

Development of a soft-sensor for the monitoring of the flue gas properties in a pyrolysis plant



Ahmed El Hanafi[a,b]
Helmut Niederwieser[a]
Martin Horn[a,b]
Markus Schwarz[a]
Michael Kolm[a,b]
Elisabeth Wopienka[a]
Manuel Schwabl[a]
Michael Fahrngruber[a]
Konstantin Moser[a]
Andre Schillingmann[c]
Markus Gölles[a]

[a)] **BEST - Bioenergy and Sustainable Technologies GmbH**
[b)] **Institute of Automation and Control, Graz University of Technology ,**
[C)] **Regenerative Energiewirtschaftssysteme GmbH**

[*] corresponding author:
markus.goelles
@best-research.eu

AREA 2.2 Automation and Control

BEST – Bioenergy and Sustainable Technologies GmbH

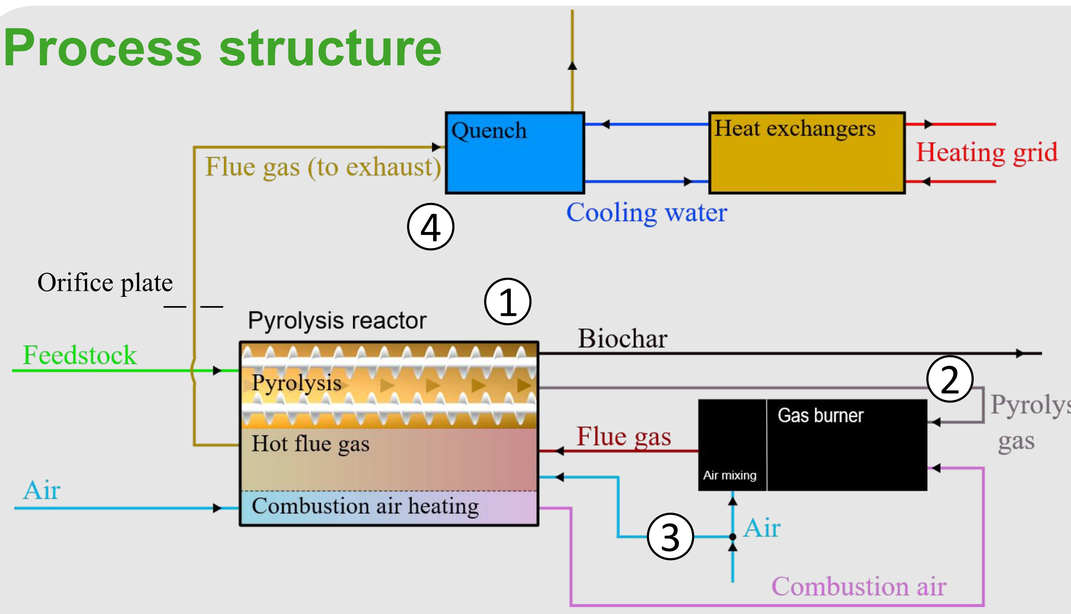
Head Office Graz
Inffeldgasse 21b
A 8010 Graz

P +43 5 02378-9201
office@best-research.eu
www.best-research.eu

Introduction and motivation

Pyrolysis is a thermochemical process devoted to the production of biochar, a black, porous, carbon rich solid employed in different applications such as carbon sink, active filtering, soil amendment, as substitute for fossil coal in steel production, and many others. Due to technological limitations, it is not possible to measure online the most interesting properties of the solid streams, e.g. the feedstock and the output biochar, making monitoring of the process challenging. On the other hand, many sensors (temperature and pressure sensors, lambda probe, flow meters) are typically available for the gas streams. Since the gas streams' properties are related to relevant properties of the solid flows, as a first step, a soft-sensor aimed at monitoring the flue gas mass flow rate and composition is developed starting from the available sensors.

