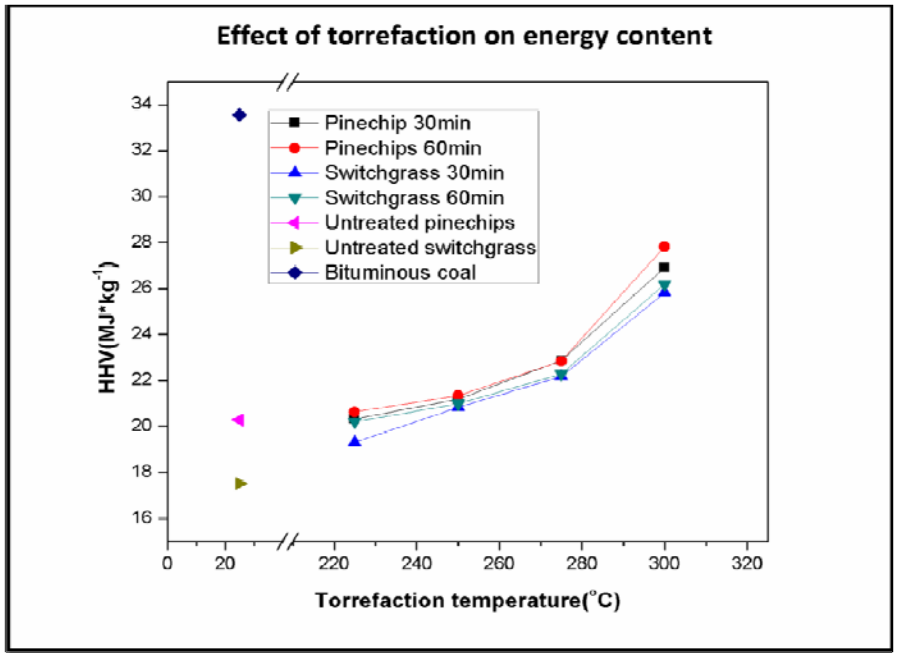
Torrefaction Technology

Slow thermal treatment of biomass at temperature ranges between 200-300°C in an inert atmosphere

