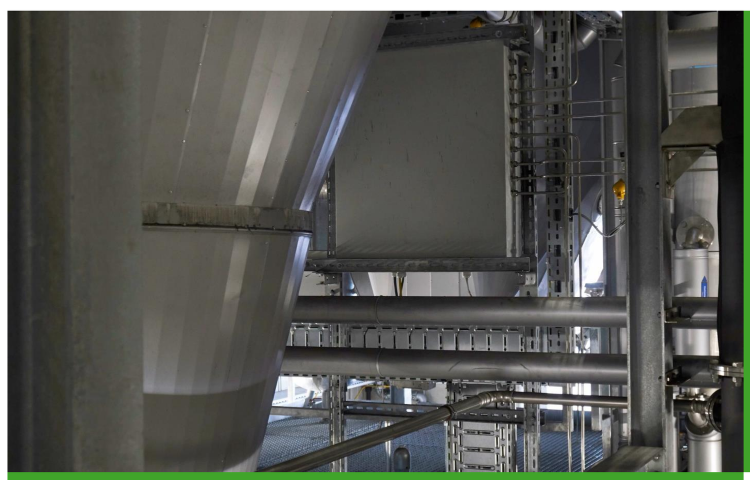


BIOCHAR – Reaction kinetics under gasification conditions by experimental tests with TGA

Jacqueline Lagler
Stefan Martini
Norbert Kienzl
Astrid Loder

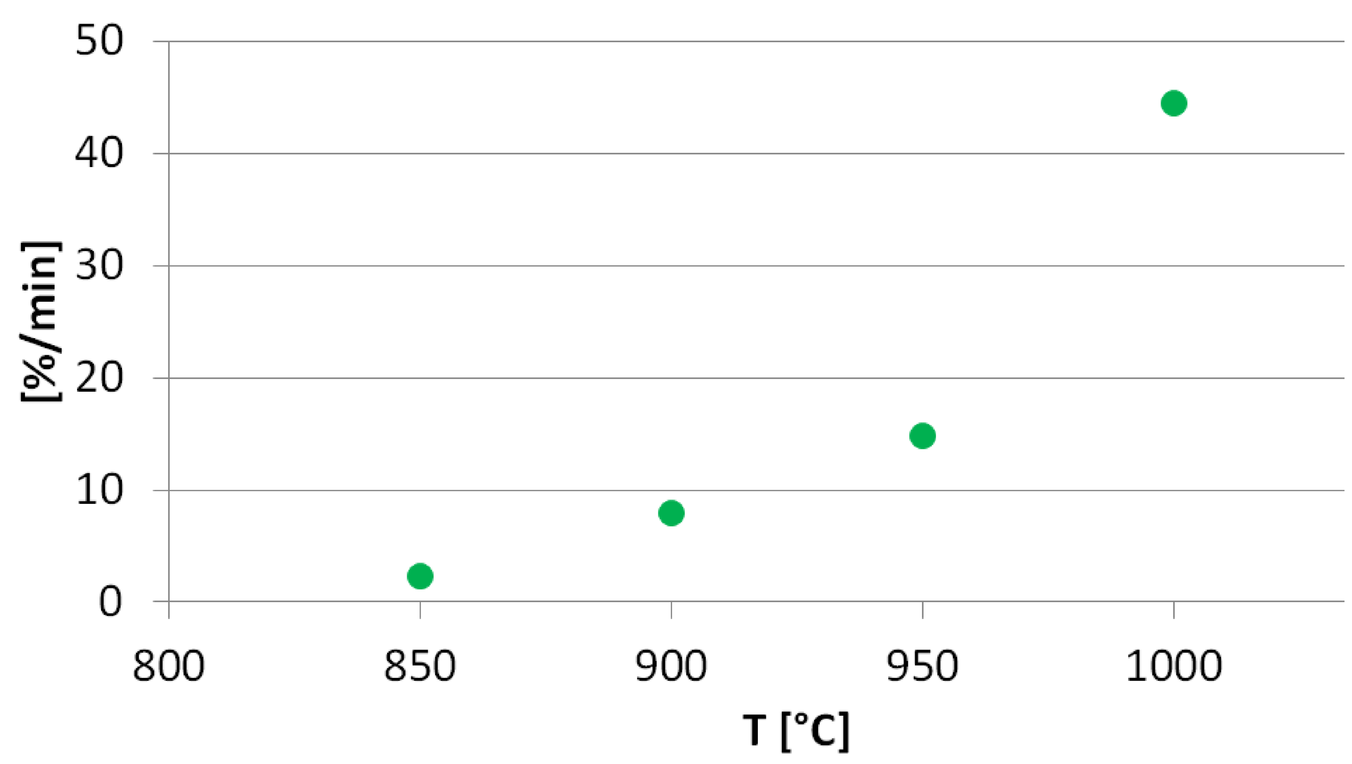
Fixed Bed Conversion Systems

Theoretical Background

Intelligent, efficient and flexible biomass conversion technologies are essential for a future regenerative energy supply system in Central Europe.

