



BEST

Bioenergy and
Sustainable Technologies



 Bundesministerium
Arbeit und Wirtschaft

 Bundesministerium
Klimaschutz, Umwelt,
Energie, Mobilität,
Innovation und Technologie



Zentrumstag 2025 pyro4PPC - Biochar product and process control

BEST Annual Conference, September 17th, 2025

Markus Schwarz, Manuel Schwabl
Area Thermochemical Technologies



 Bundesministerium
Arbeit und Wirtschaft

 Bundesministerium
Klimaschutz, Umwelt,
Energie, Mobilität,
Innovation und Technologie

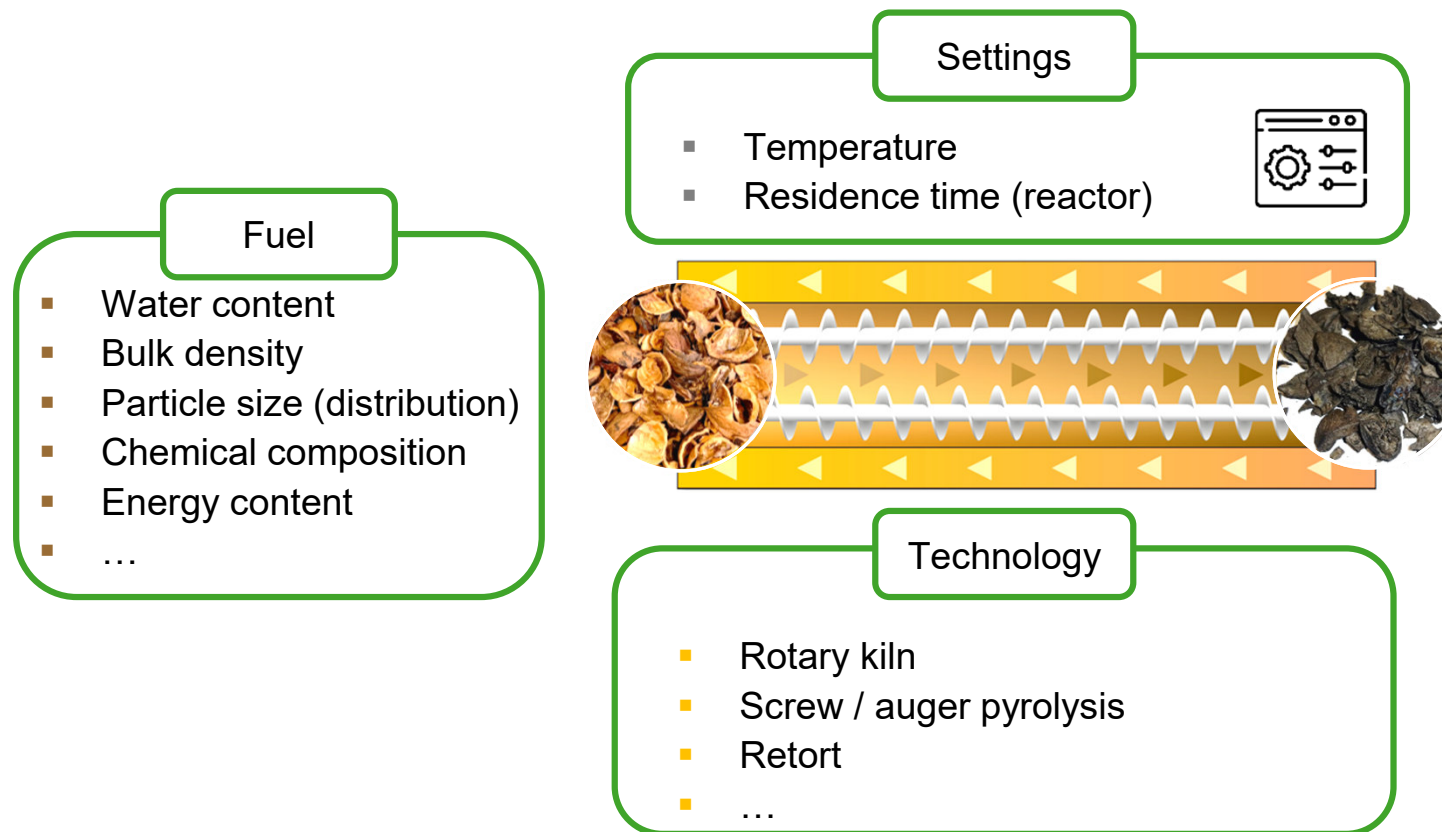


 Für die
Stadt Wien





Challenges from input material, technology-related characteristics and variables

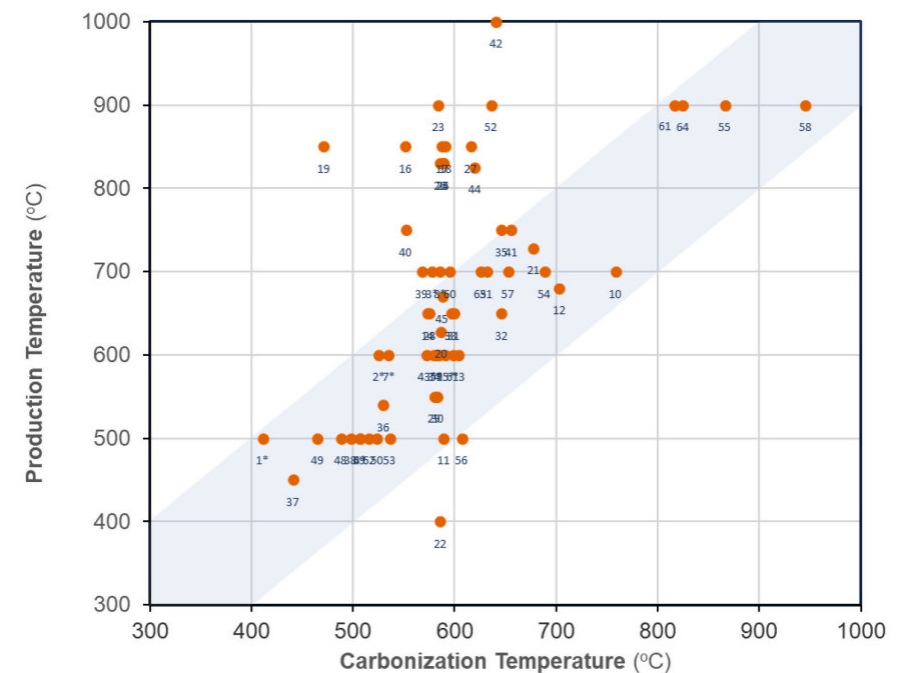


- ✓ **Variable input materials**
- ✓ **Defined specifications**
- ✓ **Continuous quality control** for „just in time“ production
- ✓ Optimum residence times for **maximum throughput & best system utilisation**



