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Assessment of Combustion and Gasification Behaviour in Pilot Scale for Addidivated Biomass

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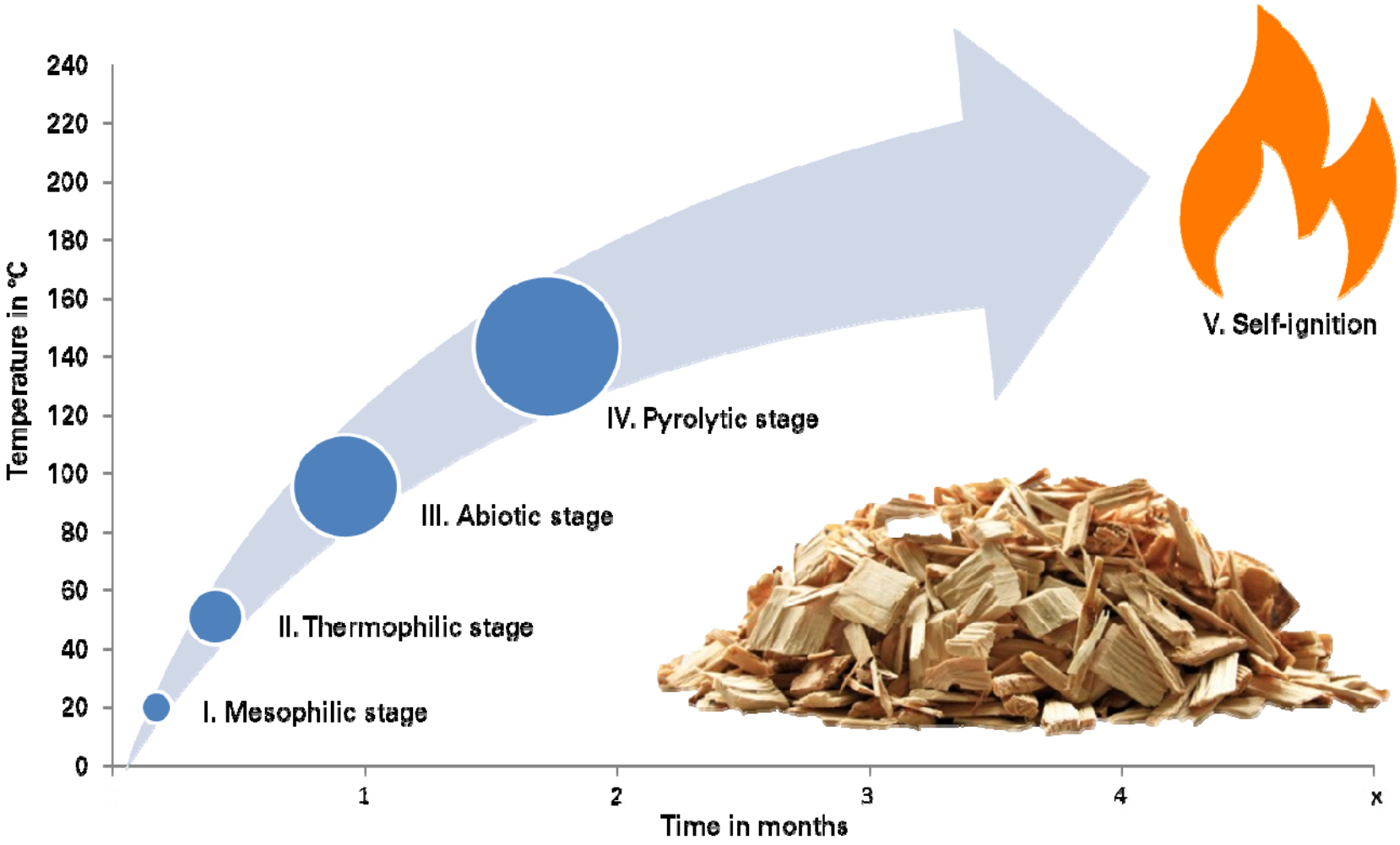
Difficulties during biomass storage

THE CHALLENGE
microbial degradation of wood chips
annually loss amounting 10-40 % dry matter
self-ignition of wood chip piles

Difficulties during biomass storage



How do overall conditions affect wood degradation?

	high storage stability	low storage stability
		
particel size	coarse	fine
moisture content	< 30 %	> 30 %
green parts	low	high
fine material content	low	high
impurities	low	high

How can we inhibit wood degrading microorganism?

