

6-23-2016

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## Recommended Citation

Rui Moreira, Rui Vaz, António Portugal, Noemí Gil-Lalaguna, Fernando Bimbela, and José Luis Sánchez, "Oxygen/steam charcoal gasification in a fluidized alumina bed" in "5th International Congress on Green Process Engineering (GPE 2016)", Franco Berruti, Western University, Canada Cedric Briens, Western University, Canada Eds, ECI Symposium Series, (2016).  
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**CIE PQPF**



# OXYGEN/STEAM CHARCOAL GASIFICATION IN A FLUIDIZED ALUMINA BED

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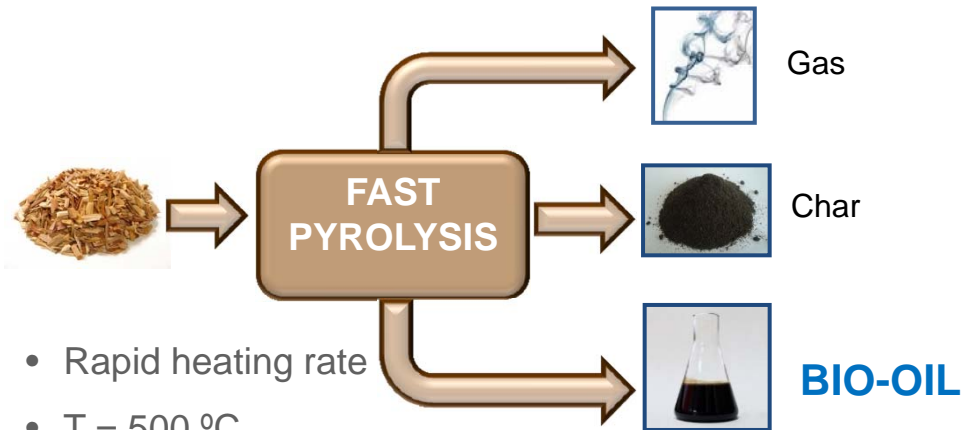
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June 19-24, 2016  
Fairmont Tremblant Hotel, Mont Tremblant, Quebec, Canada



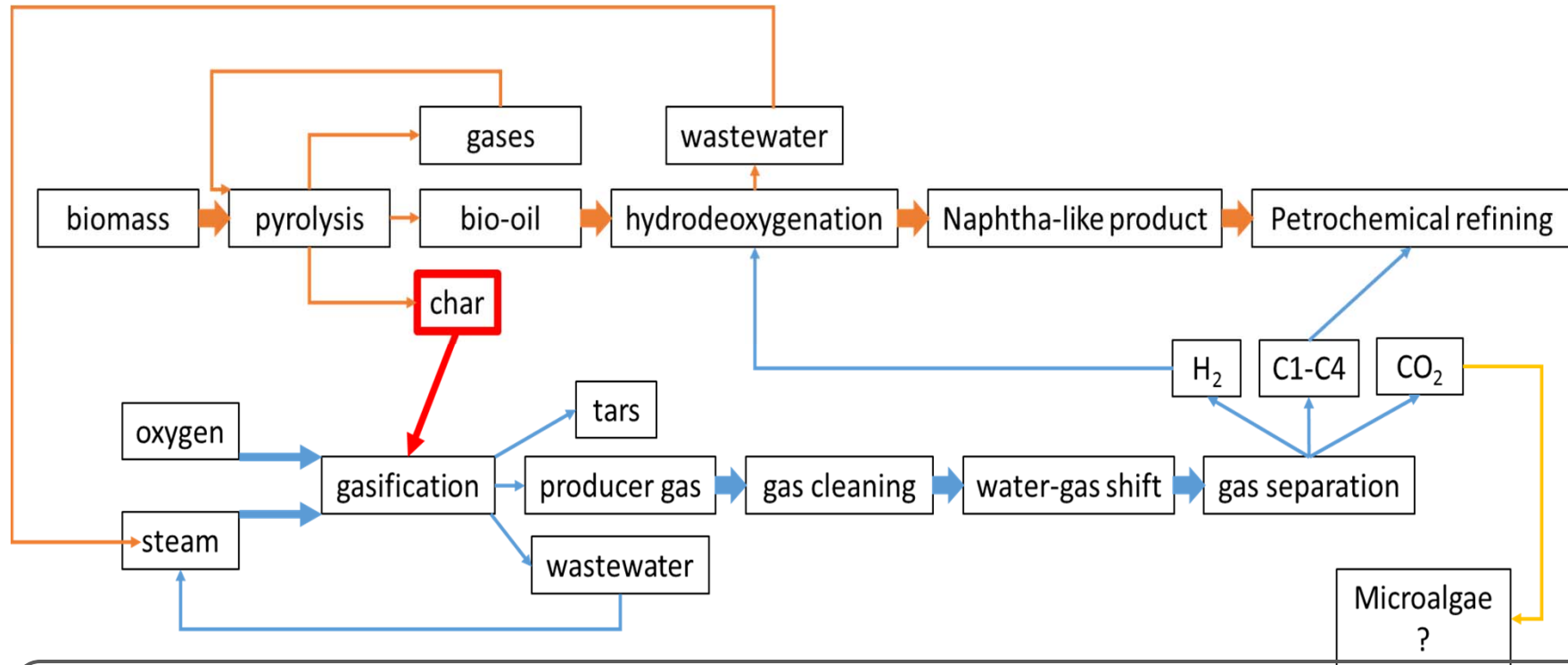
- Rapid heating rate
- T = 500 °C
- Residence time < 2 s

