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Oxygen/steam charcoal gasification in a fluidized alumina bed

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OXYGEN/STEAM CHARCOAL GASIFICATION IN A FLUIDIZED ALUMINA BED

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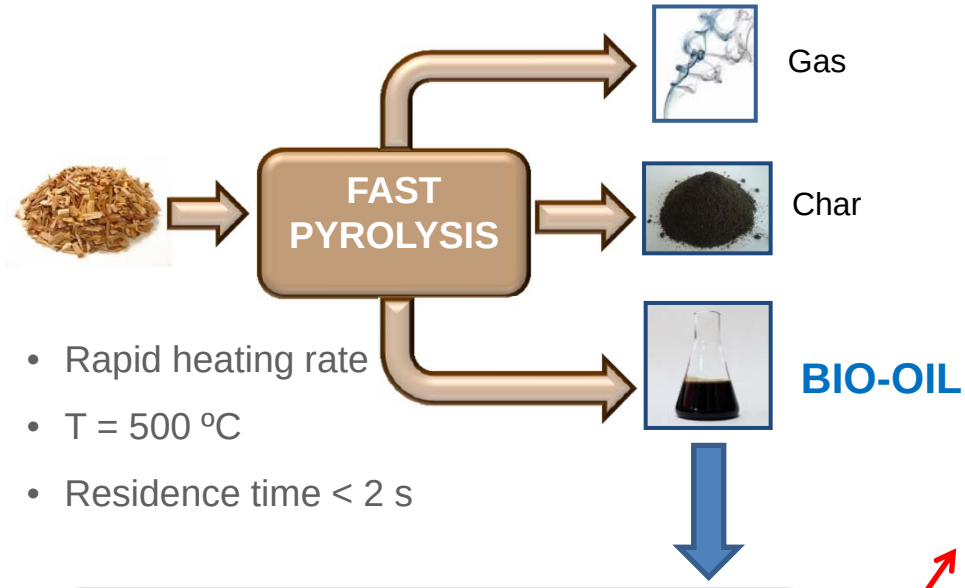


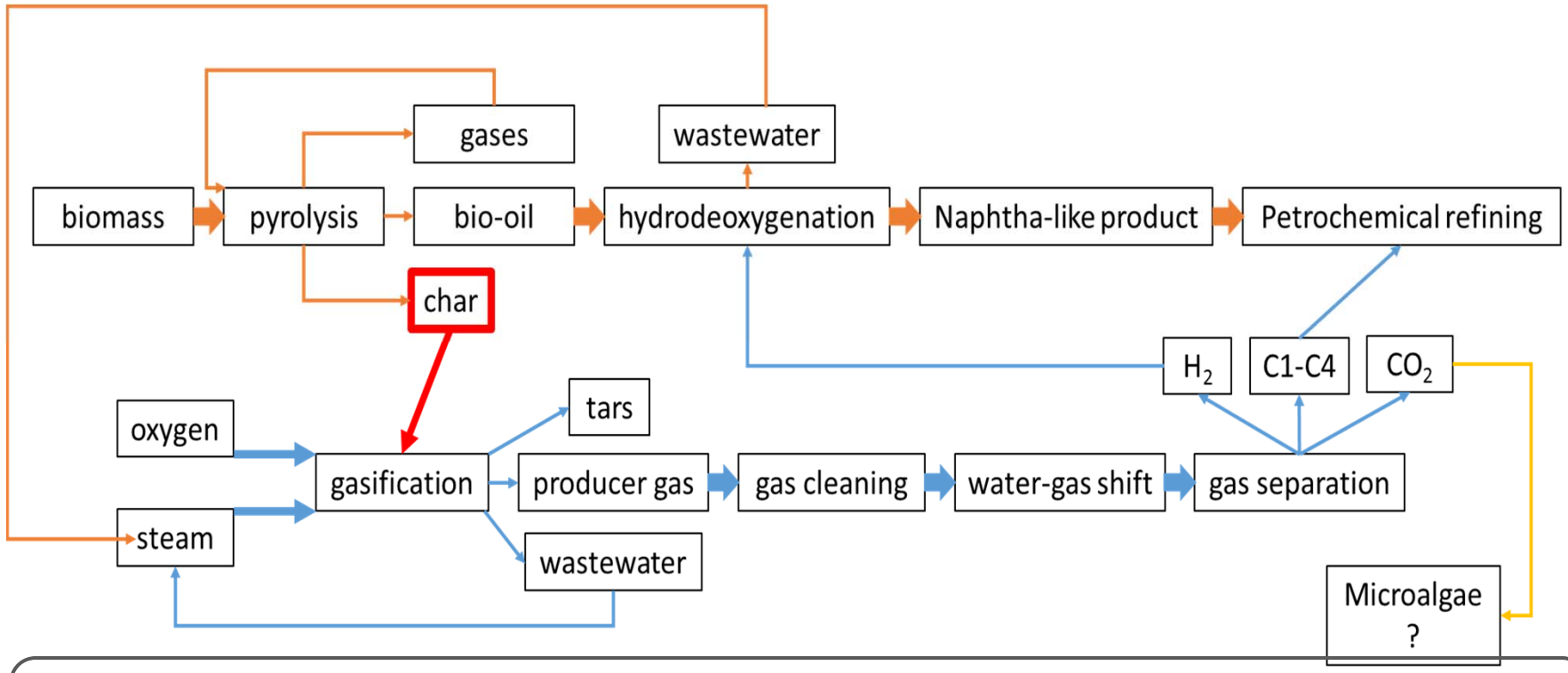
- Rapid heating rate
- T = 500 ºC
- Residence time < 2 s