Biochar Quality – product requirements and specifications

- **Minimum temperature requirement**
 - Stable and permanent modifications
 - Complete removal of unwanted volatile substances (e.g. PFAS) or hygienisation
 - Often Limited by Pyrolysis Plant Construction
- **Upper temperature limit**
 - Maximize yield
 - Avoid ash melting and side reactions (e.g. composite material separation by conversion)
- **Operation within defined temperature window**
 - Complete pyrolysis of whole piece
 - Brittleness properties for defined particle grinding
 - Defined share of volatiles for specific (metallurgic) applications



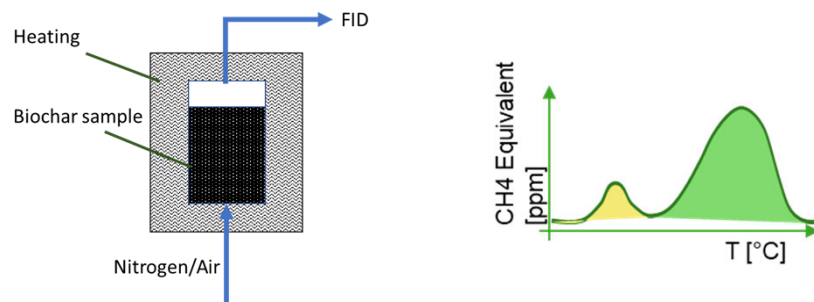
Reference: Sanei, H. et al.: Assessing biochar's permanence: An inertinite benchmark, *International Journal of Coal Geology*, Volume 281, 2024, 104409, ISSN 0166-5162



