UNIVERSITY OF LEEDS

Hydrogen Production From Waste Catalytic Gasification

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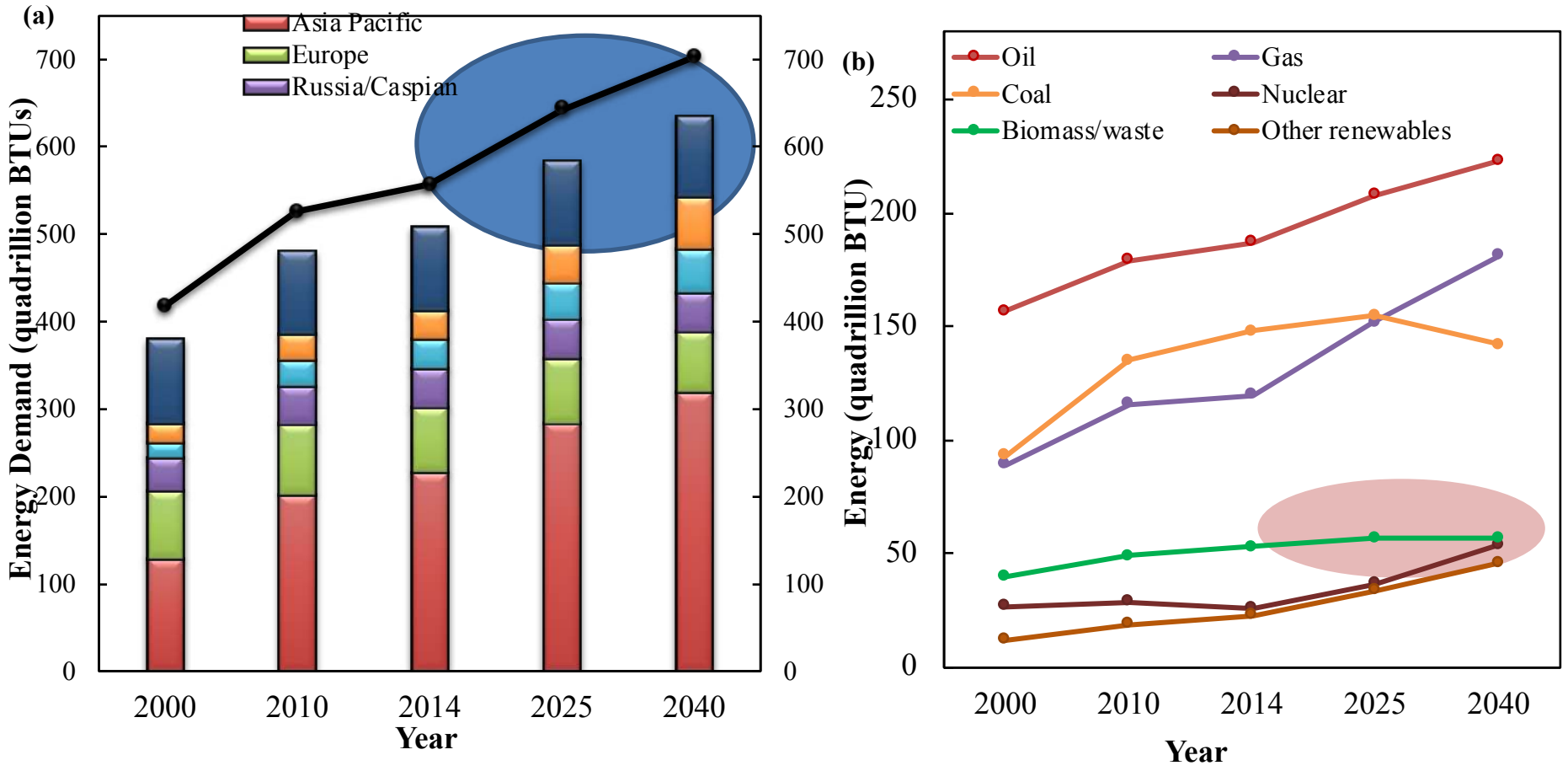
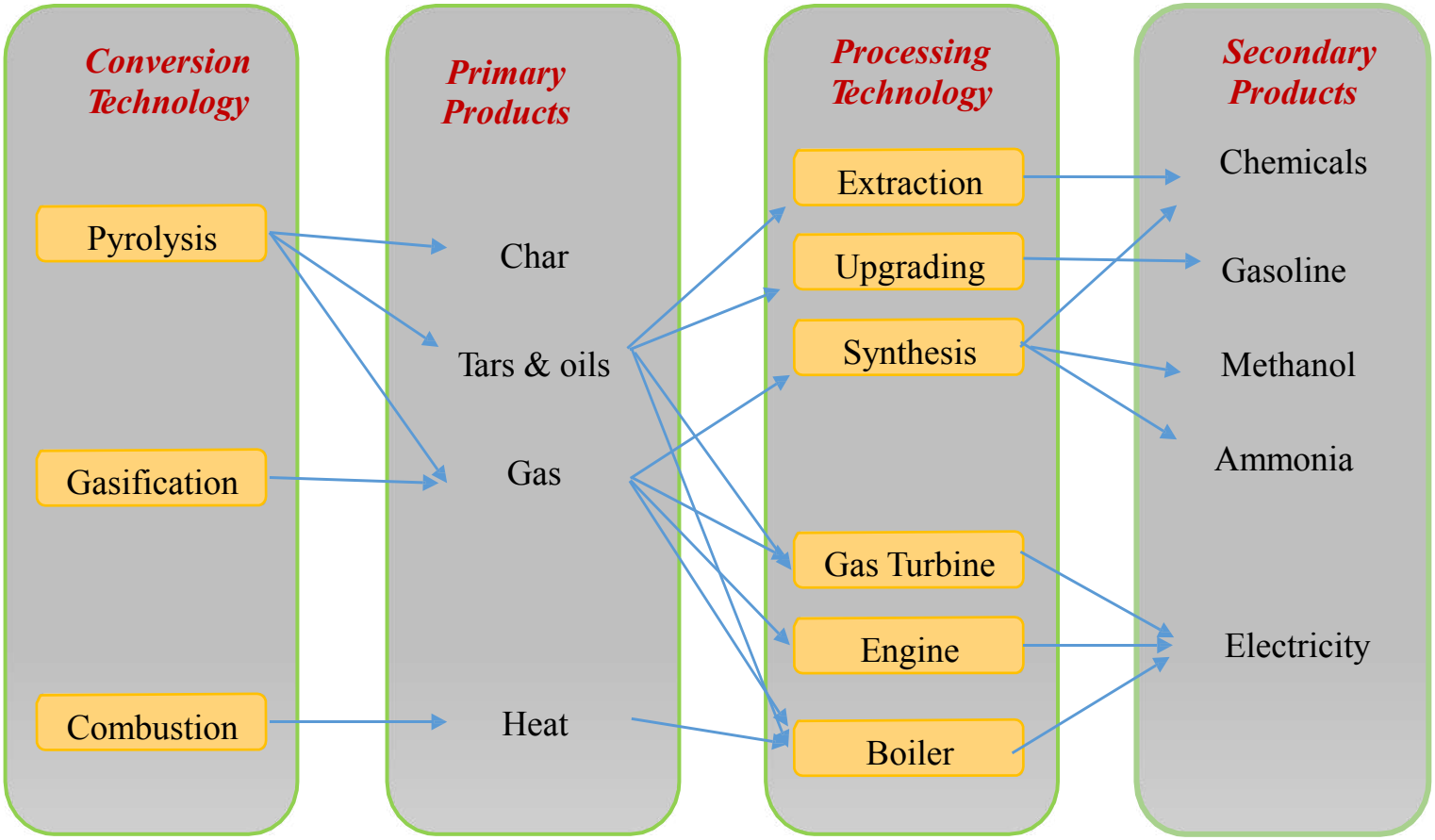
World Energy Consumption