Pyrolitic lignin and suspended solids	: 22-36%	pH	: 1.8 – 3.8
Water	: 20-28%	Density	: 1.2 – 1.3 g/cm³
Hydroxyacetaldehyde	: 8-12%	Oxygen	: 40 – 50 %
Levoglucosan	: 3-8 %	LHV	: 10 – 15 MJ/Kg
Acetic Acid	: 4-8%	Cetane N.	: 10
Formic acid	: 3-6%		
Formaldehyde	: 3-4%		
Acetone	: 3-6%		
Cellobiosan	: 1-2%		
Glyoxal	: 1-2%		

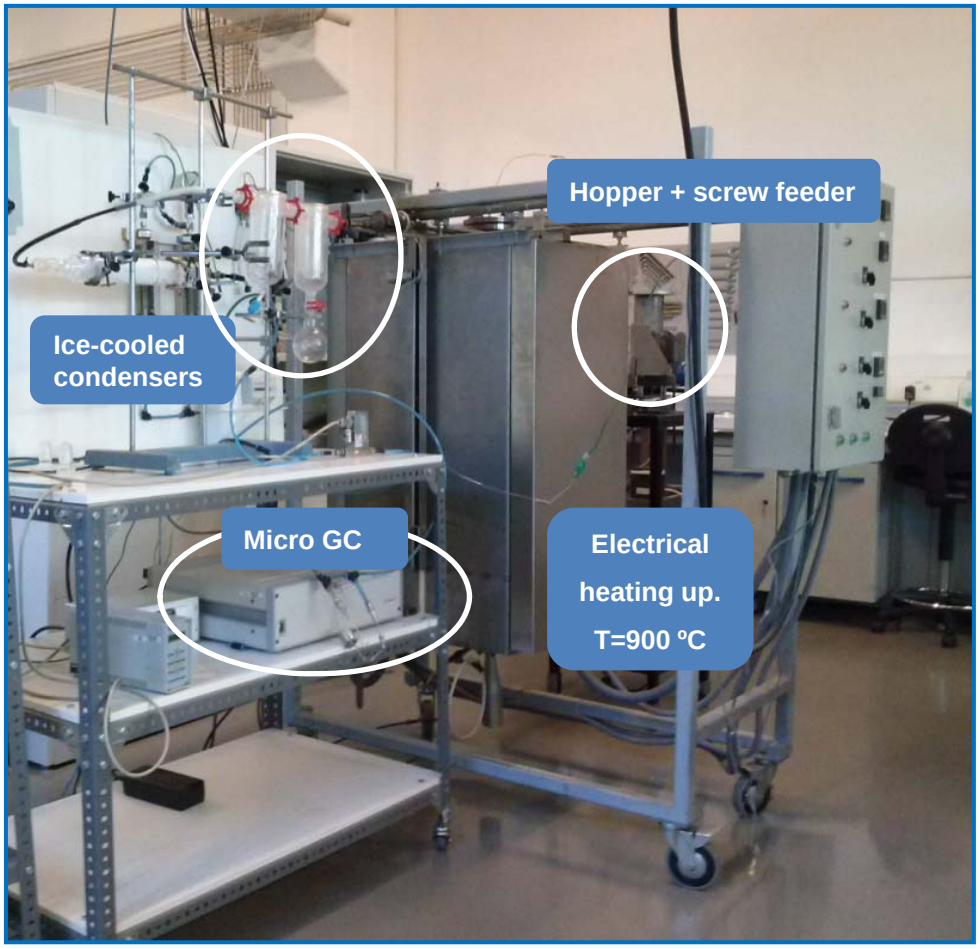
× **High O content**

- × Poor stability
- × Polymerization after/during storage
- × Poor heating value
- × High viscosity
- × Highly corrosive (carboxilic acids)

Biorefinery concept



In this work… 1st stage: production of a H_2 rich gas by oxygen/steam gasification of charcoal



- Lab-scale fluidized bed reactor: γ-Al_2O_3 bed, 900 °C
- Continuous solid feed: 1.5 g char/min
- Oxygen/steam mixtures as gasifying / fluidizing agent