- moisture content
- nutrients
- pH

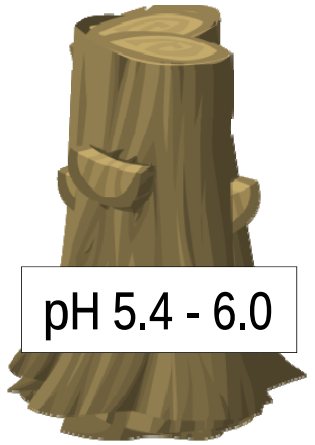
Inhibition by pH adjustment

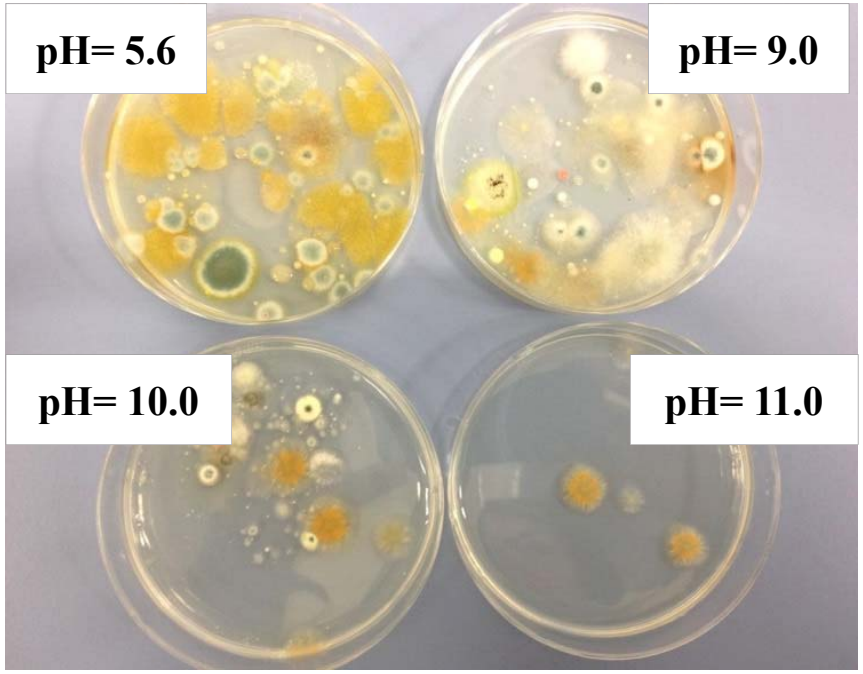
Colony forming units of fungi at pH values of

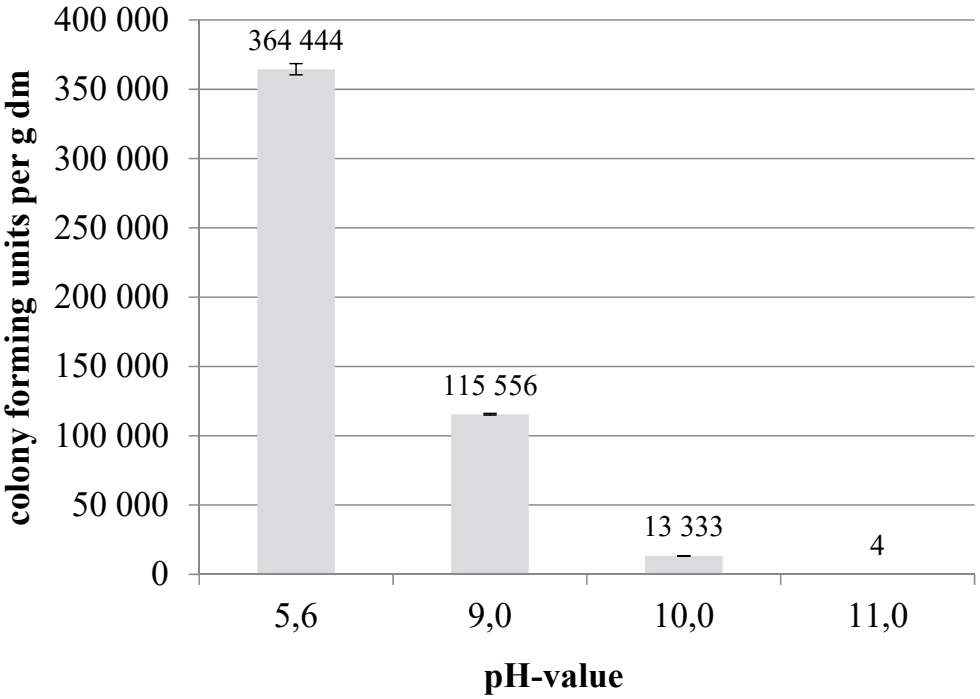
- 5.6
- 9.0
- 10.0
- 11.0

DG18-Agar

Incubation for 7 days







Which additives are suitable?