Biochar is an intermediate product which can be retrieved by reducing the conversion. This implicates less producer gas, but as a matter of course, with its high market potential, biochar comes to the fore. According to its characteristics different prices can be achieved, therefore, an extended research on reaction kinetics of biochar is from crucial importance for the development and optimisation of downstream upgrading processes in order to reach the desired quality of the biochar.

The conducted experimental tests focus primarily on conditions comparable to the gasification process in which solid biomass converts into so called producer gas and a solid residue. Depending on the degree of transformation this solid residue consists of ash only or of so called biochar as well.



Graphic 1: Reaction rates of Biochar with vapour at a conversion of 40% and different temperatures

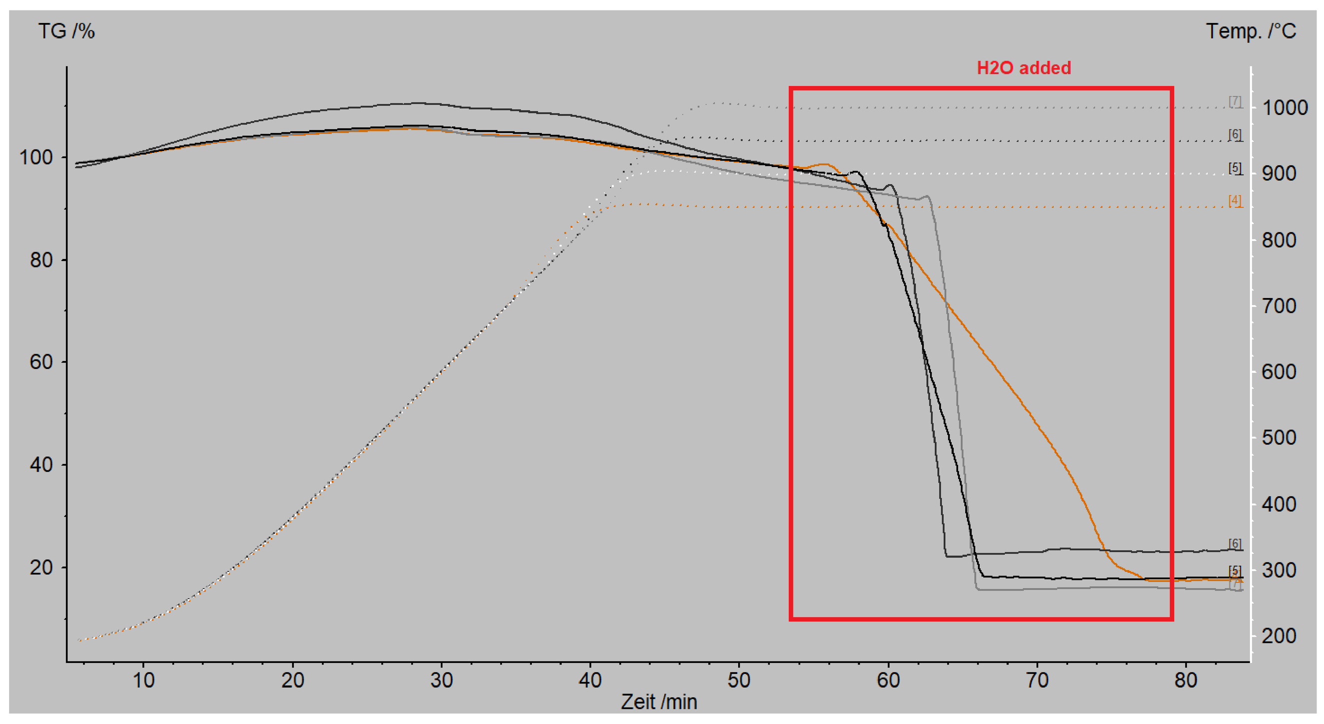
In order to derivate the correlation between reaction kinetics and atmosphere composition, experimental test runs are conducted with a Thermogravimetric Analyser (TGA). For achieving highest adequacy in the results of the experimental tests, the limitations of the TGA-test-setup, like sample mass and gas flow, are evaluated. For example, from comparative tests with other TGA systems we detected differences due to the flow direction.