Pyrolitic lignin and suspended solids	: 22-36%	pH	: 1.8 – 3.8
Water	: 20-28%	Density	: 1.2 – 1.3 g/cm <sup>3</sup>
Hydroxyacetaldehyde	: 8-12%	Oxygen	: 40 – 50 %
Levogluconan	: 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%		

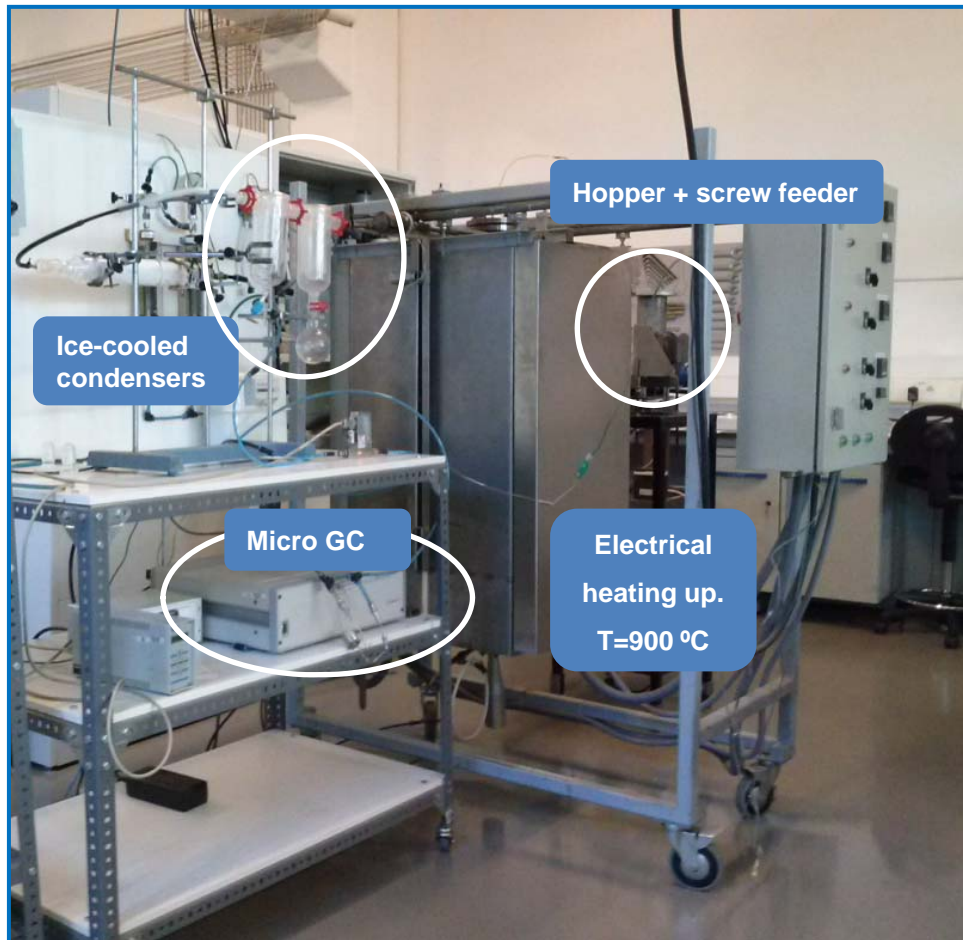
× **High O content**

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

Biorefinery concept



In this work... 1<sup>st</sup> stage: production of a H<sub>2</sub> rich gas by oxygen/steam gasification of charcoal



- Lab-scale fluidized bed reactor:  $\gamma\text{-Al}_2\text{O}_3$  bed, 900 °C
- Continuous solid feed: 1.5 g char/min
- Oxygen/steam mixtures as gasifying / fluidizing agent