ER = 0.25-0.35 S/C = 0.5-0.75g/g

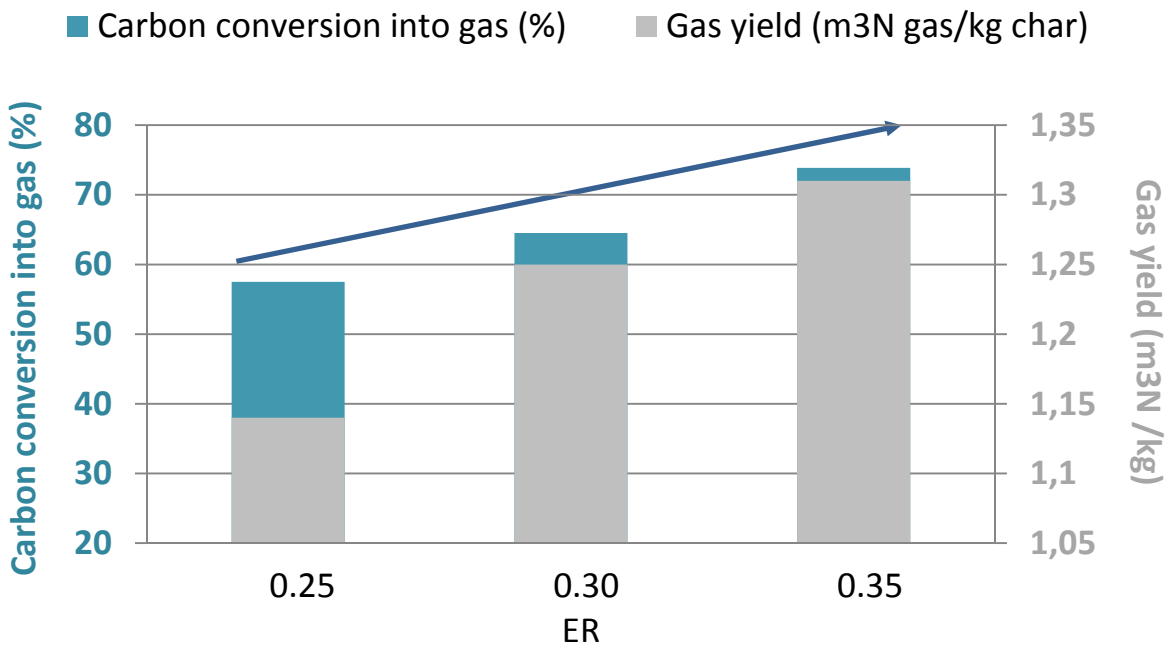
Raw material: commercial charcoal

LHV : 30.4 MJ/kg

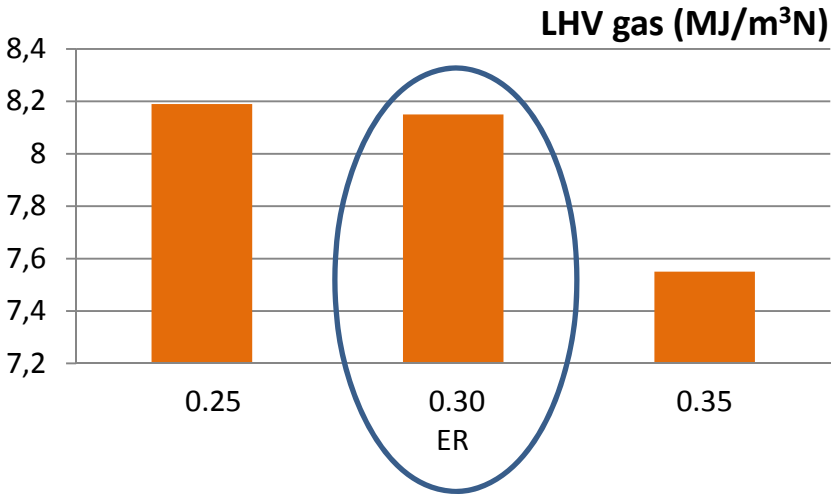
