PROCESS CHEMISTRY CENTRE

ÅBO AKADEMI UNIVERSITY

Gasification of biomass char particles – experiments and modeling

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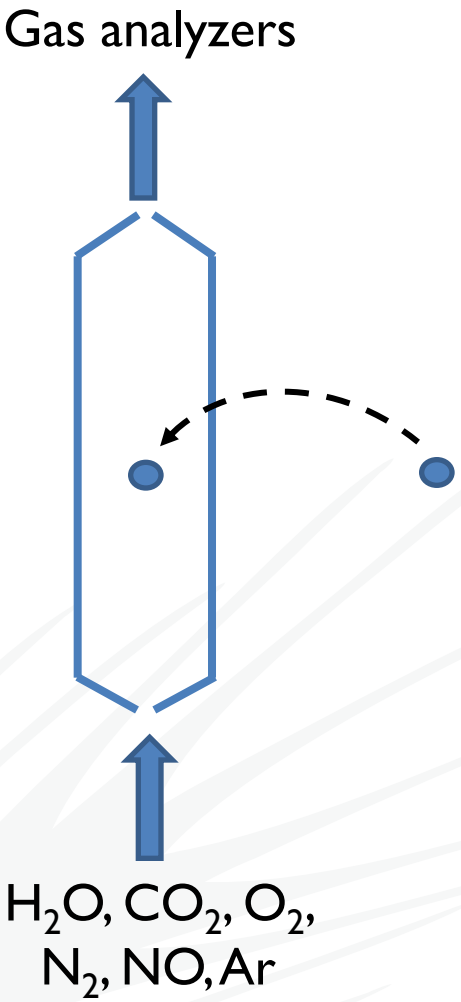
Objectives

- Develop single particle model for char oxidations
- test the model against experiments