Bluesky Project pyro4PPC Solution

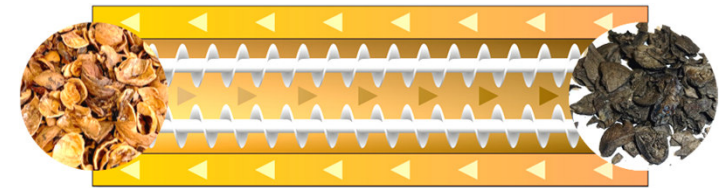
at-line and smart process & product quality control

pyro-FID



- “Pyrographic” Analysis
 - PAH/condensates
 - Volatiles
 - Carbon content

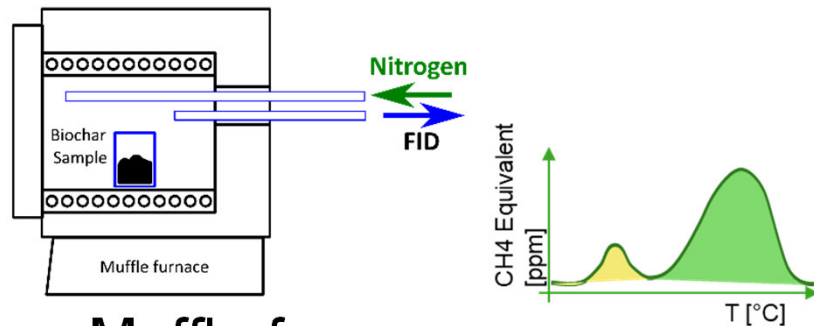
Model based process monitoring



- Soft sensor for
 - Carbonisation temperature
 - Residence time



Function test setup for Pyro-FID



- Muffle furnace
 - Heating rate 7,5°C/min
 - Flushed with Nitrogen 1-10 l/min
- Flame ionization detector
 - Gas extracted via 6 mm quartz glass pipe
 - Huge measurement range