- Energy consumption is expected to increase worldwide as a result of growths in population and industrialization.

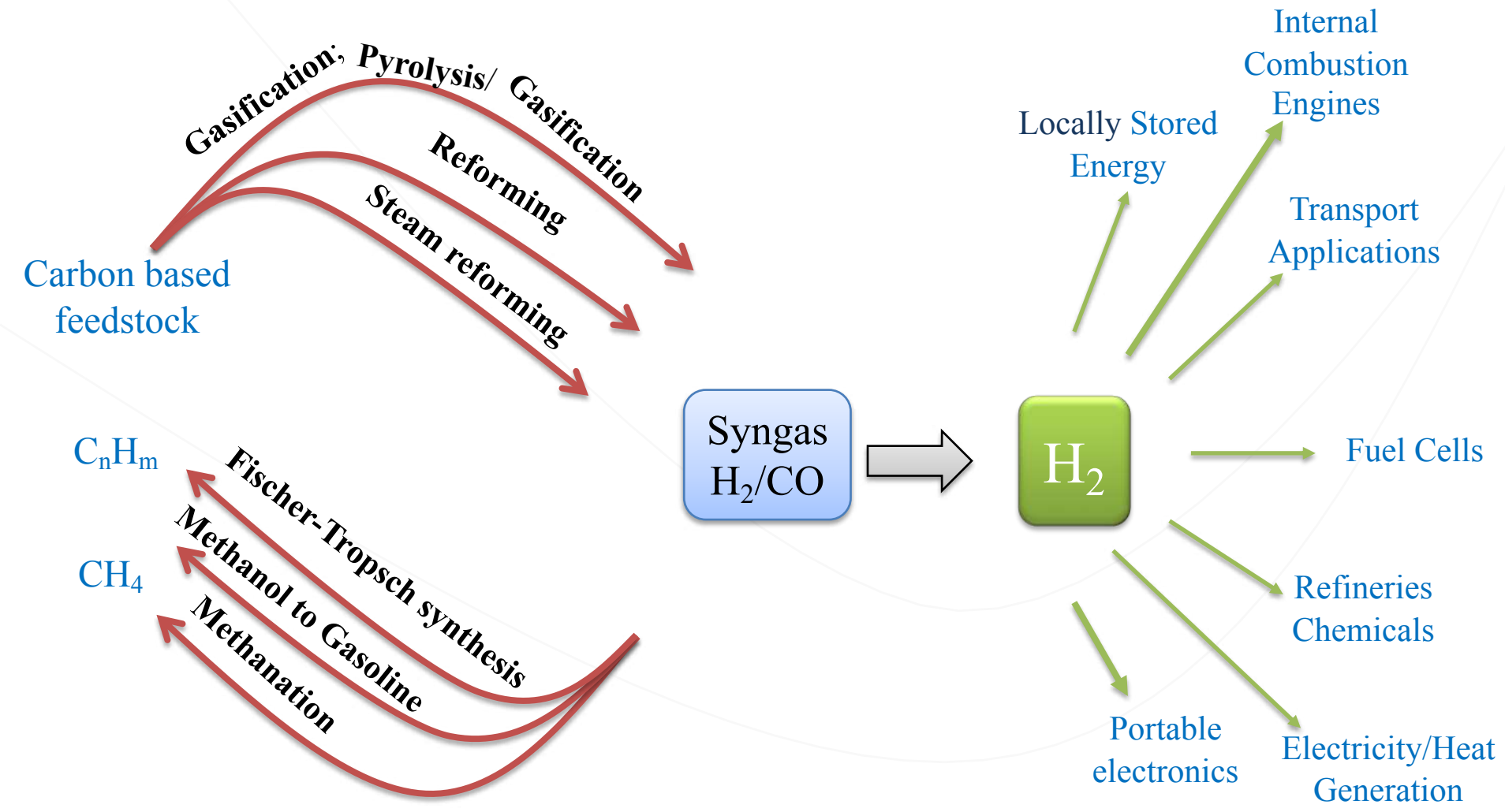


Energy Recovery from Waste/Thermochemical Conversion of Waste to Fuels, Chemicals & Materials

- Waste could have an important role in both meeting the rising demand for energy and in mitigating the environmental pollution caused by waste management practices such as landfills.



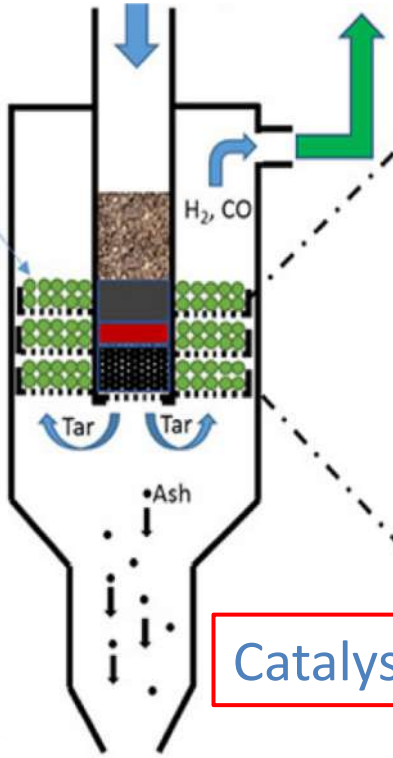
Syngas & Hydrogen; potential applications



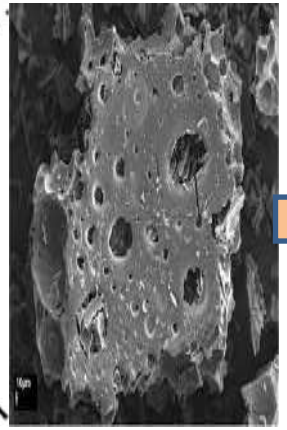
Research Goal

Syngas (H_2, CO)