Volatile matter: 19 %
Fixed carbon: 73.2 %
Ash: 4.2 %
Moisture: 3.6 %

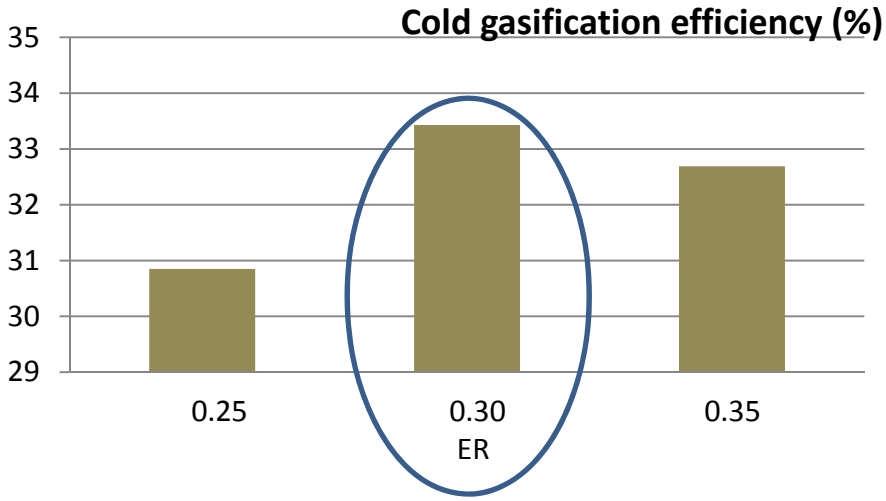
C: 80.0 % H: 3.1 %
N: 1.8 % O: 15.1 %
BET area: 50 m^2/g