Experiments

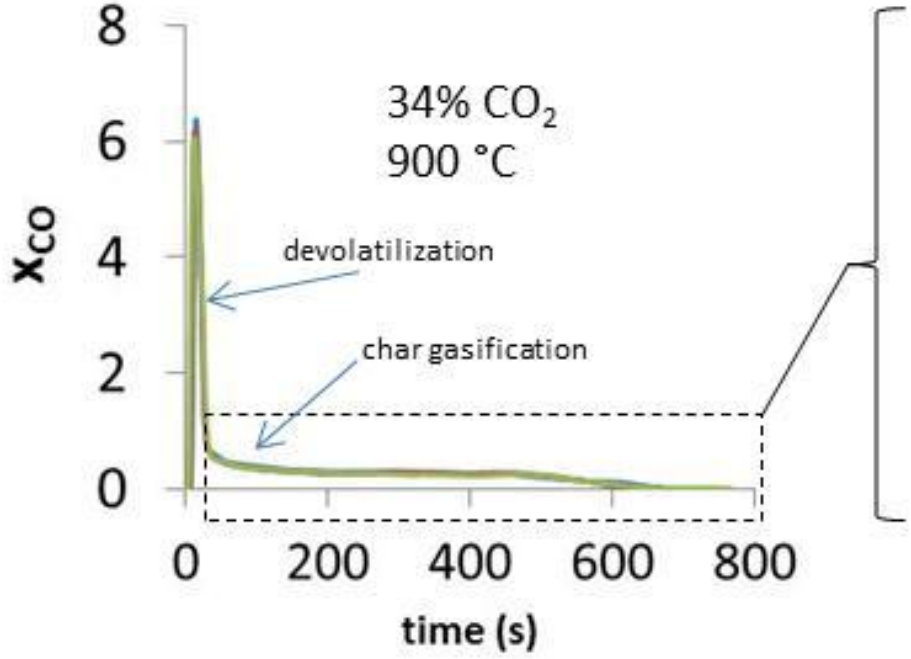
Åbo Akademi
Single Particle Reactor

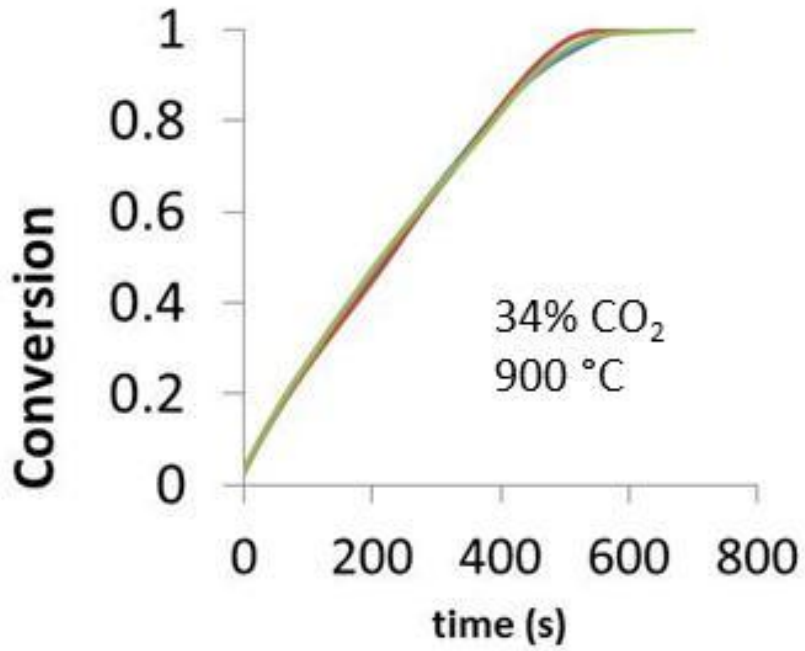


Experiments

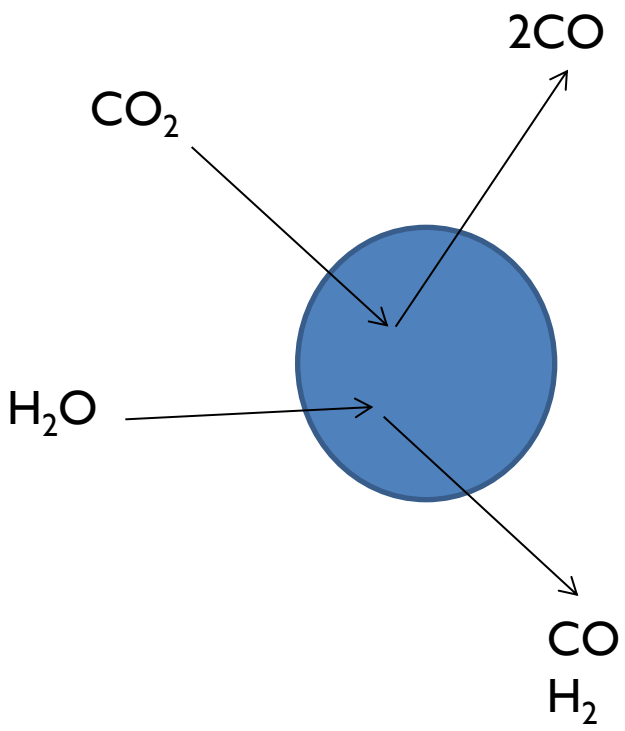
- SRC poplar
- 0.2 g
- 1 cm cylinders
- 800 °C, 900 °C, 1050 °C
  - 34% CO_2, 66% N_2
  - 34% H_2O, 66% N_2

Experiments





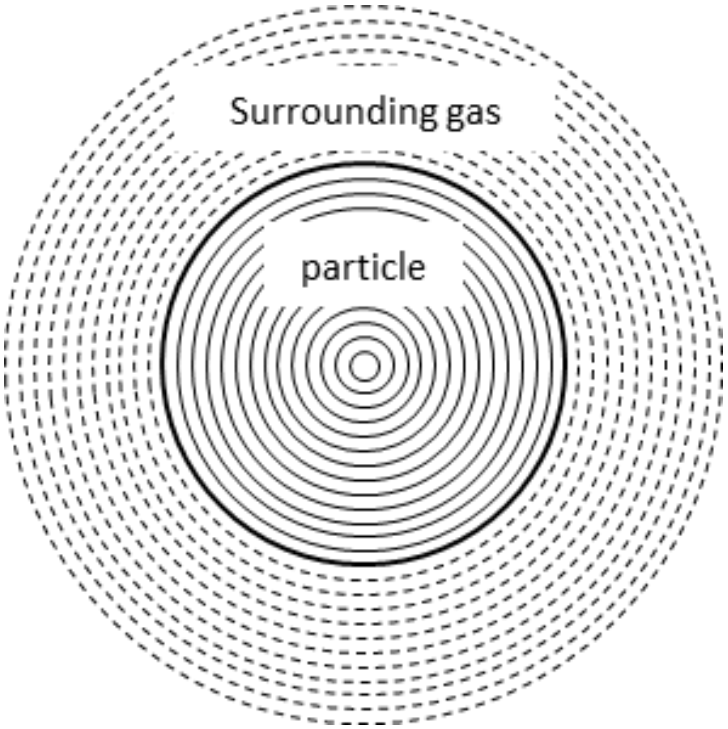
Model



Goal:
dm/dt

Diameter of particle?