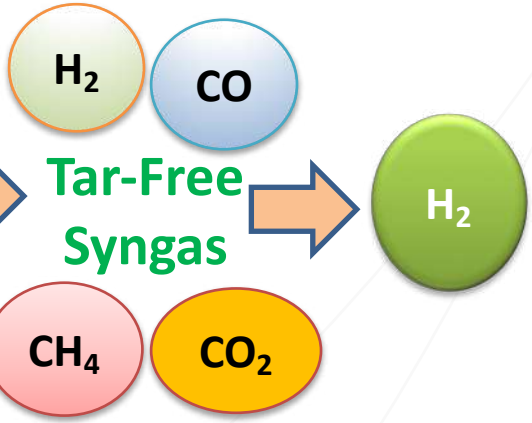
Waste



Gasification



Catalyst for tar reforming



Experimental setup

EFFECT OF BED TYPE

Tar cracking in the Absence of steam

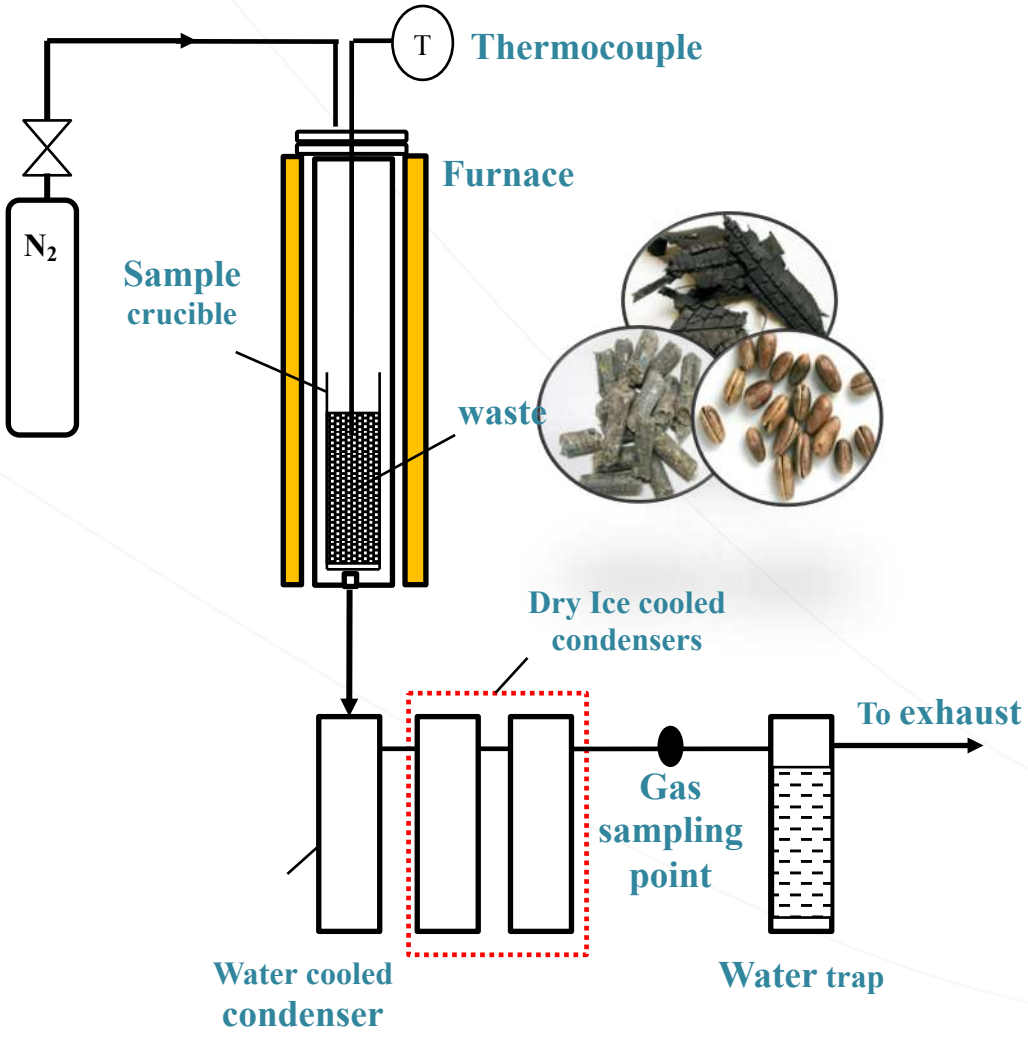
- Sand
- Tyre char
- RDF (MSW) char
- Date stones char

EFFECT OF CHAR ASH/with steam

Hydrogen-rich syngas production & tar reforming

- Tyre char
- Acid treated tyre char

Char production



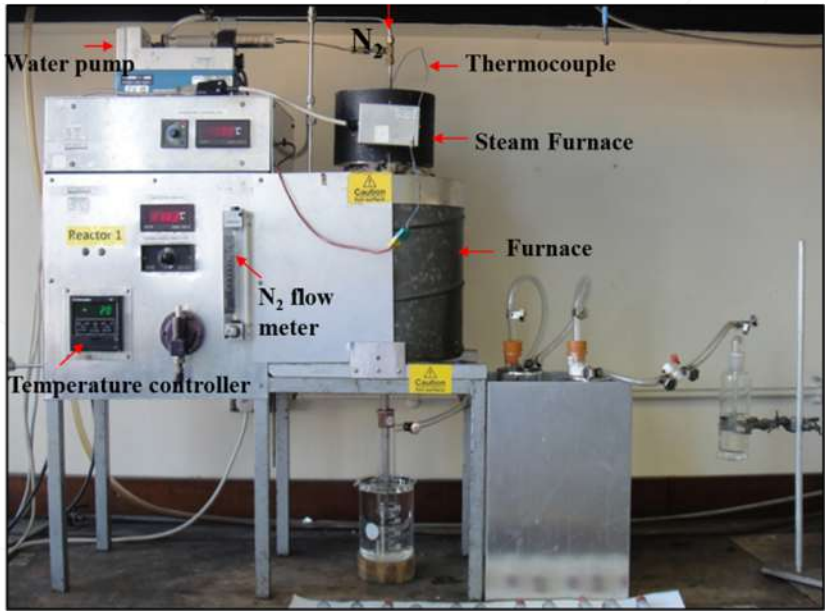
Conditions:

√ Char: Waste Tyres, RDF, Date stones.