Must-haves:

- increasing wood-pH to > 9.0
- cheap
- easy handling

Nice-to-haves:

- optimizing ash melting behaviour
- decreasing gaseous emissions during combustion such as chloride and SOx-emissions

Additives:

- dolomite $CaMg(CO_3)_2$
- calcite $CaCO_3$
- slaked lime $Ca(OH)_2$
- kaolin $Al_2Si_2O_5(OH)_4$
- natrium-carbonate Na_2CO_3

pH of poplar woodchips
additive concentrations regarding the dry matter

	$CaMg(CO_3)_2$	$CaCO_3$	$Ca(OH)_2$
Ref	6.5	6.5	6.5
1 %	6.7	8.3	11.1
2 %	7.3	8.5	11.6
4 %	7.9	8.6	12.1

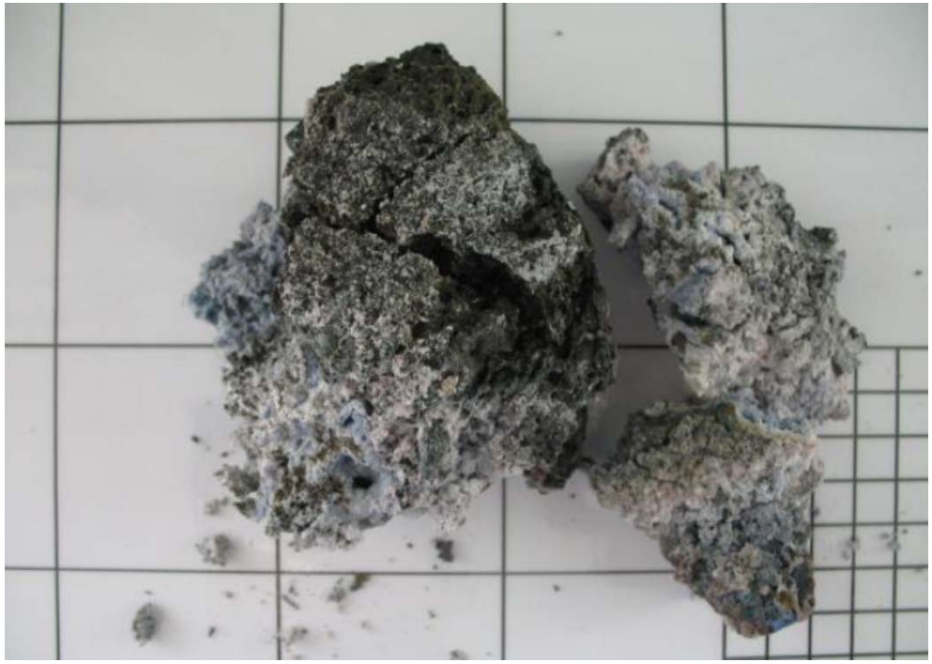
Storage tests with addidivated biomass

Respiratory tests in laboratory

Storage tests at combustion site

Ash melting challenge

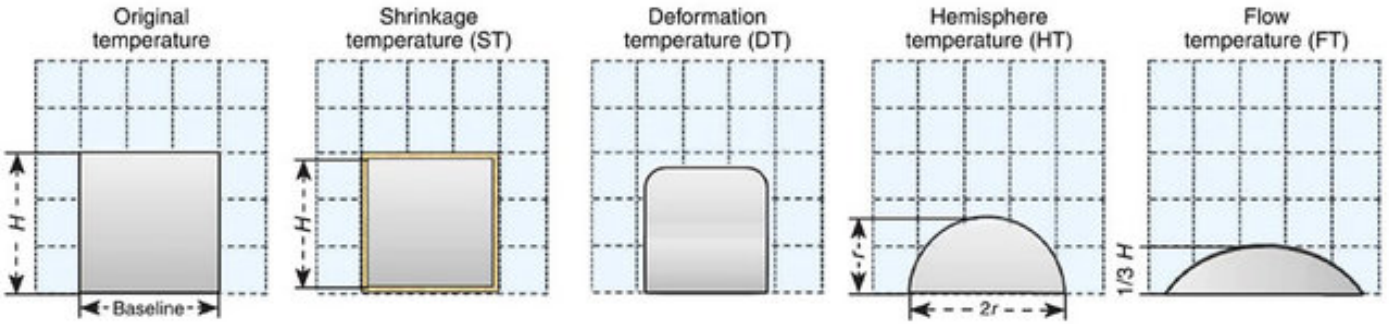
Biomass ash agglomerates

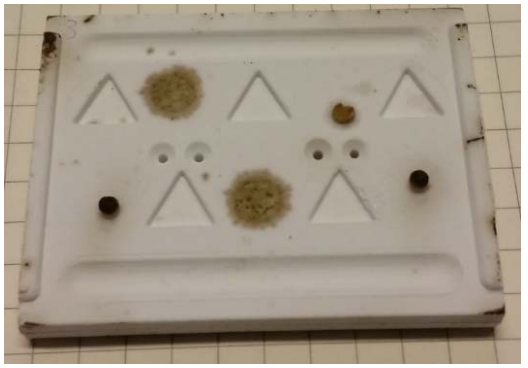


Heat exchanger fouling

Source: Sulzbacher, L., 2015, PhD Thesis, University of Natural Resources and Life Sciences, Vienna.