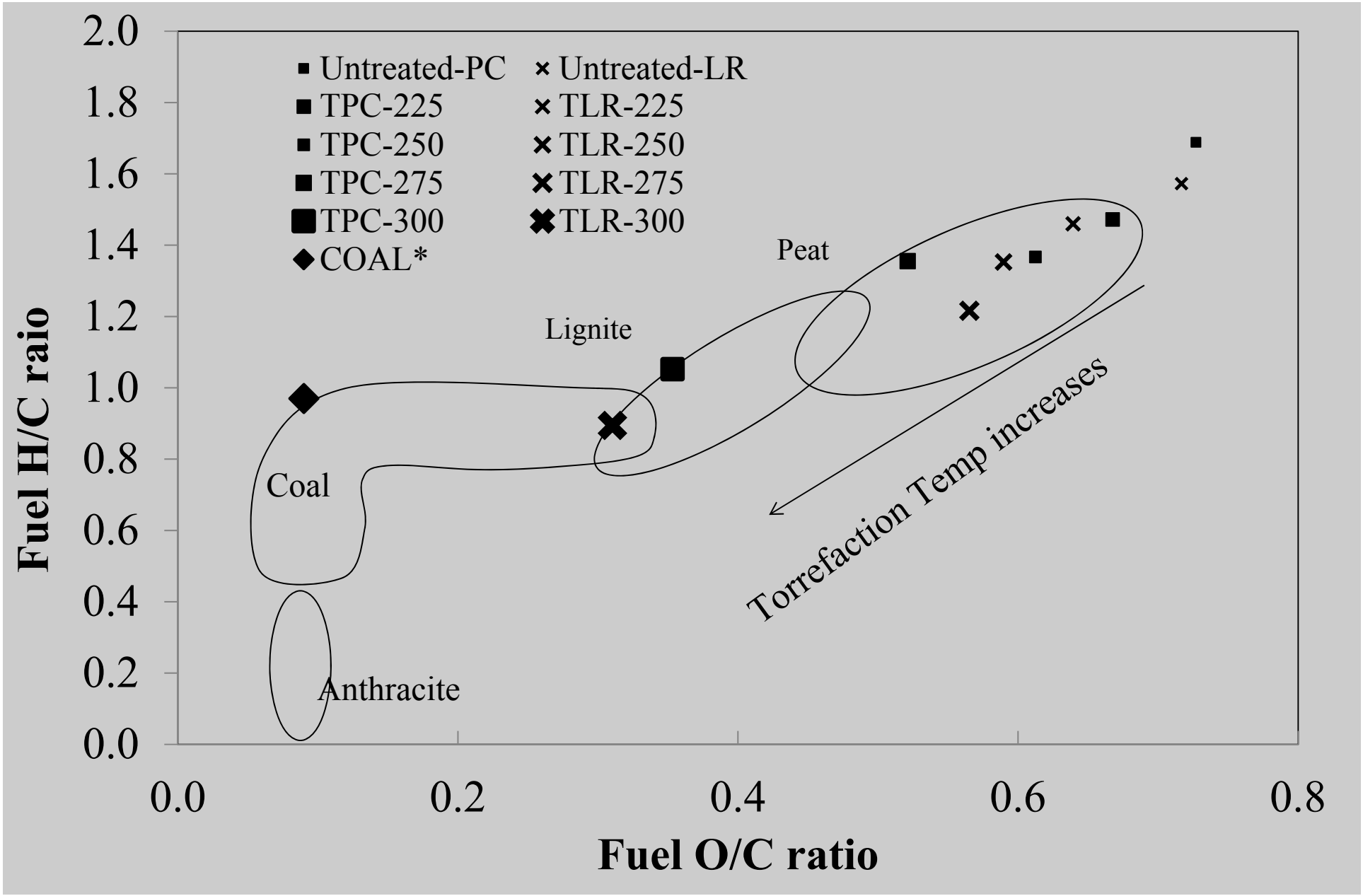
Torrefaction Process



Improved Grindability



Improved Energy Density


Untreated-PC
Untreated-LR
TPC-225
TLR-225
TPC-250
TLR-250
TPC-275
TLR-275
TPC-300
TLR-300
COAL*
Peat
Lignite
Coal
Anthracite
Torrefaction Temp increases
Fuel H/C raio
Fuel O/C ratio
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8

Co-firing with Coal

Torrefied Biomass

Coal + Biomass Mix

Raw Pine

Table A. 1 The threshold limit value of carbon monoxide, carbon dioxide, methane and oxygen [US. Department of Labor]

Chemical Substance	Threshold Level	
CO_2	5,000 ppm for 8 hours	Maximum exposure allowed by OSHA in the workplace over an eight hour period
	30,000 ppm and above (short exposure)	headache, loss of judgment, dizziness, drowsiness, and rapid breathing
CO	25 ppm for 8 hours	Maximum exposure allowed by OSHA in the workplace over an eight hour period
	200 ppm for 2-3 hours	Mild headache, fatigue, nausea and dizziness
	400 ppm for 1-2 hours	Serious headache- other symptoms intensify. Life threatening after 3 hours
	800 ppm for 45 minutes	Dizziness, nausea and convulsions. Unconscious within 2 hours. Death within 2-3 hours
	1600 ppm for 20 minutes	Headache, dizziness and nausea. Death within 1 hour
	3200 ppm for 5-10 minutes	Headache, dizziness and nausea. Death within 1 hour
	6400 ppm for 1-2 minutes	Headache, dizziness and nausea. Death within 25-30 minutes
	12800 ppm for 1 minutes	Death
CH_4	500,000 ppm- 8hours	Could asphyxiate by displacing oxygen this concentration. The main danger with CH_4 is explosions. CH_4 is one of the main constitutes of natural gas. Being lighter than air, it tends to be removed through ventilation as the gas is being produced.
O_2	17%	Breathing is faster and deeper; impaired judgment may result
	16%	The first signs of anoxia appear
	< 6%	Convulsive movements and gasping respiration occurs; respiration stops and soon after the heart also stops

Summary

- The off-gassing tests for six types of charred pellets: canola straw, willow, bagasse, wheat straw, switchgrass and miscanthus, were conducted at room temperature 25±2 °C in sealed storage containers.
- Pairs of 2-litre sealable glass containers were filled with 800 g of each sample to approximately 75% of the container volume.
- One container contained charred pellets. The other container contained uncharred (untreated pellets).
- The two glass containers were sampled in alternate weeks for CO_2, CO, O_2, and CH_4.