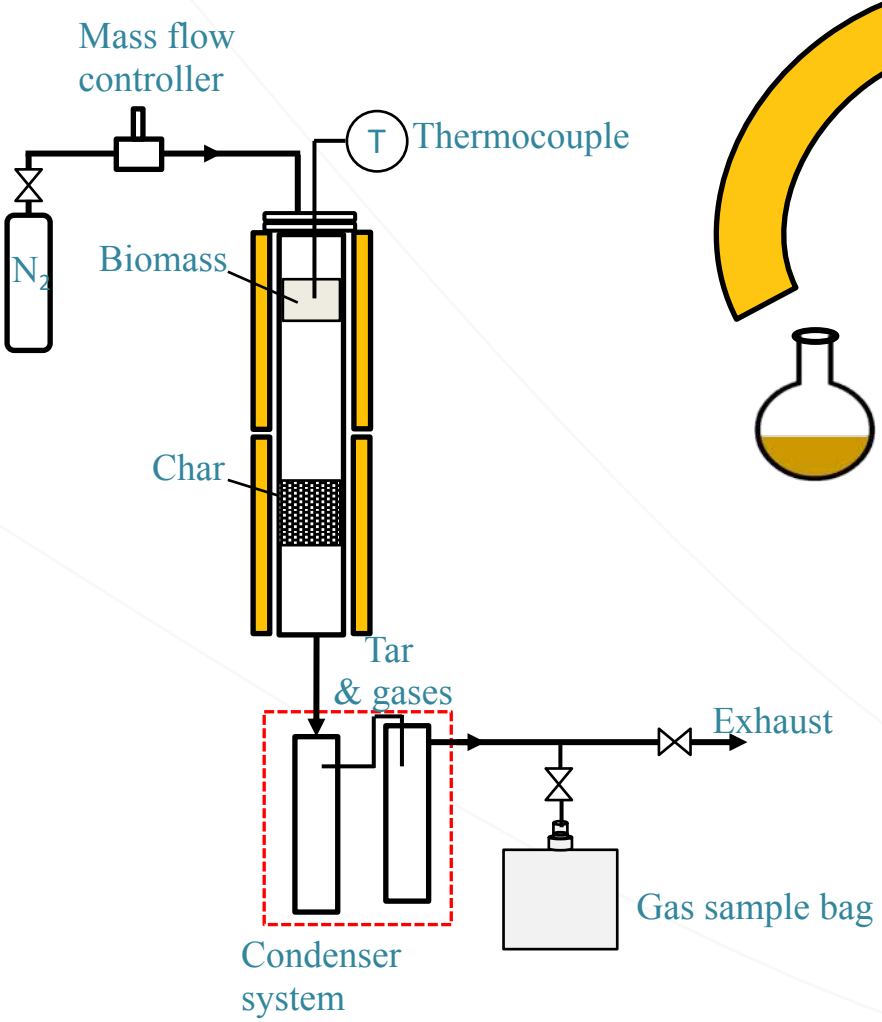
√ Pyrolysis temperature: 800°C.

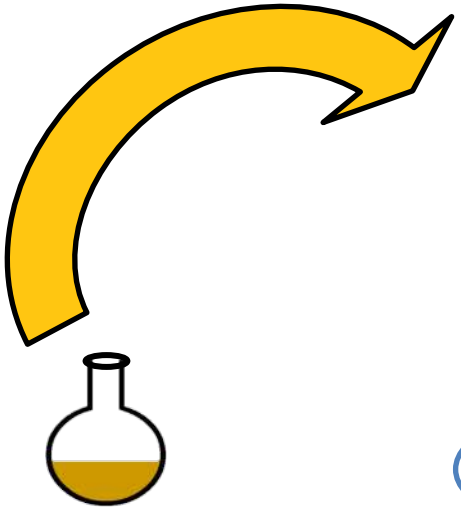
√ Carrier gas: N_2

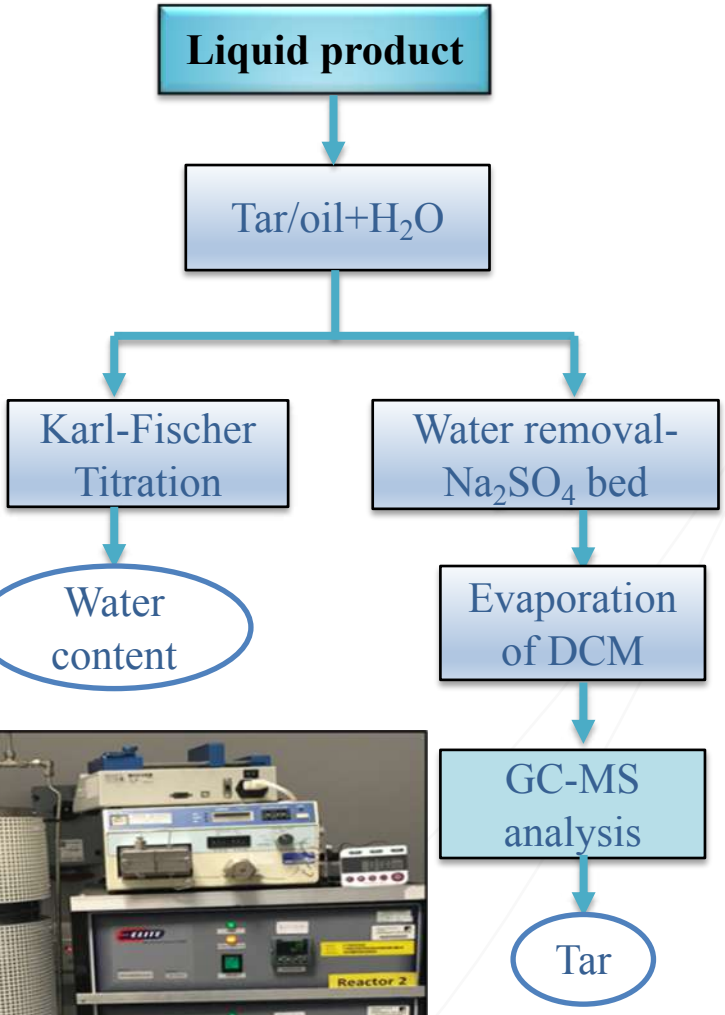
(Also de-mineralised pyrolysis tyre char was investigated)