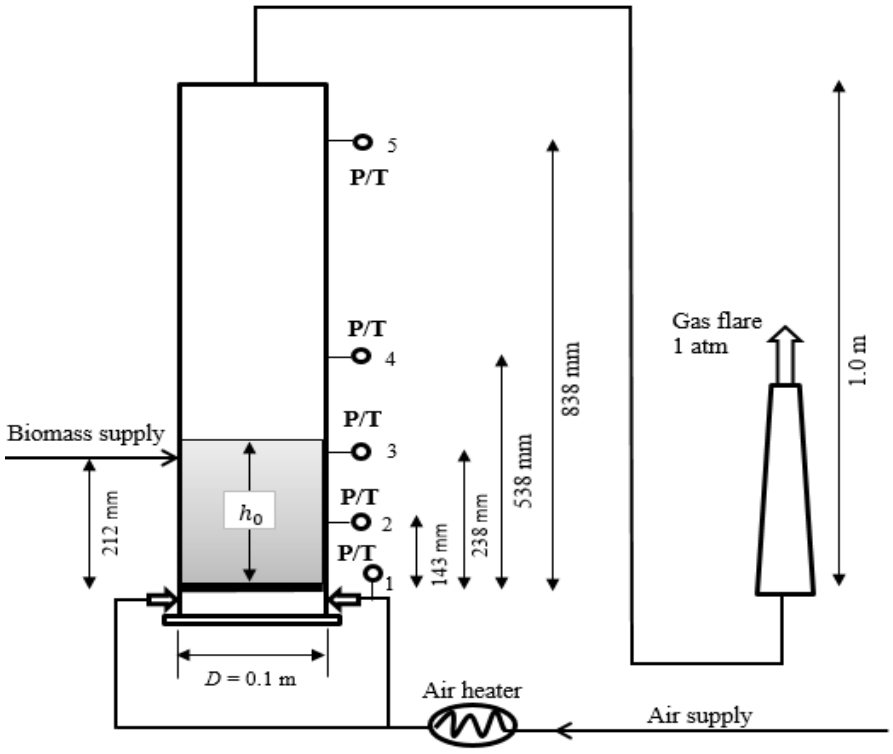
Renewable energy consumption in major markets