$$\text{ER} = 0.25\text{-}0.35 \quad \text{S/C} = 0.5\text{-}0.75\text{g/g}$$

**Raw material: commercial charcoal**

LHV : 30.4 MJ/kg



Volatile matter: 19 %

**Fixed carbon: 73.2 %**

Ash: 4.2 %

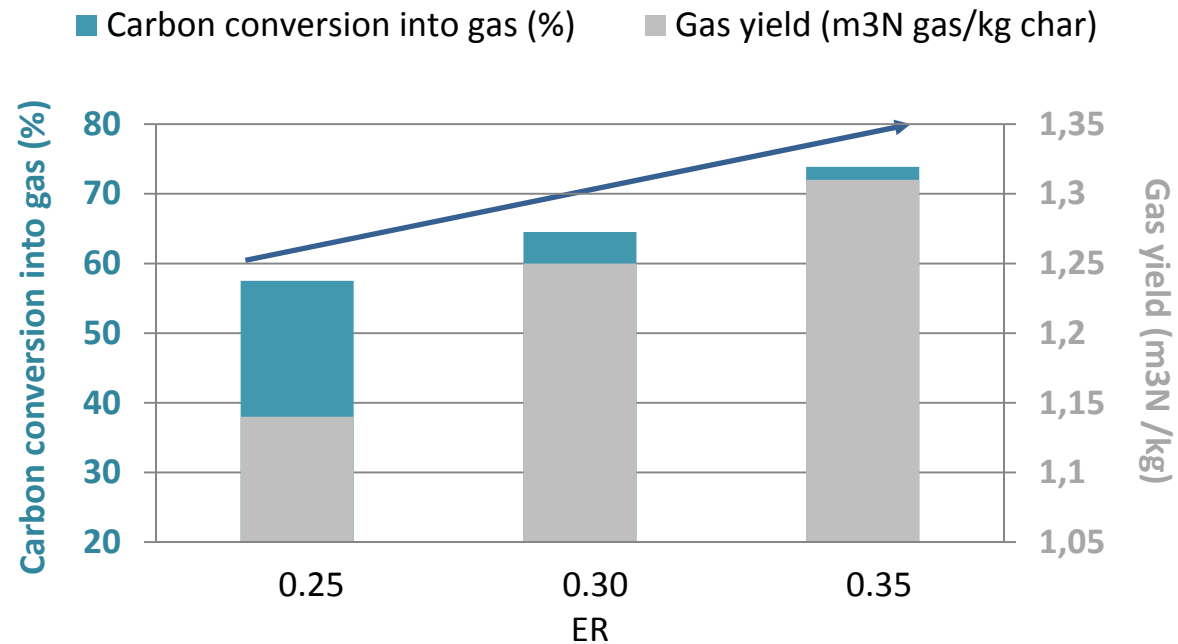
Moisture: 3.6 %

**C: 80.0 %** H: 3.1 %

N: 1.8 % O: 15.1 %

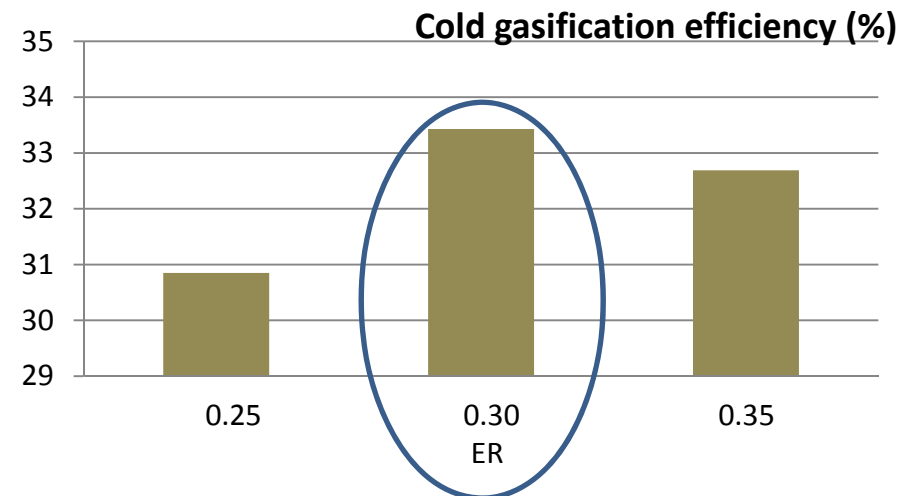
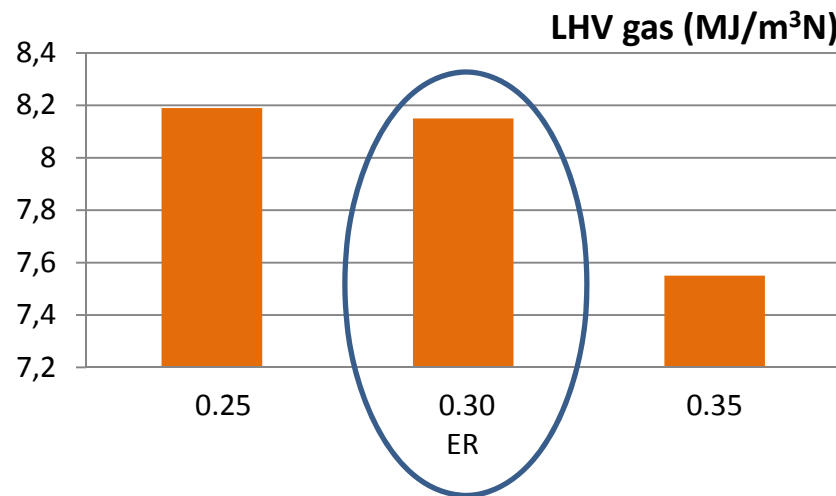
BET area: 50 m<sup>2</sup>/g