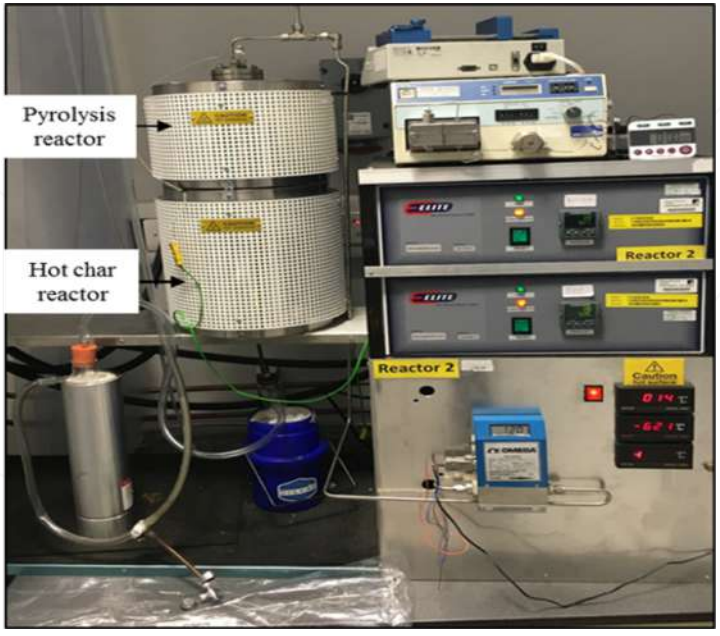


Experimental setup-Gasification







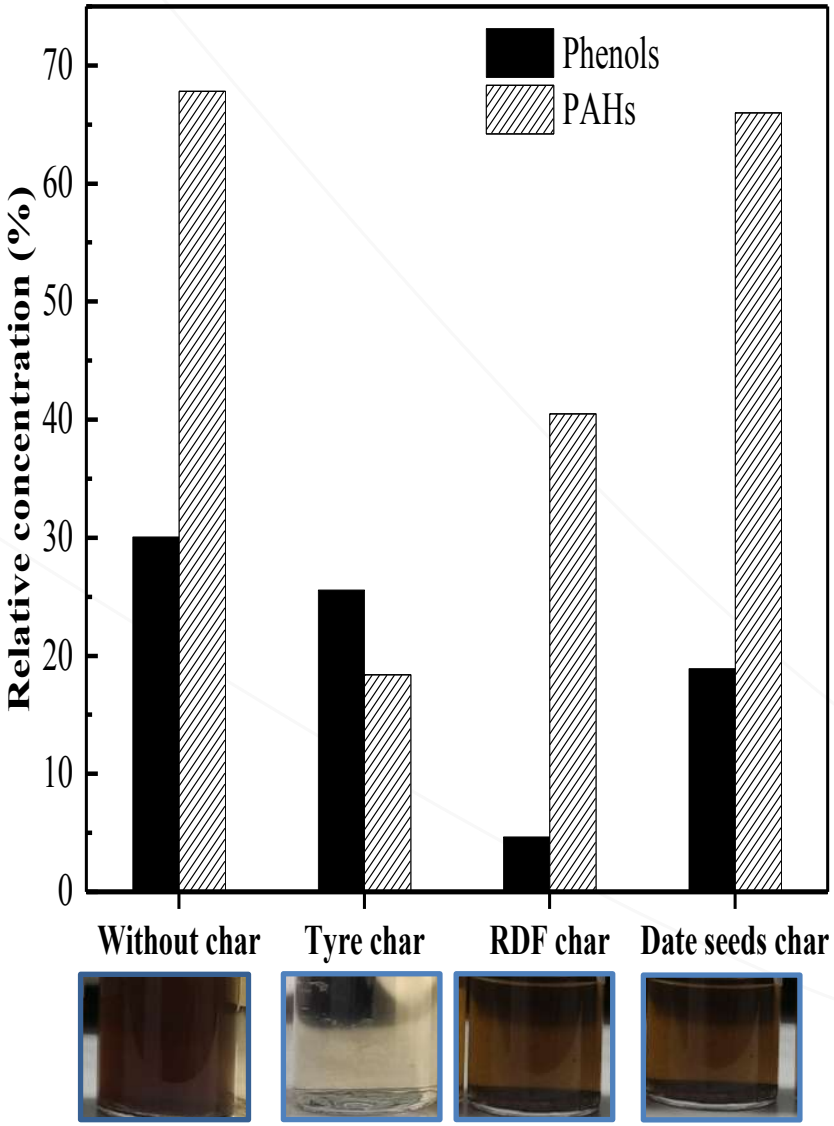


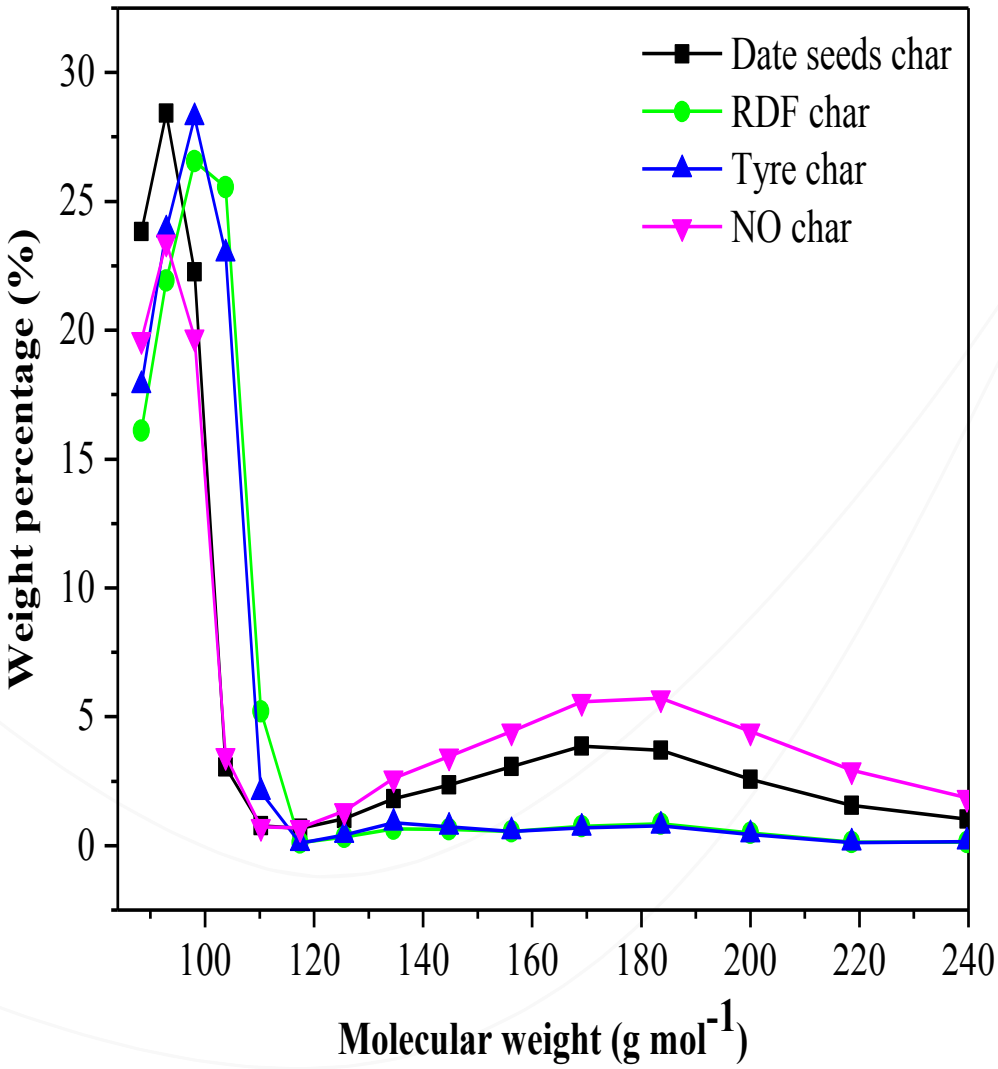
- ✓ Pyrolysis temperature=500°C
- ✓ Biomass : char ratio=1:1