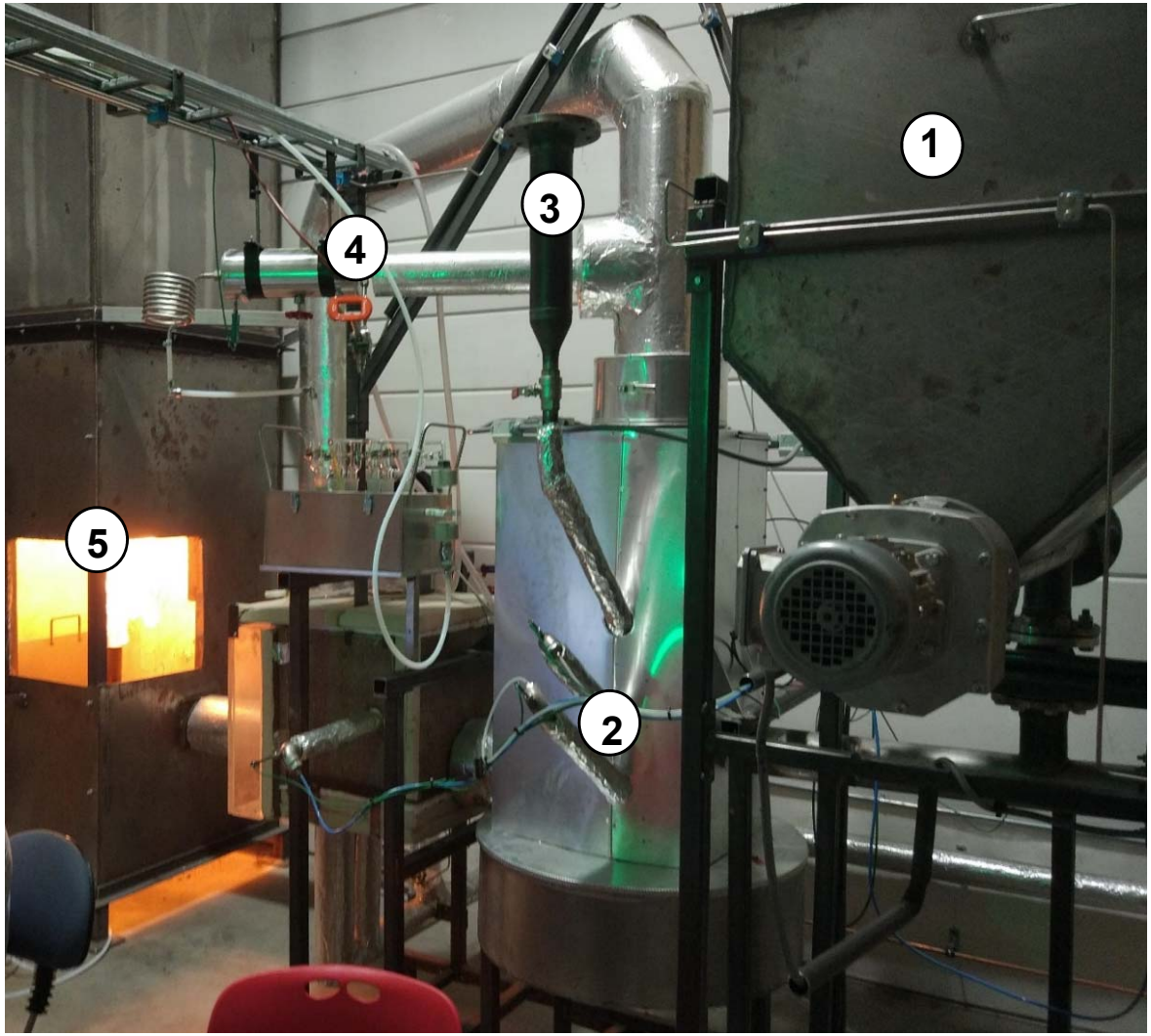




$CaCO_3$	Heartwood		Bark		Needles		Mixed	
wt%	DT	HT	DT	HT	DT	HT	DT	HT
	°C	°C	°C	°C	°C	°C	°C	°C
0	1079	1460	1210	1420	1184	1490	1120	>1500
1	1142	1429	1236	1462	1262	>1500	1155	>1500
2	1084	1445	1276	>1500	1147	>1500	1072	>1500
4	1140	1450	1171	>1500	1218	>1500	1144	1467

Schematic illustration of 20kW BFB pilot plant





Materials

Bed material – silica sand		
Mean particle size	µm	615
Density	kg/m³	2650

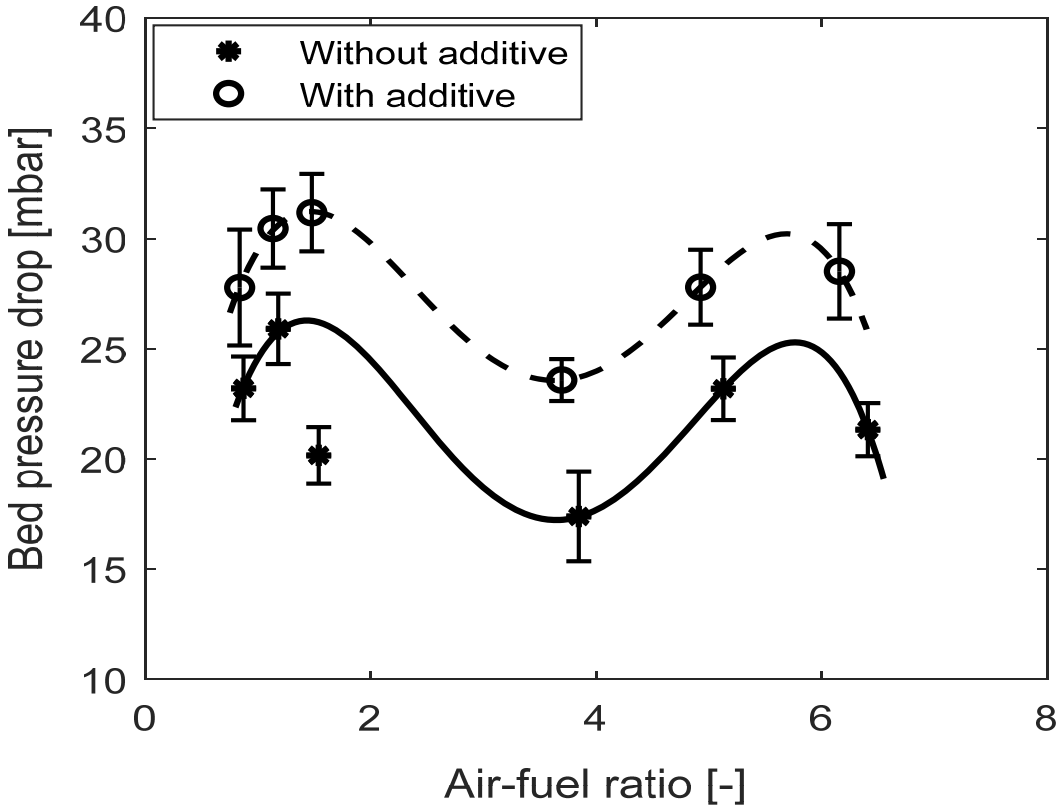
Feedstock - spruce			
Water content	wt%	15	
Particle size	mm	20-50	
Biomass flow rate	kg/h	2.0	
Additive $Ca(OH)_2$	wt%	0	4
HHV	MJ/kg	20.05	18.72
Ash content	wt%	0.64	4.45