## 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)



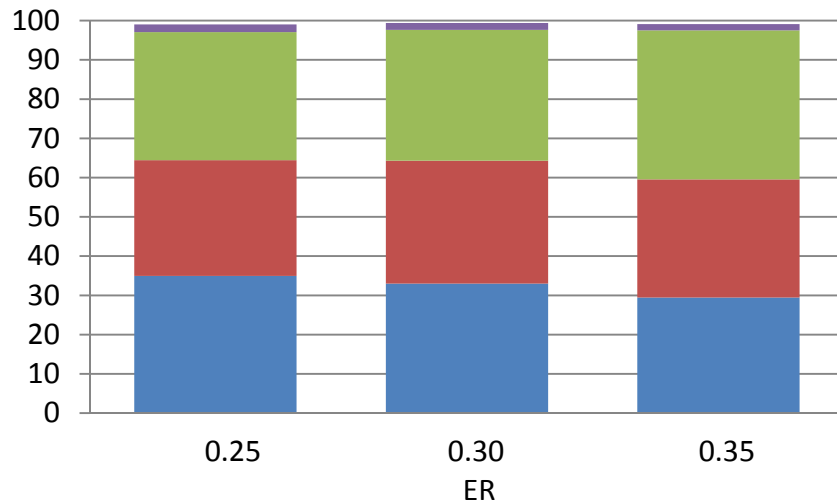
$$CGE = \frac{Vol_{gas} \times LHV_{gas}}{m_{charcoal} \times LHV_{charcoal}} \times 100$$



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