Process structure



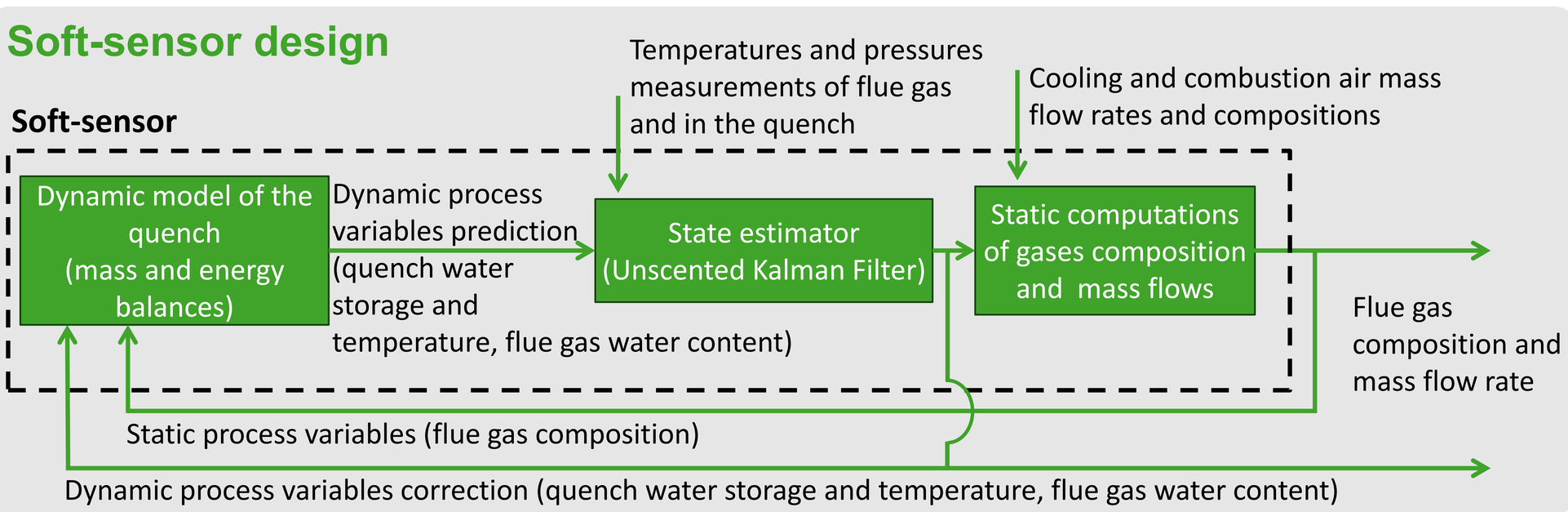
① Feedstock is pyrolysed to biochar, and pyrolysis gases are released as a byproduct.

② Pyrolysis gases are burned to produce hot flue gas, used for reactor heating.

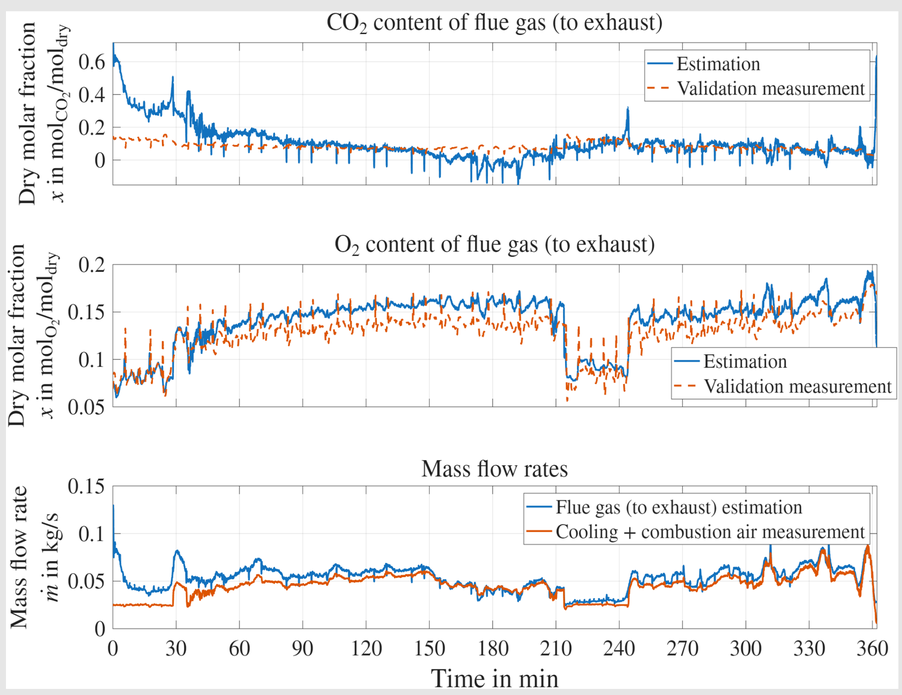
③ Ambient air is used for temperature regulation (cooling).

④ Flue gas is quenched and then exhausted.

Soft-sensor design



Exemplary results and validation



It is assumed that the flue gas dry composition is comprised of CO_2, O_2 and N_2.

Conclusion and outlook

- Large fluctuations were observed in the CO_2 estimate, along with an offset in the O_2 estimate with respect to the validation measurement in some time intervals. A possible cause is the uncertainty in the measurements of the cooling and combustion air mass flow rates, which must be further investigated.
- Future developments will focus on extending the estimations to the pyrolysis gas properties.
- The final goal is to estimate the biochar composition and yield from the gas properties estimates.

FFG Promoting Innovation. Federal Ministry Innovation, Mobility and Infrastructure Republic of Austria. Federal Ministry Economy, Energy and Tourism Republic of Austria. vienna business agency. For the City of Vienna. Das Land Steiermark Economy, Labour, Finance, Science and Research. SFG Styrian Future Group