Model

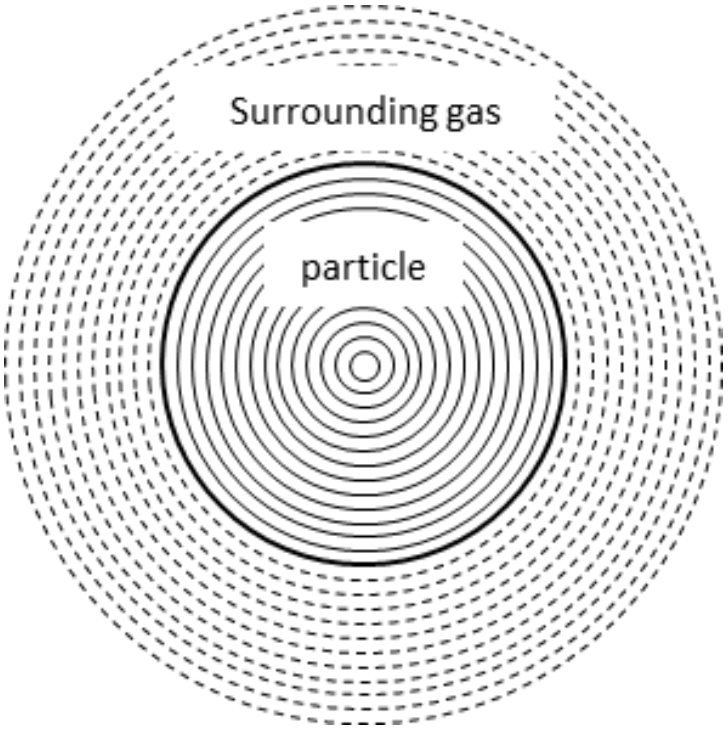


- 100 layers
- Conversion modeled separately in each layer

Conversion 100% in one layer

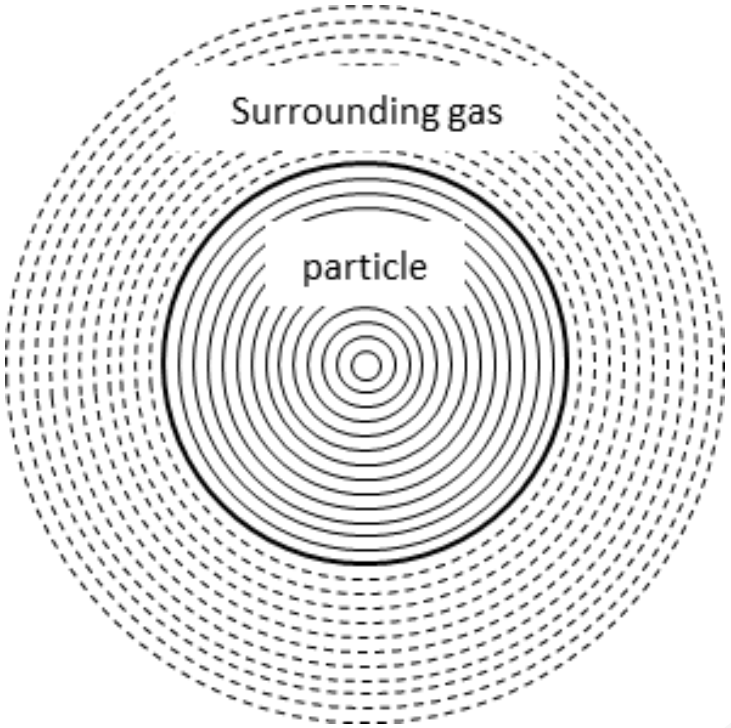
Layer disappears and particle decreases in size

Model



- Internal surface area modeled separately in each layer

Model



Inside particle

$$D_i\left(\frac{d^2C_i}{dr^2}+\frac{2}{r}\frac{dC_i}{dr}\right)-k_iC_i^{\,n_i}=0$$