(S/C=0.625 g/g)

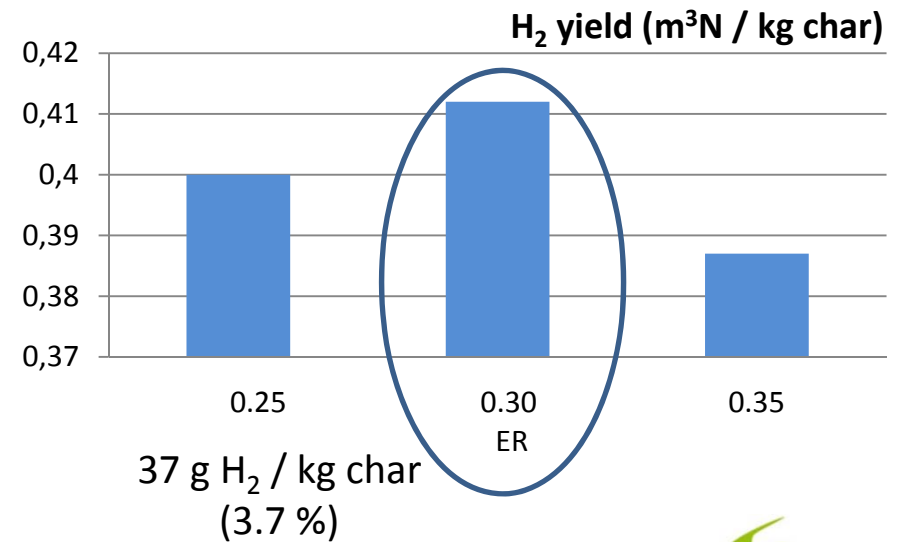
Gas composition (vol. %) CH<sub>4</sub> CO<sub>2</sub> CO H<sub>2</sub>



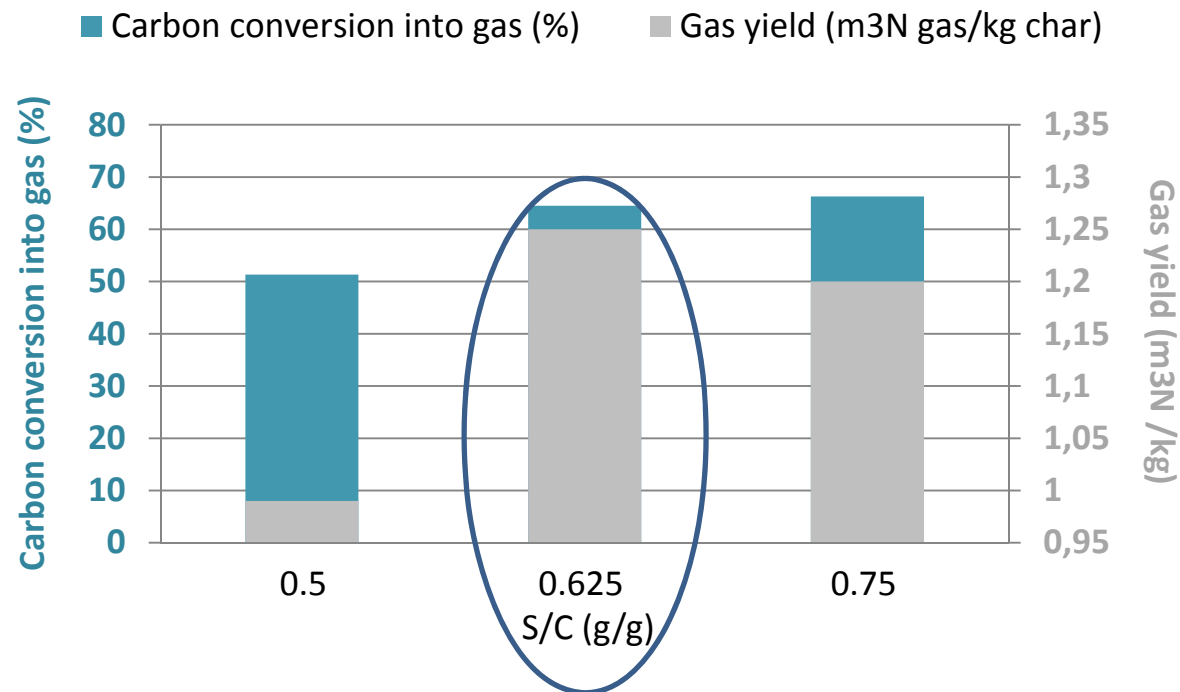
H<sub>2</sub>/CO molar ratio = 0.98 - 1.19