I. Effect of the equivalence ratio: 0.25-0.35 % (i) (S/C=0.625 g/g)



I. Effect of the equivalence ratio: 0.25-0.35 (ii) (S/C=0.625 g/g)

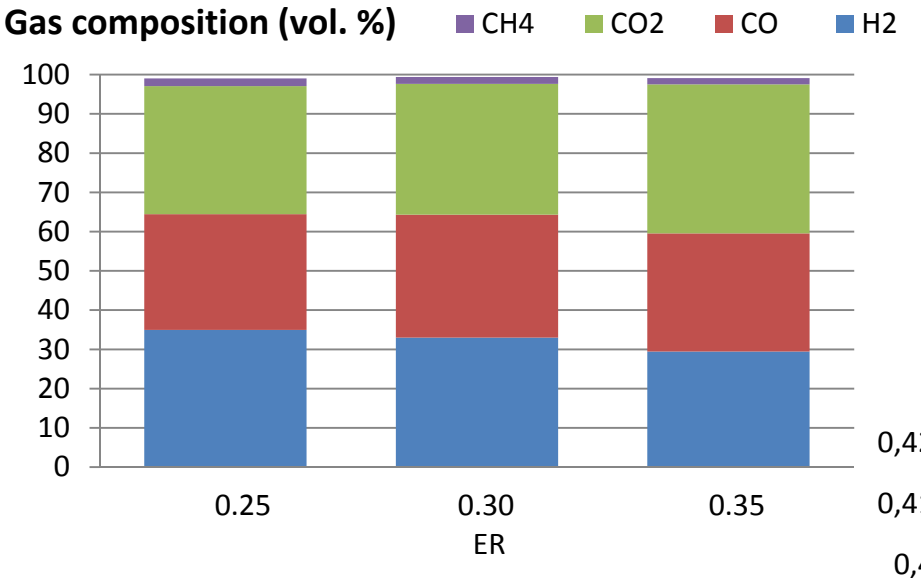




$$CGE = \frac{Vol_{gas} \times LHV_{gas}}{m_{charcoal} \times LHV_{charcoal}} \times 100$$

I. Effect of the equivalence ratio: 0.25-0.35 (iii)

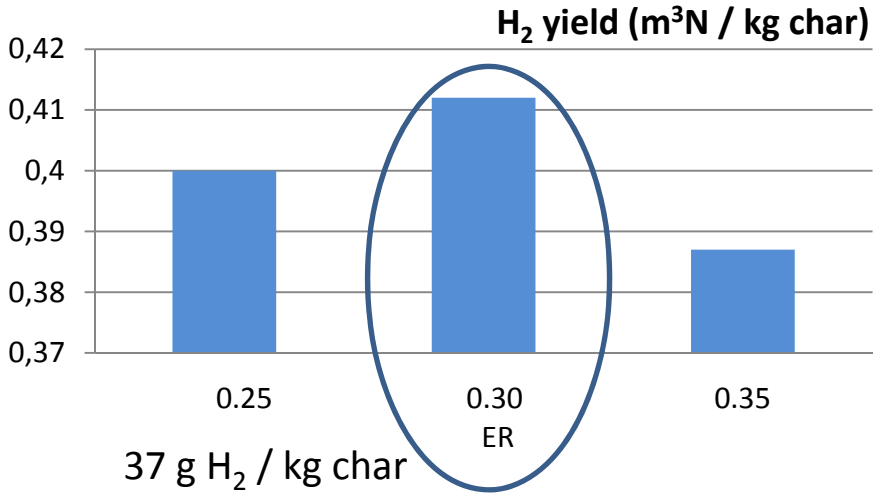
(S/C=0.625 g/g)