Summary and conclusions

- The results indicate that after 2 months of storage the level of CO_2 generation was higher than CO_2 generated from untreated pellets but CO levels were lower.
- No trace of CH_4 was detected measured though the depletion of O_2 was comparable to untreated pellets.
- The oxygen concentrations in the charred pellets were ranked from the lowest to highest as follows: switchgrass, willow, bagasse, wheat straw, canola straw, miscanthus.
- The overall conclusion was that off-gassing from charred pellets from the tested biomass crops were as dangerous as from untreated pellets.

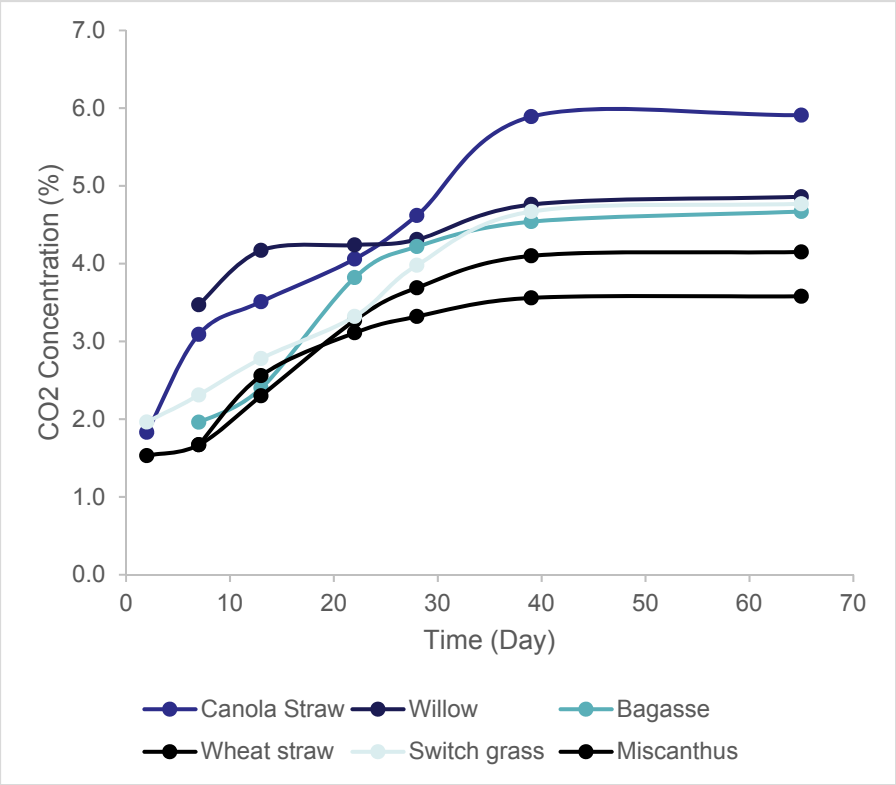


Figure 1. Concentration of CO_2 for emissions from torrefied pellets stored at room temperature in a sealed jar.