Influence of waste derived pyrolysis char on the product yield from the pyrolysis-gasification of biomass

	Without char	Tyre char	RDF char	Date stones char
Temperature (°C)	800	800	800	800
Residual Biomass Char (wt.%)	23	23.5	23.5	24
Liquid (wt.%)	28.5	8.5	17	24.5
Tar (wt.%)	15.3	4.6	7.6	13.9
Water (wt.%)	13.3	3.9	9.4	10.6
Gas yield (wt.%)	46.6	59.5	55.5	50.6
Gas composition (vol.%)				
CO	42.3	34	29.9	40.1
H_2	19.6	29	34	25
CO_2	16.2	20.3	21.7	16.2
CH_4	15.1	12.1	10.5	12.8
C_2—C_4	6.7	4.7	3.9	5.9
Mass balance (%)	98	91.5	94.9	99.1

Tar composition

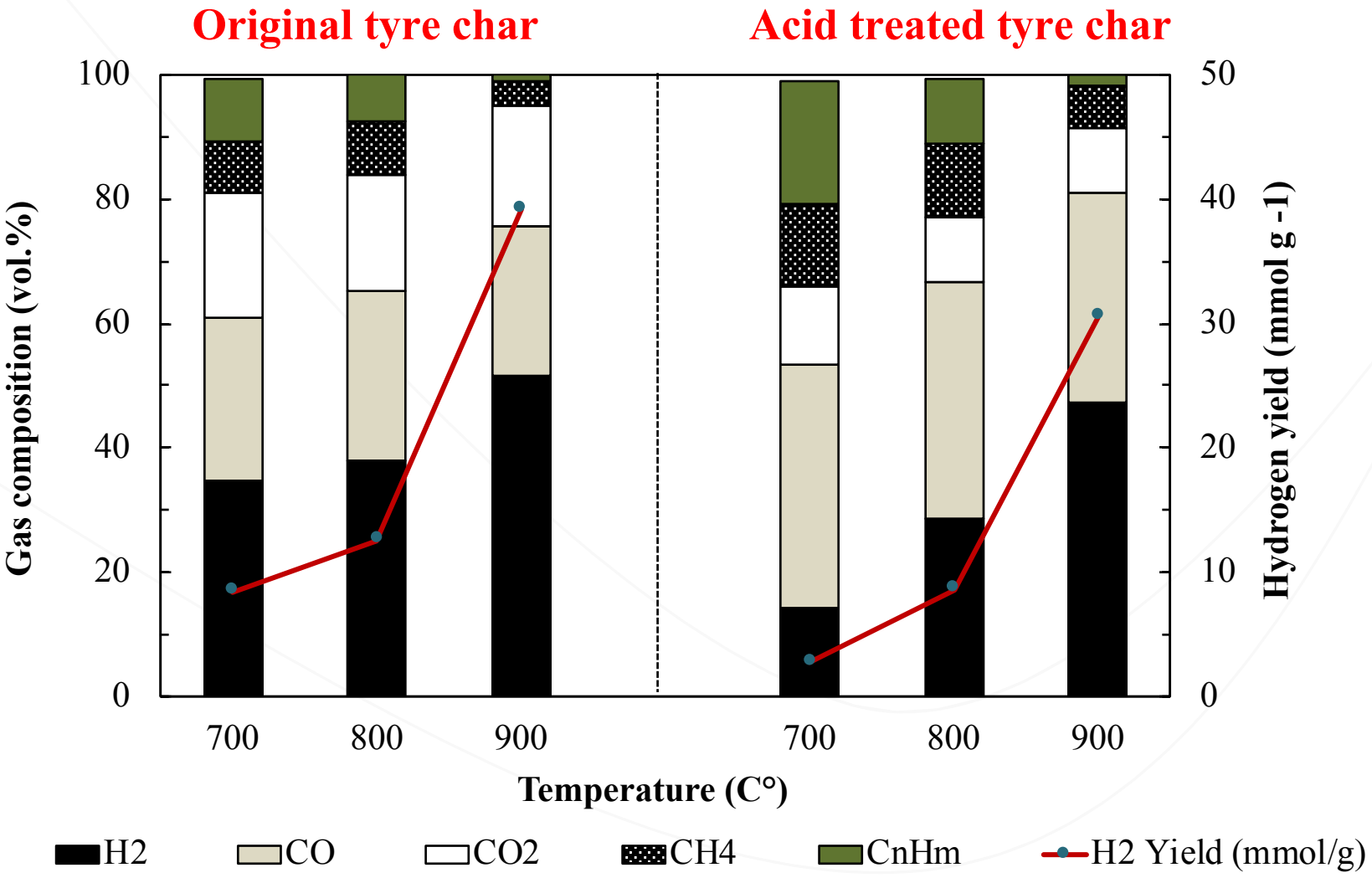




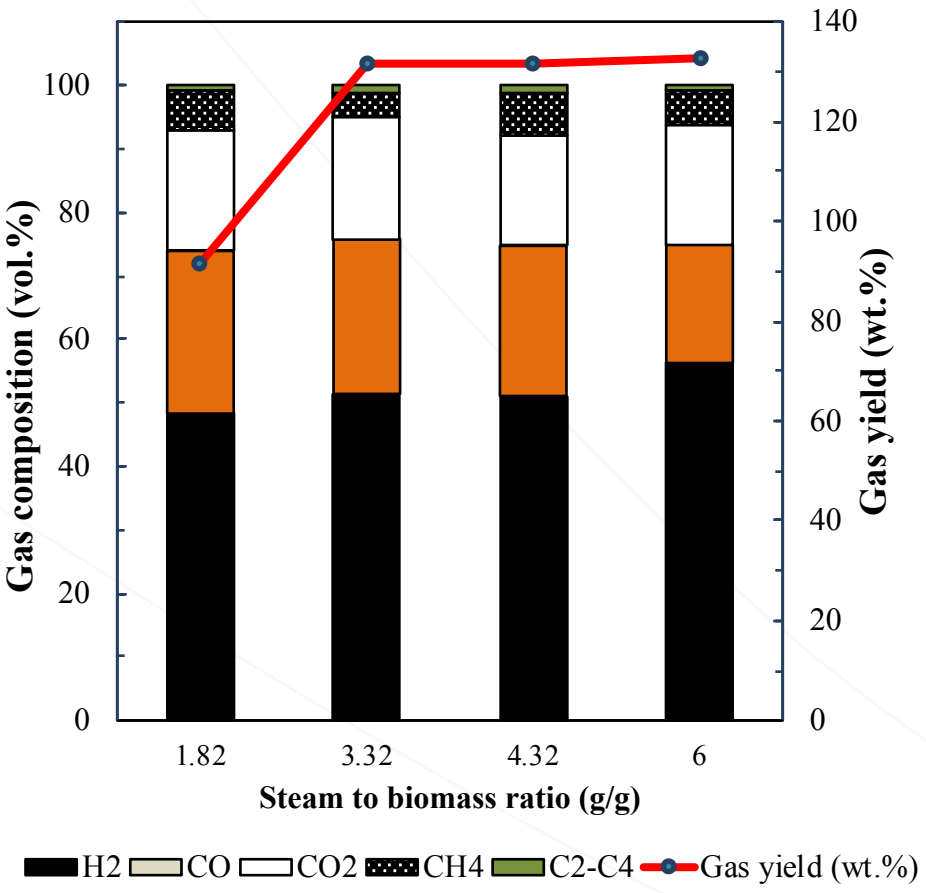
The influence of simultaneous gasification of pyrolysis gases and char