↑ CO_2 and ↓ H_2 with ER

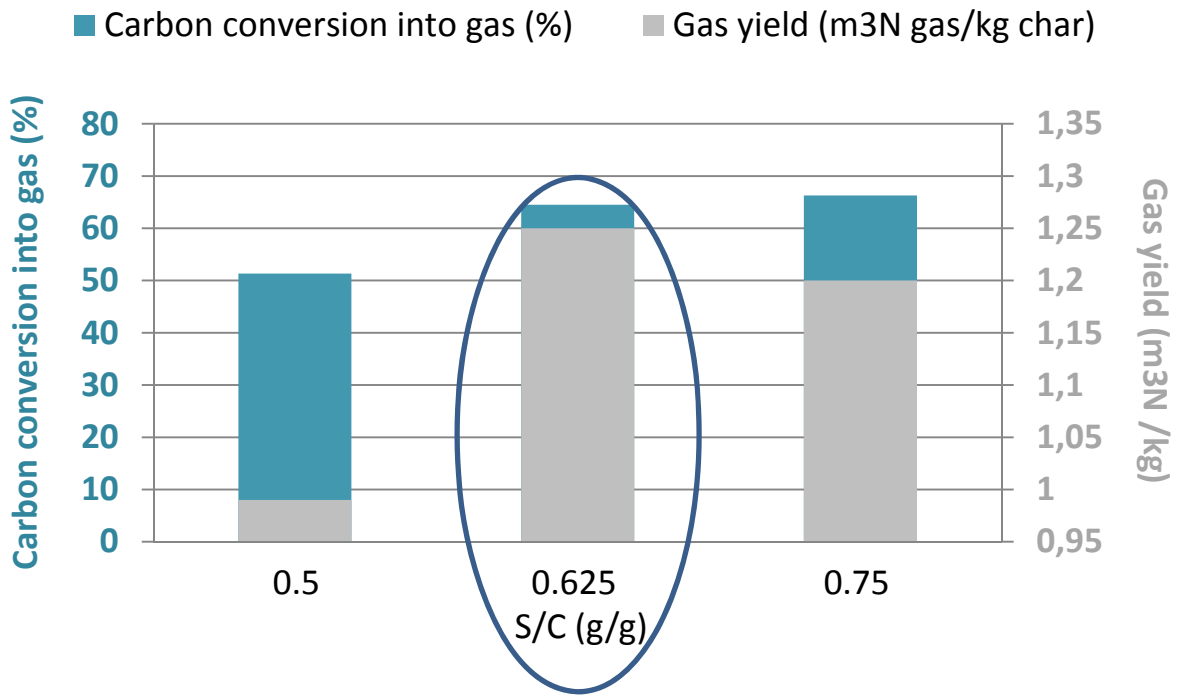
H_2/CO molar ratio = 0.98 - 1.19

CO/CO_2 molar ratio = 0.79 - 0.94



37 g H_2 / kg char
(3.7 %)

II. Effect of the steam to carbon ratio: 0.5-0.75 g/g (i) (ER = 0.3)



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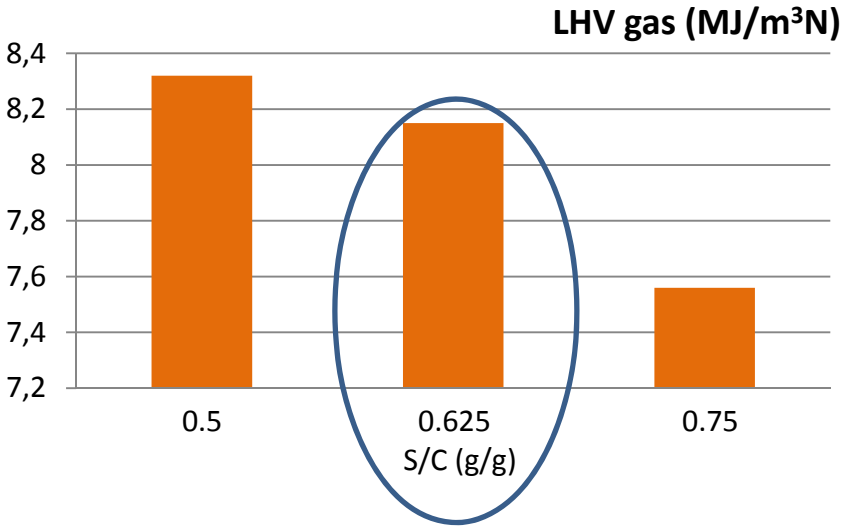