CO/CO<sub>2</sub> molar ratio = 0.79 - 0.94

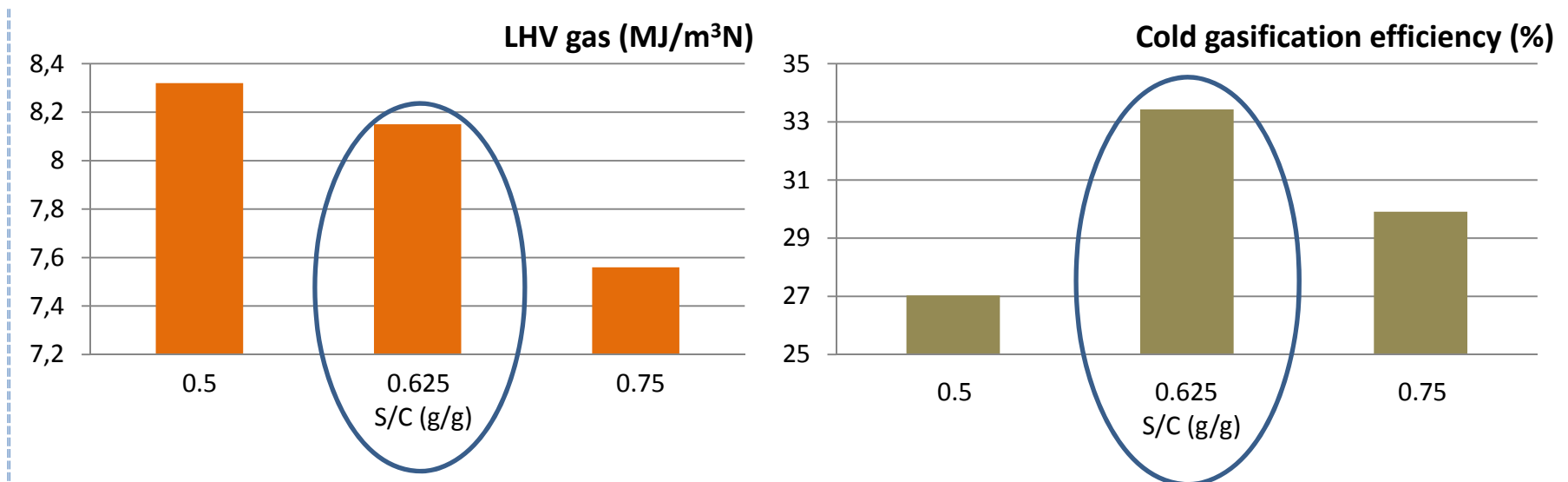
↑ CO<sub>2</sub> and ↓ H<sub>2</sub> with ER