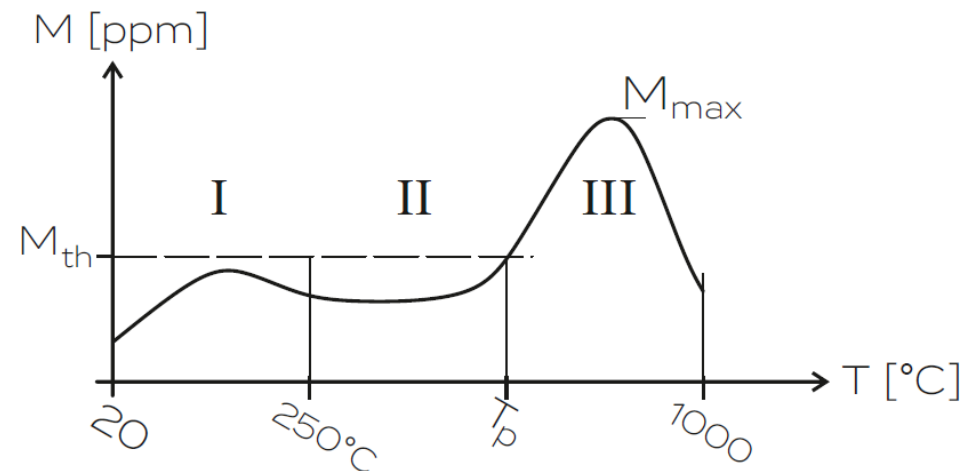




Temperature evaluation ranges

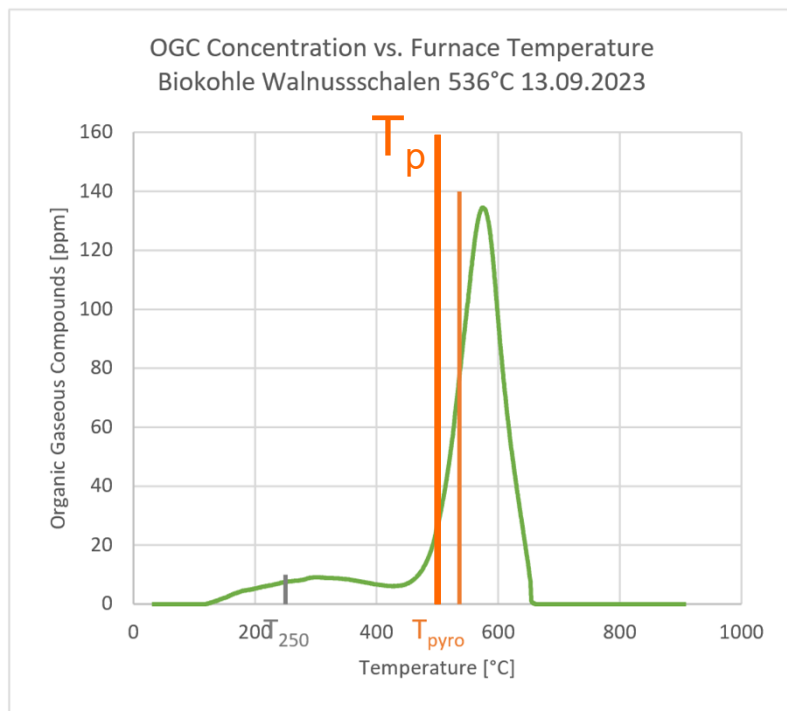
Determination of nominal Pyrolysis Temperature

- Temperature range I
 - Up to 250 °C
 - On Surface adsorbt or condensed org. substances
- Temperature range II
 - 250°C to T_p
 - Homogeneity of pyrolysis
- Temperature range III
 - T_p to 900°C
 - Non inertinite



T_p ... nominal Pyrolysis temperature

Measurement results

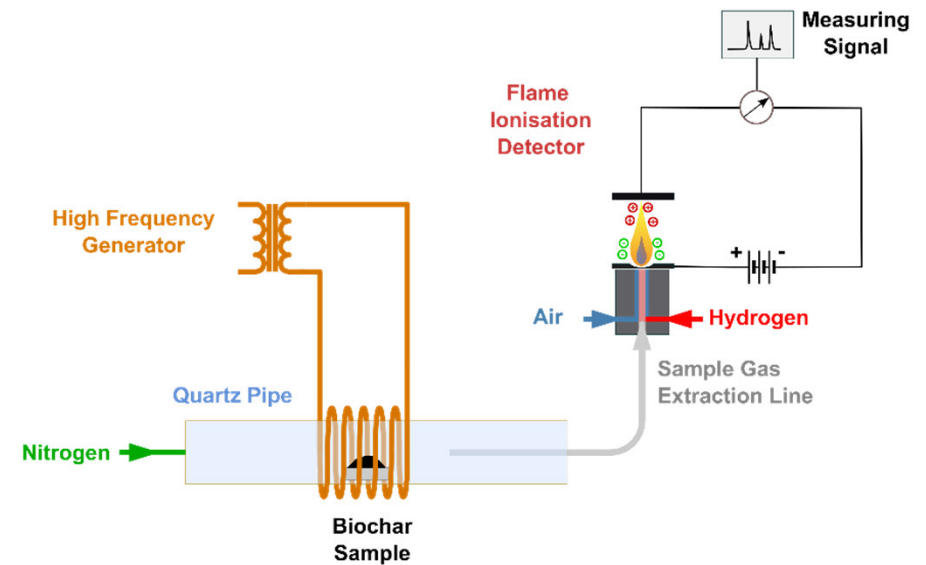


Parameter	Value
Sum orgC below T_{250}	3,9%
Sum orgC below T_{pyro}	31,0%
Sum orgC above T_{pyro}	69,0%
Nominal Pyrolysis Temp. T_p	507°C
H/C _{org} ratio	0,40
O/C _{org} ratio	0,09



Next steps

- Assembly of improved setup
 - Speed up of analysis
 - heating using inductive heater
 - Preheating of nitrogen
 - Airtight system
- Patent for analyzer applied





Elisabeth Wopienka
Area Manager
Thermochemical Technologies
elisabeth.wopienka@best-research.eu



Manuel Schwabl
Area Manager
Thermochemical Technologies
manuel.schwabl@best-research.eu



Markus Schwarz
Senior Researcher
Thermochemical Technologies
markus.schwarz@best-research.eu



Markus Gölles
Area Manager
Automation and Control
markus.goelles@best-research.eu



Helmut Niederwieser
Senior Researcher
Automation and Control
helmut.niederwieser@best-research.eu