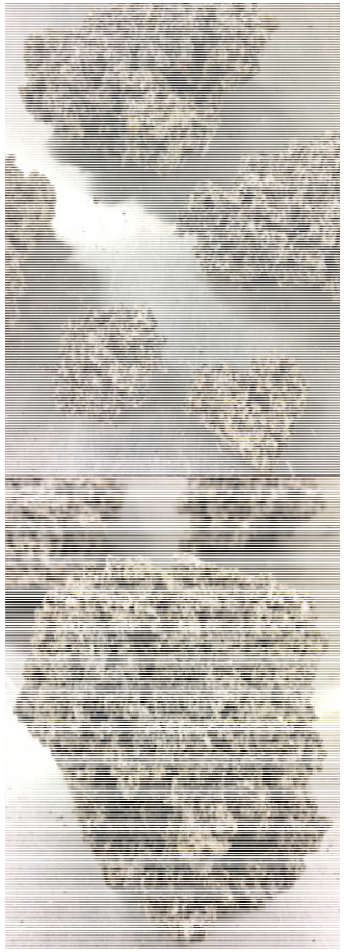
Experimental set up

Experimental set up		
Bed height	cm	22
Biomass flow rate	kg/h	2.0
Air flow rate	kg/h	1.7-12.5

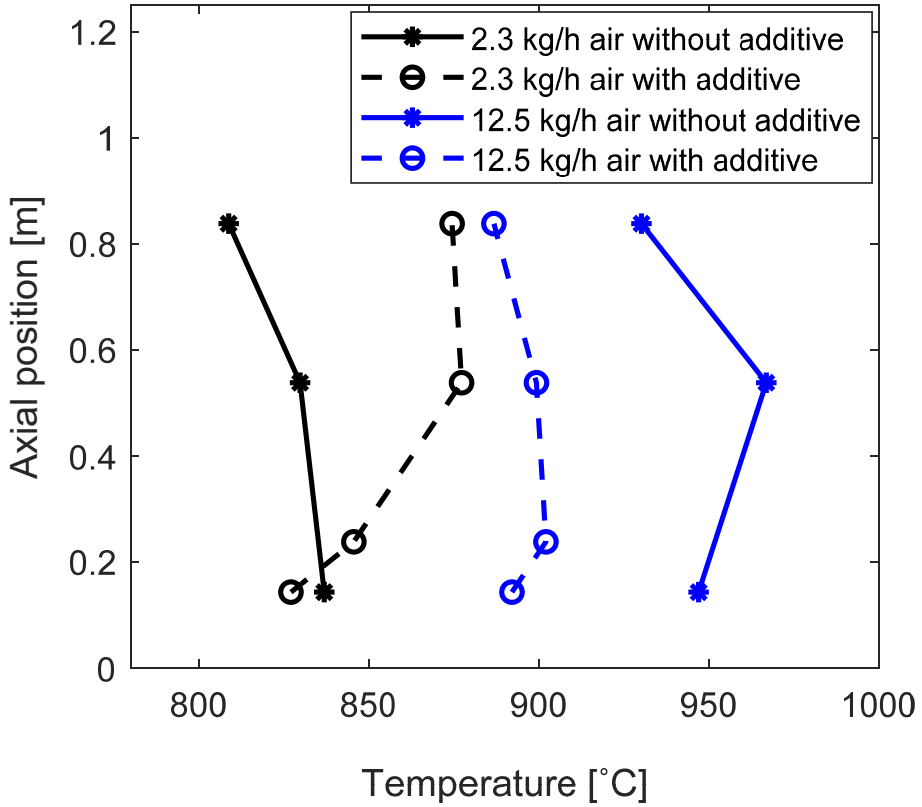
Air flowrate (kg/h)	ER (-)
1.7	0.22
2.3	0.30
3.0	0.39
7.5	0.96
10.0	1.28
12.5	1.60