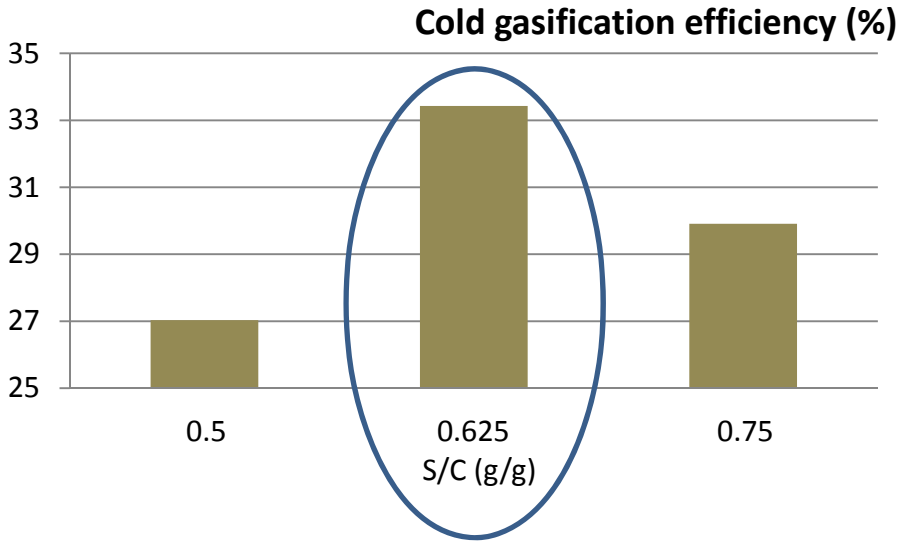

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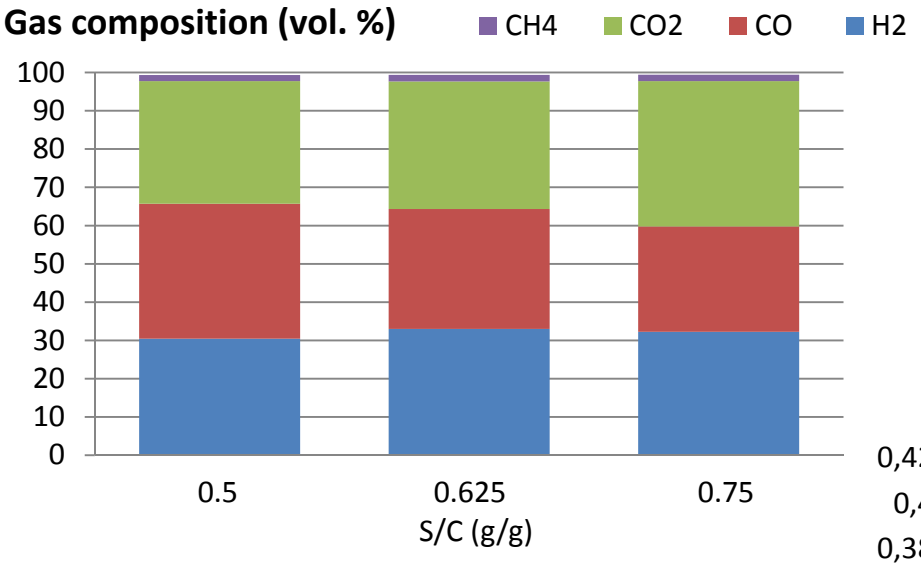
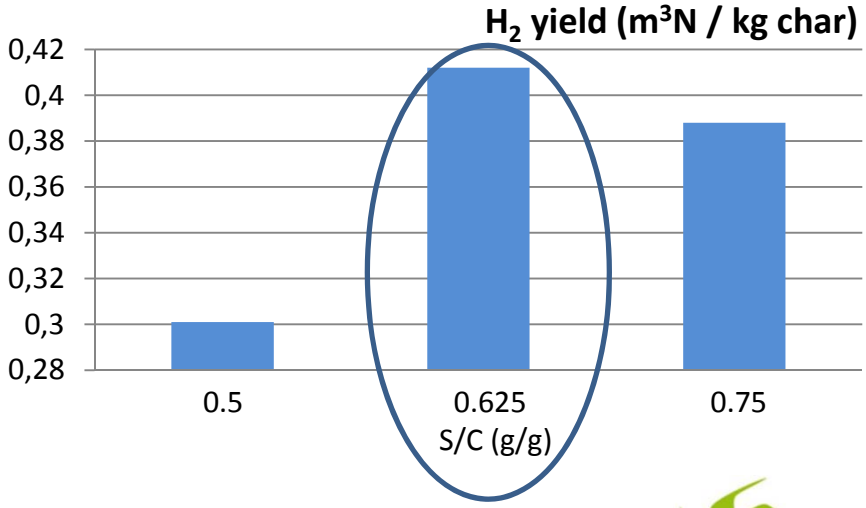


↑ CO_2 and ↓ CO with S/C



- H_2 production from char gasification for HDO of bio-oil → Bio-refinery concept.
- Moderate values of ER (0.3) and S/C (0.63 g/g) were required to maximize H_2 production.
- Maximum H_2 yield of 0.41 m^3N / kg char (37 g H_2 / kg char) was obtained.

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