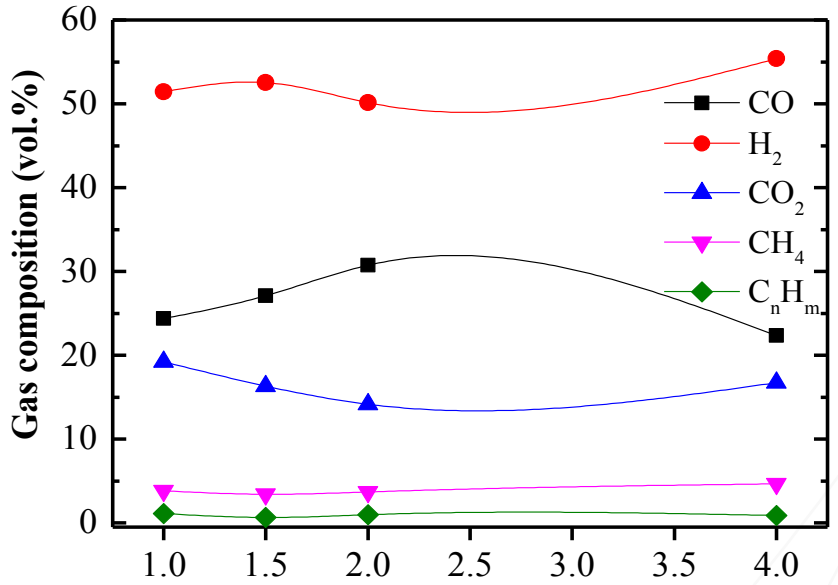
	Tyre char			Acid treated tyre char		
Temperature (°C)	700	800	900	700	800	900
Mass balance based on the biomass sample + water (wt.%)						
Gas	12.1	16.6	**33.0**	11.6	15.8	**26.1**
Liquid	82.8	76.87	**61.4**	84.5	79.9	**69.5**
Biomass char	5.6	5.8	5.5	5.5	5.9	5.5
Mass Balance	100.5	99.2	99.8	101.6	101.0	97.5
Tyre char recovered (%)	100.0	91.0	**82.5**	101.0	98.0	**85.5**
Mass balance based on the biomass sample (wt.%)						
Gas	50.0	67.1	131.6	48.9	63.1	106.8
Biomass char	23.0	23.3	22.0	22.5	23.5	22.5
Gas characterization						
HHV (MJ Kg^{-1})	48.3	52.5	66.1	27.9	44.3	63.6
H_2 yield (mmol g^{-1})	8.4	12.5	39.2	2.7	8.6	30.5
H_2/CO (mol mol^{-1})	1.31	1.37	2.11	0.37	0.75	1.41

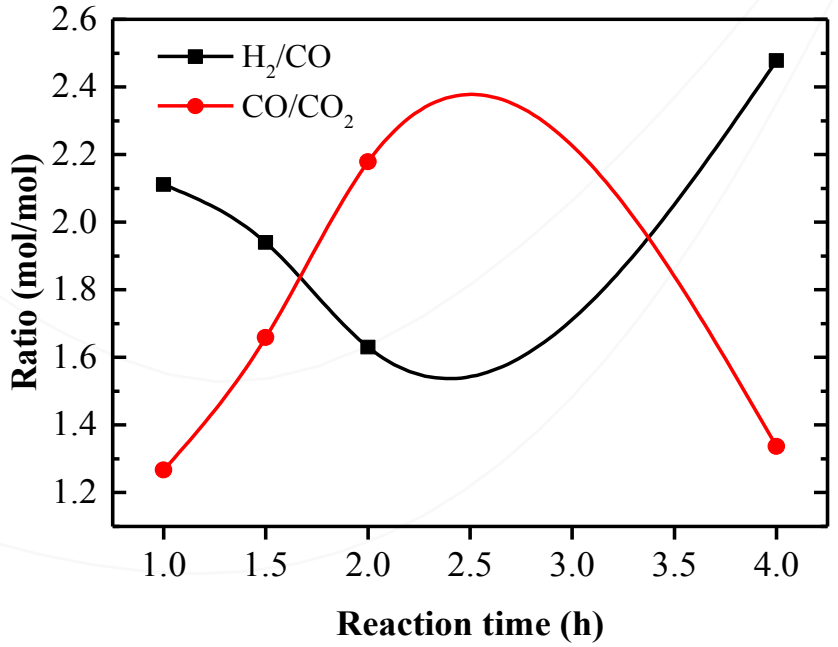
Gas compositions and hydrogen yield with original and acid treated tyre chars