Pressure drop across the bed

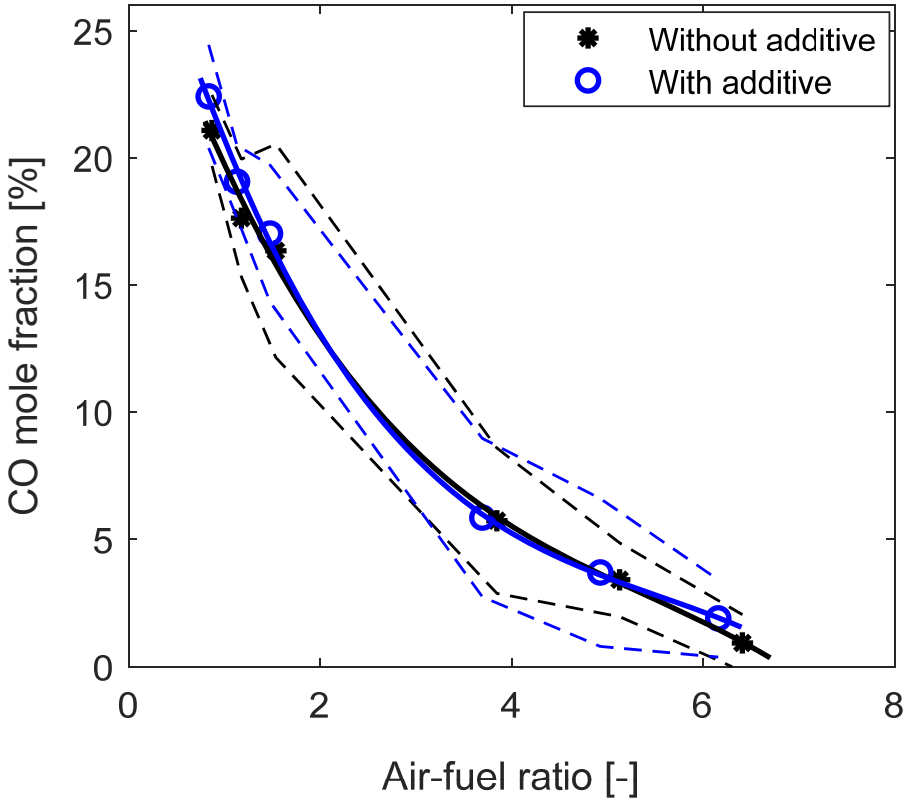


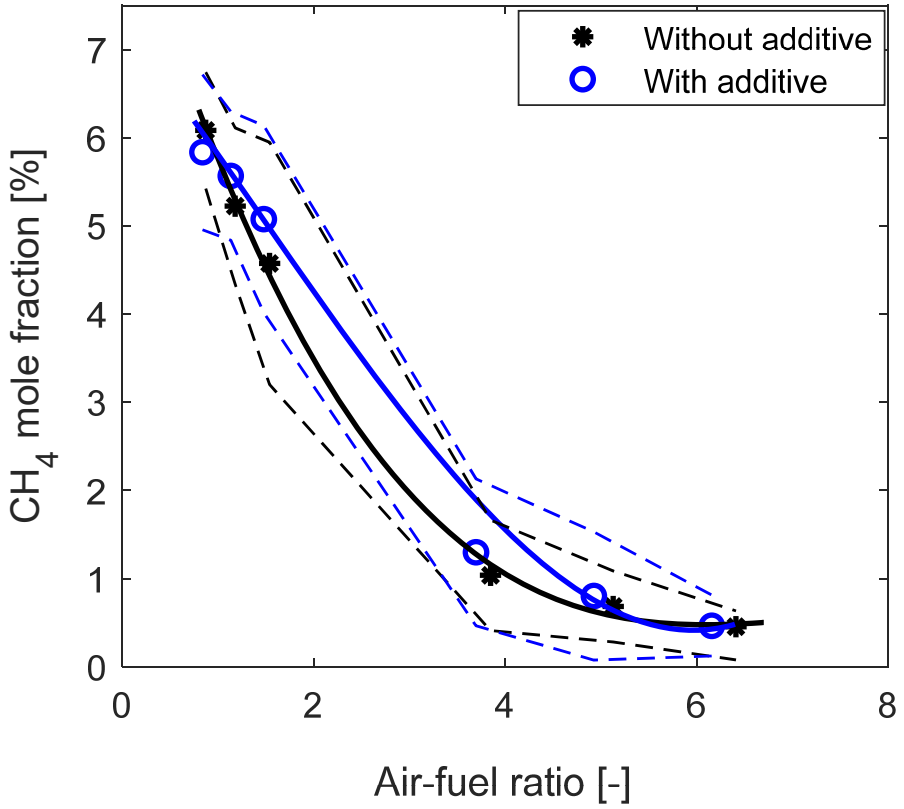


Axial temperature distribution

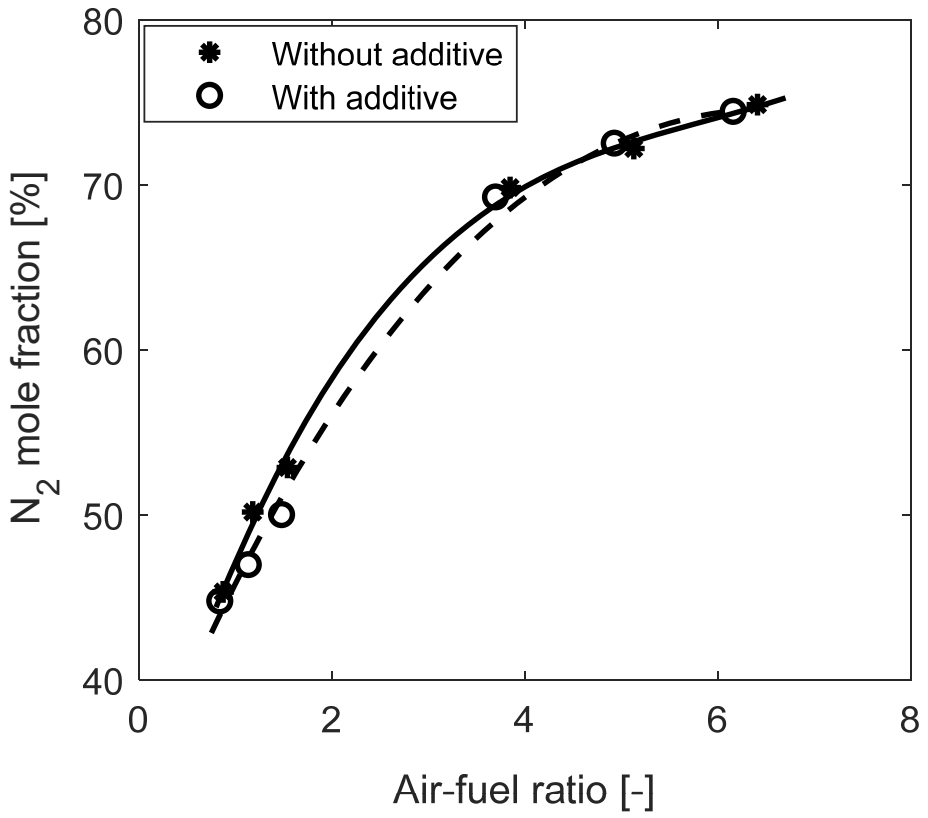


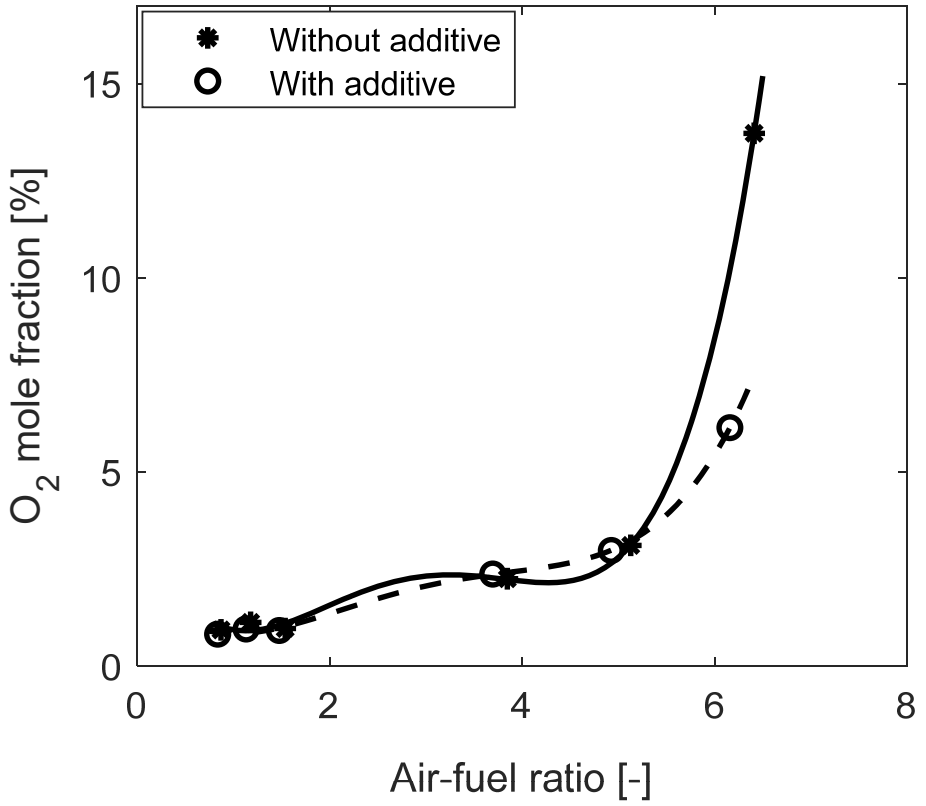
Mole fraction of carbon monoxide and methane





Mole fraction of carbon nitrogen and oxygen





Summary and conclusions

- Additives created agglomerations
- Gasification reactions slightly enhanced (CaO)
- Combustion limited with additives
- Further tests needed with stored biomass

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