Outside particle

$$D_i\left(\frac{d^2C_i}{dr^2}+\frac{2}{r}\frac{dC_i}{dr}\right)=0$$

$$i = CO_2,\ H_2O,\ O_2$$

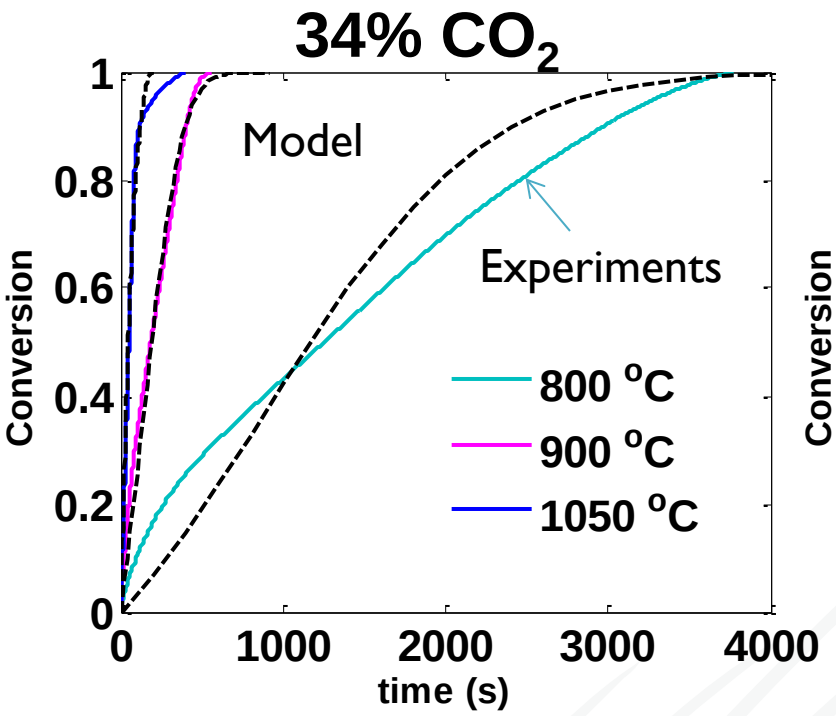
Model

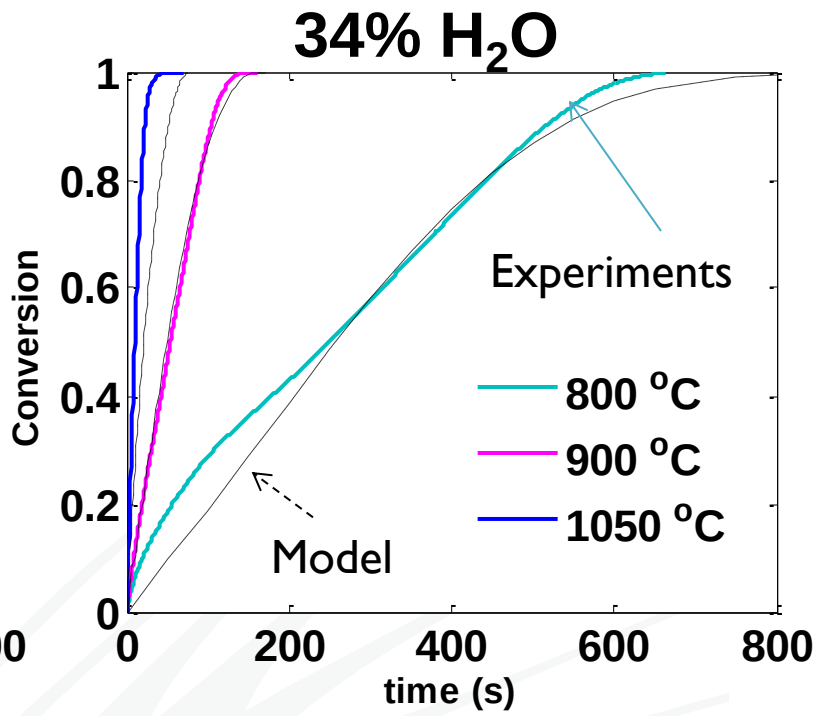
$$m_p c_p \frac{dT_p}{dt} = hS_p(T_\infty - T_p) - f_h \frac{dm_p}{dt} H_{reac} + S_p \varepsilon_p \sigma(\theta_R^4 - T_p^4)$$

H_{reac}

- $2C(s) + O_2 \rightarrow 2CO$
- $C(s) + CO_2 \rightarrow 2CO$
- $C(s) + H_2O \rightarrow CO + H_2$

Results


34% CO_2
Conversion
time (s)
Model
Experiments
800 °C
900 °C
1050 °C
0
0.2
0.4
0.6
0.8
1
0
1000
2000
3000
4000


34% H_2O
Conversion
time (s)
Model
Experiments
800 °C
900 °C
1050 °C
0
0.2
0.4
0.6
0.8
1
0
200
400
600
800

Conclusions

- Comprehensive single particle model developed
- H_2O gasification reactivity higher than CO_2 gasification reactivity
- High activation energies, especially for the H_2O gasification

Acknowledgement

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