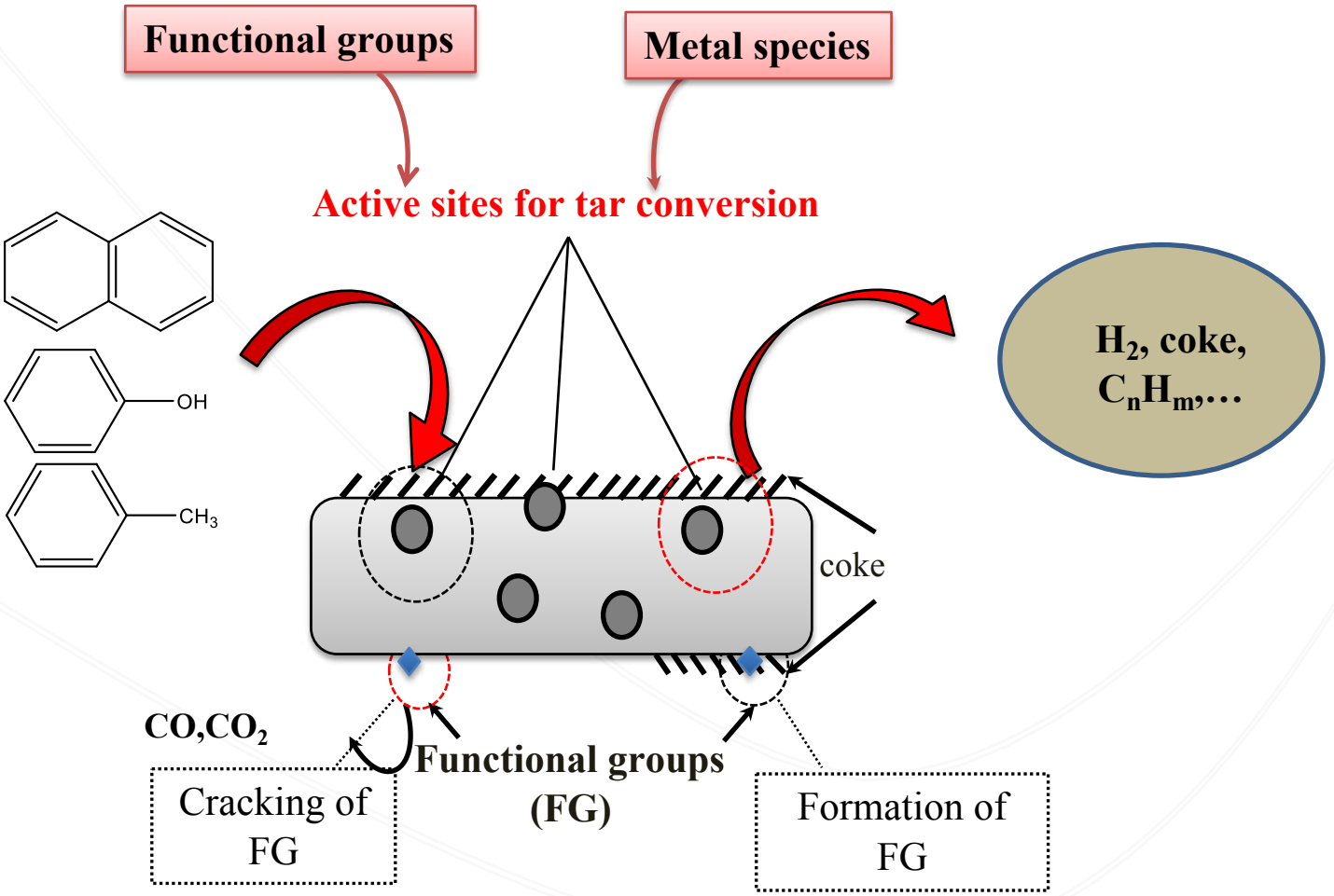
Influence of Steam and Reaction time on H_2 yield







Mechanism of tar conversion & H_2 Production over carbonaceous materials



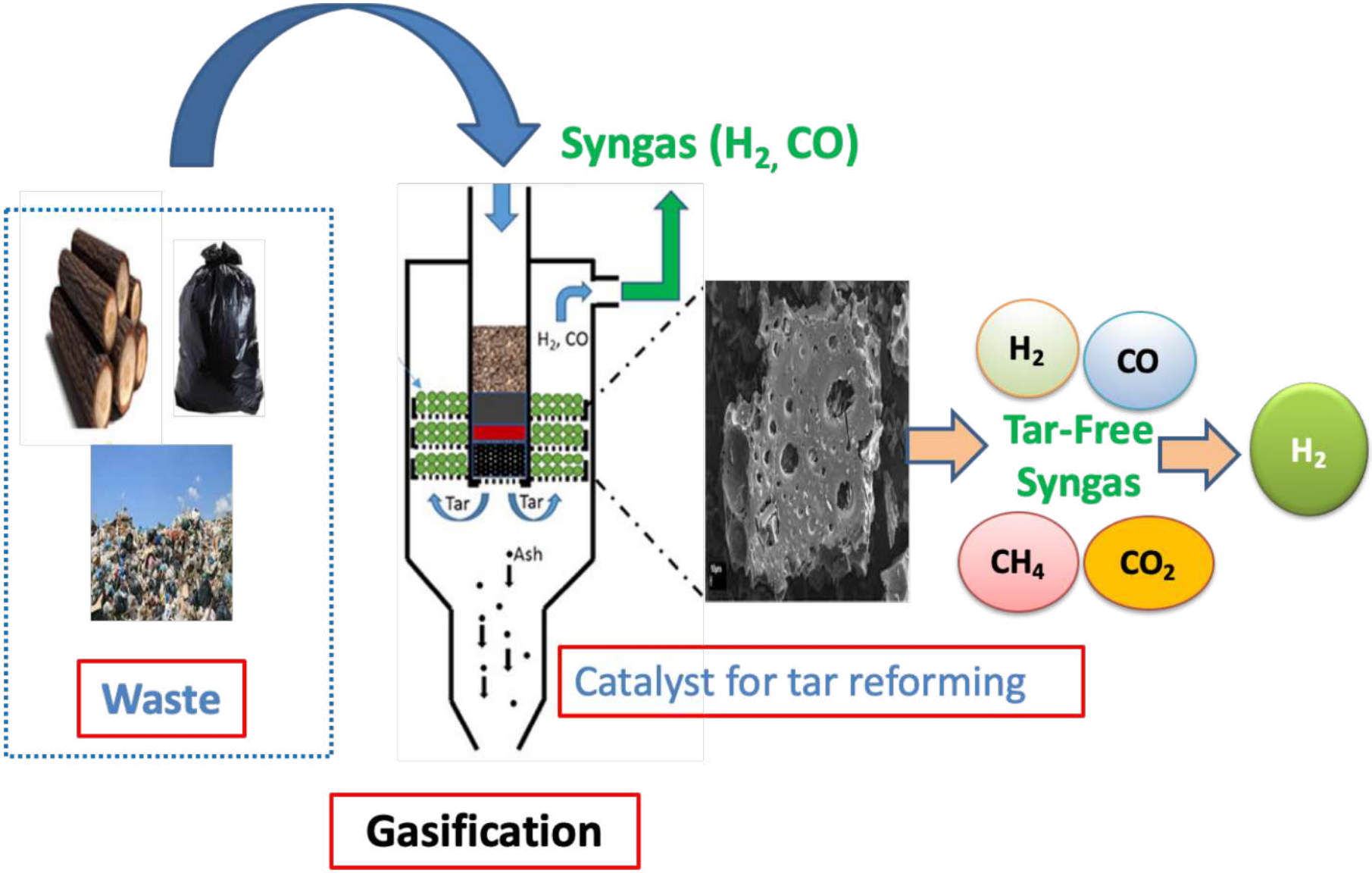
Conclusion

- Cracking of biomass derived hydrocarbons by carbonaceous chars simulates the cracking of tar in gasification syngas.

- Hydrogen production increased significantly with the use of tyre char in the 2nd stage to be about 39.20 mmol g^{-1} biomass due to the simultaneous reactions of tar reforming and char gasification.

- The difference in hydrogen production between the original and the acid treated tyre chars suggests that metals present in tyre char have a significant catalytic effect in enhancing the water gas shift, tar reforming and char steam reactions.

- Waste-derived chars would represent a low cost source of catalytic char material for hydrogen production during biomass gasification.


Syngas (H_2, CO)
Waste
H_2, CO
Tar
Tar
Ash
Catalyst for tar reforming
H_2
CO
Tar-Free Syngas
CH_4
CO_2
H_2
Gasification


THANK
YOU !