This leads to a definition of the test design. Afterwards, the reaction kinetics is examined by varying the content of moisture and CO_2 in the atmosphere in a temperature range between 700 and 1000°C.

TGA – test setups

Variations of the following parameters are to be examined:

- temperature (isothermal test-setup)
- heating rate (dynamic test-setup)
- H2O
- CO2



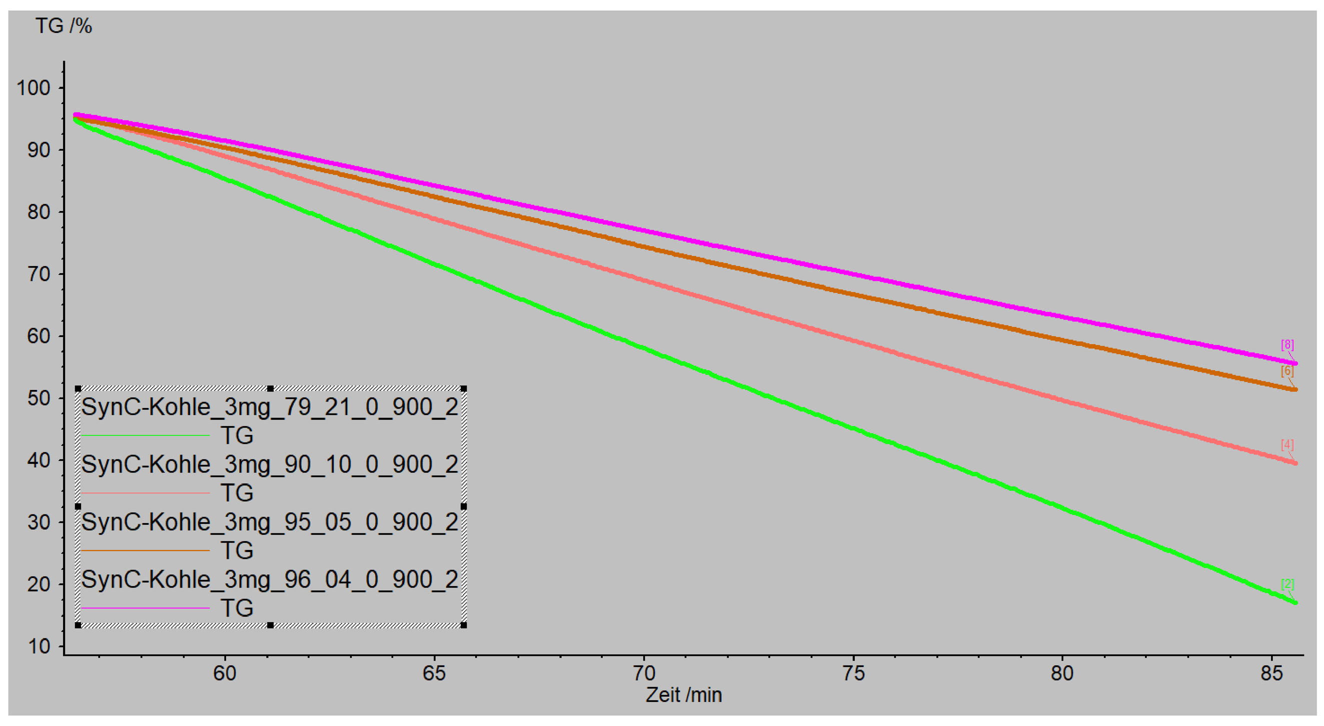
Graphic 2: TGA setup

By adding nitrogen the total flow is held constant at 100ml/min. The temperature program of the TGA is usually started at 200°C and heated with a constant heating rate to the temperature under investigation. If other parameters are under investigation the sample is heated to 900°C. After a short isothermal phase the atmosphere is changed to the investigated atmosphere.

This test setup shall be compared with the approach that the atmosphere under investigation is already added during the heating phase. Instead of varying the end temperature, the heating rate is changed.

Reaction kinetics

The experimental reaction rate calculated as quotient of the conversion and the time period which was ned for the conversion.



Graphic 3: TG signals of CO_2 -variations

First tests already show the positive dependency of reaction rate to temperature and the amount of moisture in the atmosphere. CO2 on the other hand is slowing down the conversion.

It will be investigated if the experimental reaction rates at isothermal conditions equals the dynamic ones. Additionally, they are to be compared with models from the literature to find the most accurate one or a new one will be implemented by a regression model fitting the data.

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

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