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



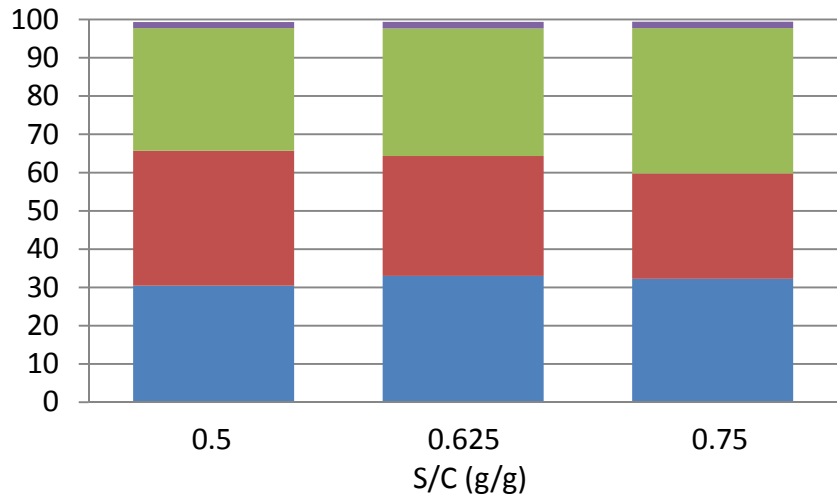
## II. Effect of the steam to carbon ratio: 0.5-0.75 g/g (ii) (ER = 0.3)



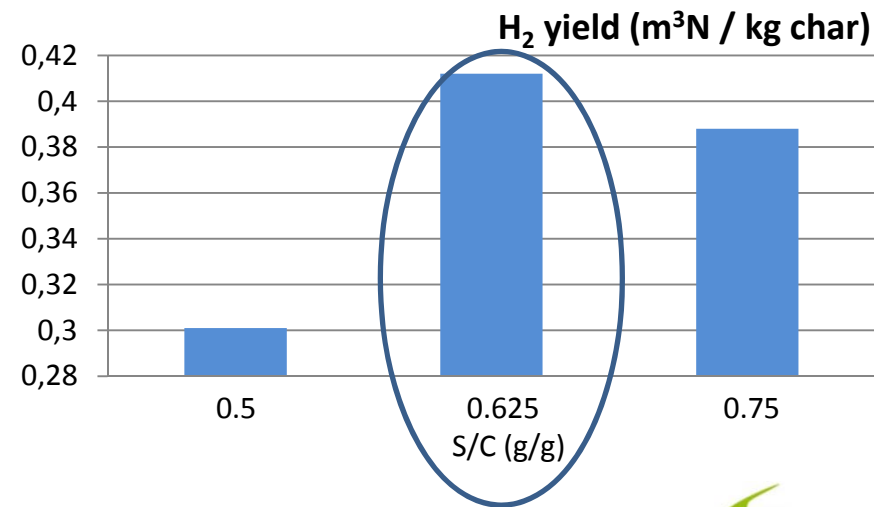
$$CGE = \frac{Vol_{gas} \times LHV_{gas}}{m_{charcoal} \times LHV_{charcoal}} \times 100$$

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

Gas composition (vol. %) CH<sub>4</sub> CO<sub>2</sub> CO H<sub>2</sub>



↑ CO<sub>2</sub> and ↓ CO with S/C



- H<sub>2</sub> 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<sub>2</sub> production.
- Maximum H<sub>2</sub> yield of 0.41 m<sup>3</sup>N / kg char (37 g H<sub>2</sub> / kg char) was obtained.

**The authors express their gratitude to Aragón Government and European Social Fund (GPT group) for financial support and BRISK project (Biofuels Research Infrastructure for Sharing Knowledge) for the transnational access awarded to R. Moreira and R. Vaz**



BRISK was funded by the European Commission Seventh Framework Programme (Capacities)



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