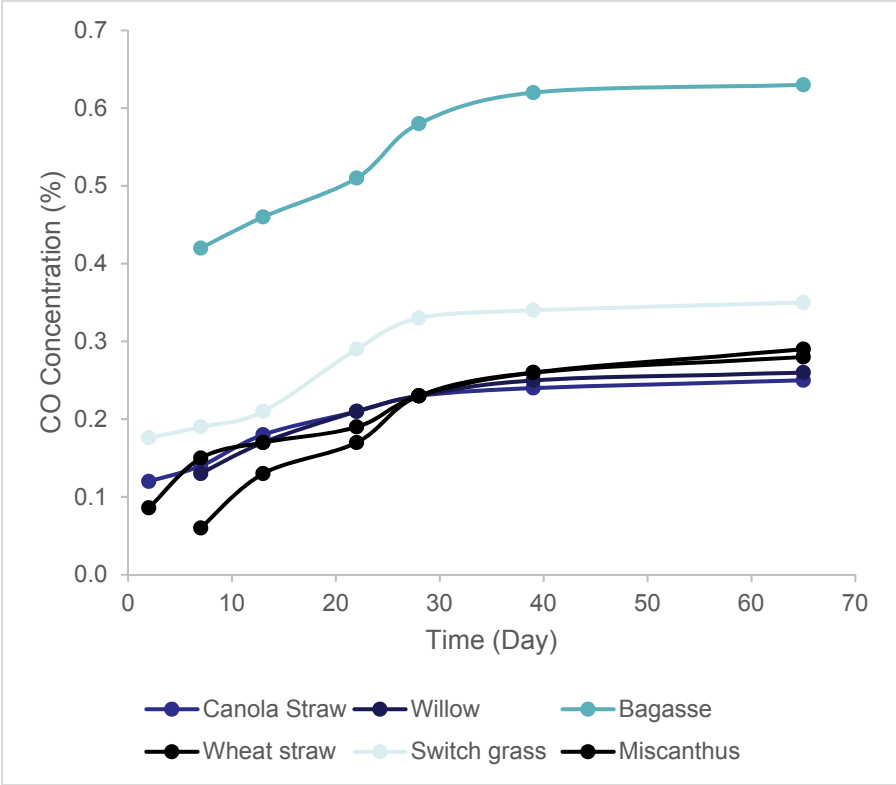


Figure 2. Concentration of CO for emissions from torrefied pellets stored at room temperature in a sealed jar.

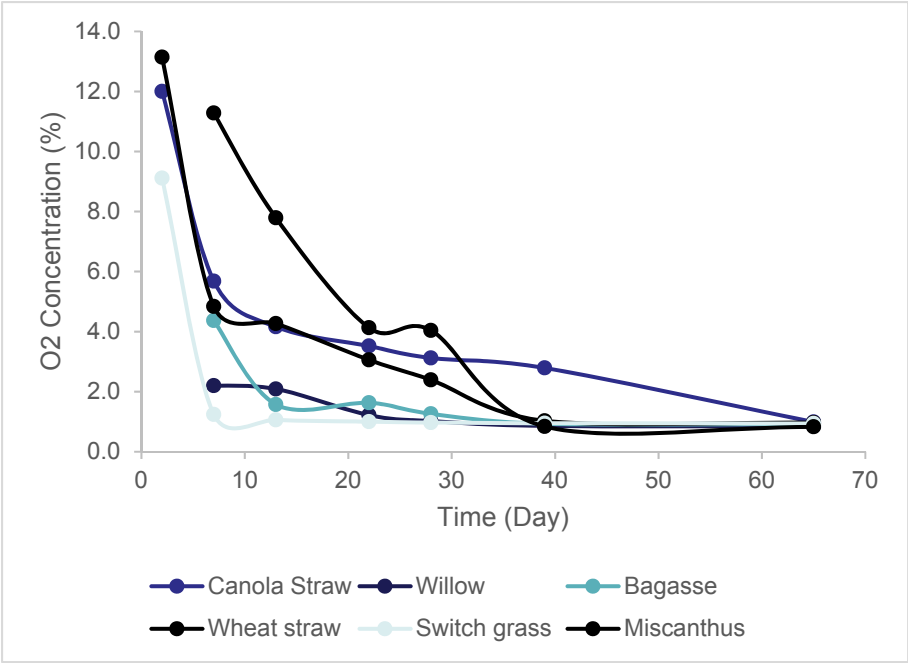


Figure 3. Oxygen depletion for torrefied pellets torrefied pellets stored at room temperature in a sealed jar.

The H_2 concentration for the 6 torrefied pellets reached 0.2-0.4%. The emissions of CH_4 were negligible,
Methane emission is due to the activities of anaerobic microorganisms.

Conclusions

- From a previous UBC research, the maximum concentrations of CO_2 and CO of pine wood pellets at room temperature were 0.9-1.5% and 1.2-1.3%.
- By comparison, the maximum emission concentrations of CO_2 of torrefied pellets were notably more than pine wood pellets, while concentrations of CO were significantly lower.
- The accumulated CO concentration of 0.3-0.6% or 3000-6000 ppm was still well above the threshold limit value (TLV) of 0.0025% or 25 ppm for human health, and it can cause severe headache, nausea and vomiting, confusion and collapse, according to U.S. Department of Labor.
- it will be imperative to prohibit personnel to enter any confined storage space with torrefied pellets without proper personal protective equipment (PPE) due to a combination of low oxygen level and high concentration of CO
- The most dangerous aspect is the extreme depletion of oxygen which spontaneously causes hypo-ventilation for a person entering such space which in turn results in inhalation of large amounts of CO

Production of “high quality torrefied wood pellets” with minimum energy consumption

Is it better to do torrefaction before or after pelletisation?

Low quality wood residue

Regular pellets

Torrefied pellets