

Combined Filter Material for Emission Reduction in an Internal Combustion Engine Fired with Bioliquids



EUBCE 2019
27TH EUROPEAN BIOMASS
CONFERENCE & EXHIBITION

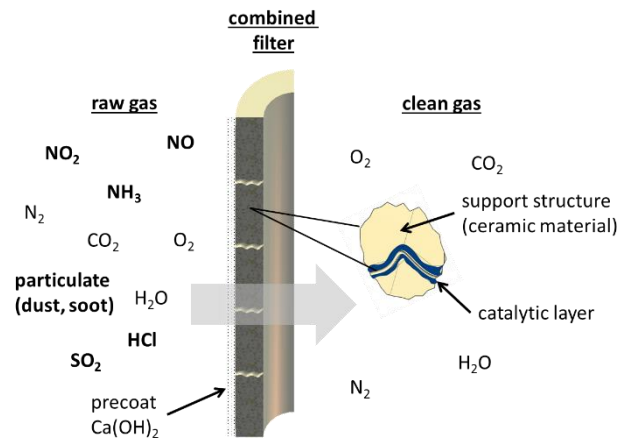
27 - 30 MAY CONFERENCE AND EXHIBITION
31 MAY TECHNICAL TOURS
LISBON - PORTUGAL
LISBON CONGRESS CENTER - CCL

27.05.2019

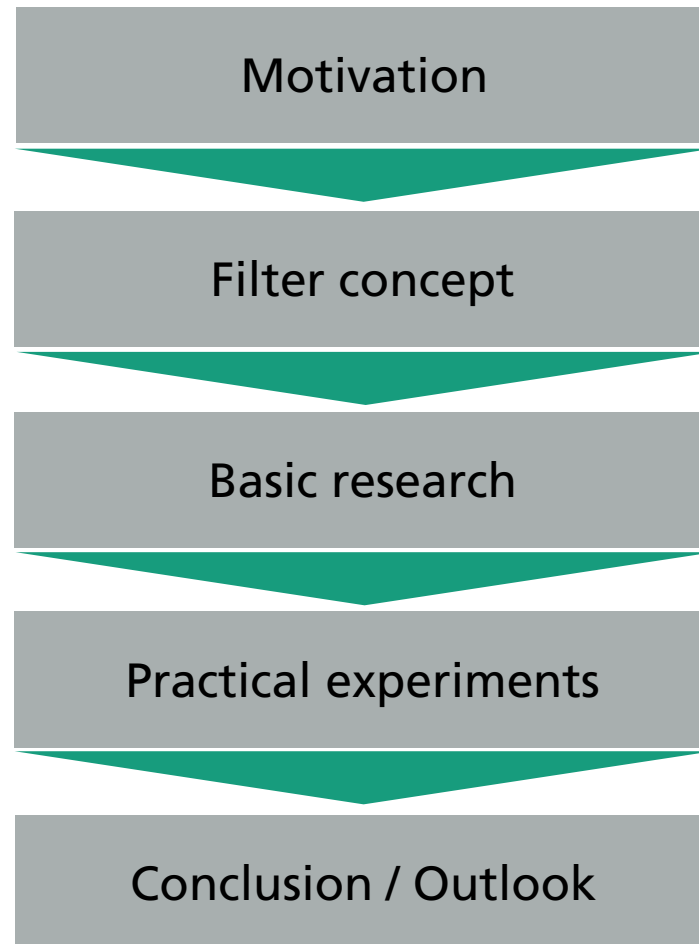
Lisbon

Julian Walberer

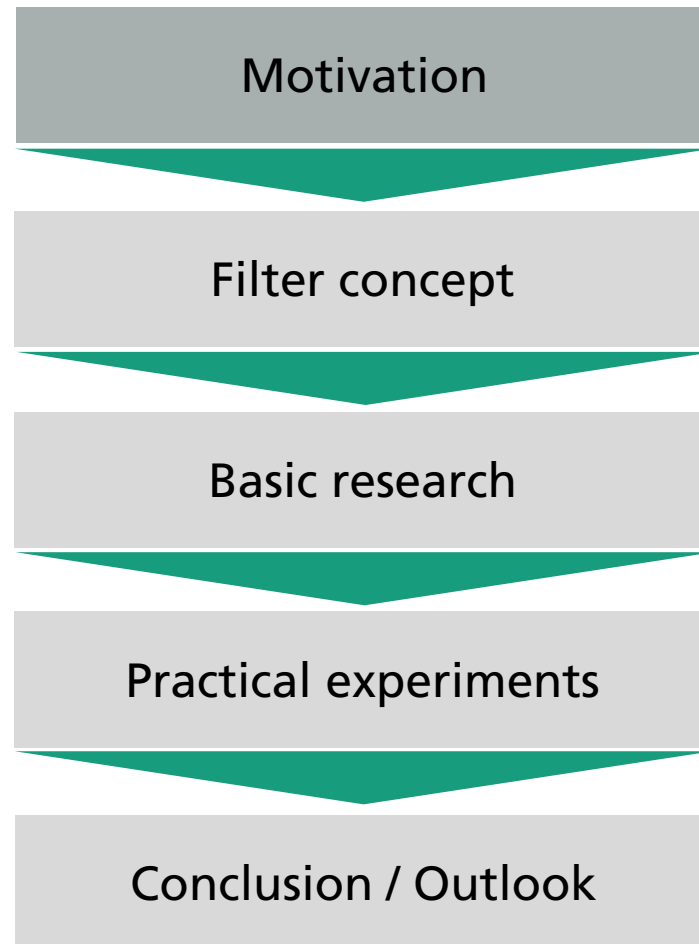
Fraunhofer UMSICHT



AGENDA



AGENDA



Motivation

Air pollution / legal framework



- IE-Directive 2010/75/EU (>50 MW)
- MCP-directive (EU) 2015/2193 (1-50 MW)
- Ecodesign-directive 2009/125/GG (< 1MW)



- 1.BImSchV
- TA Luft



- Individual programs for municipalities

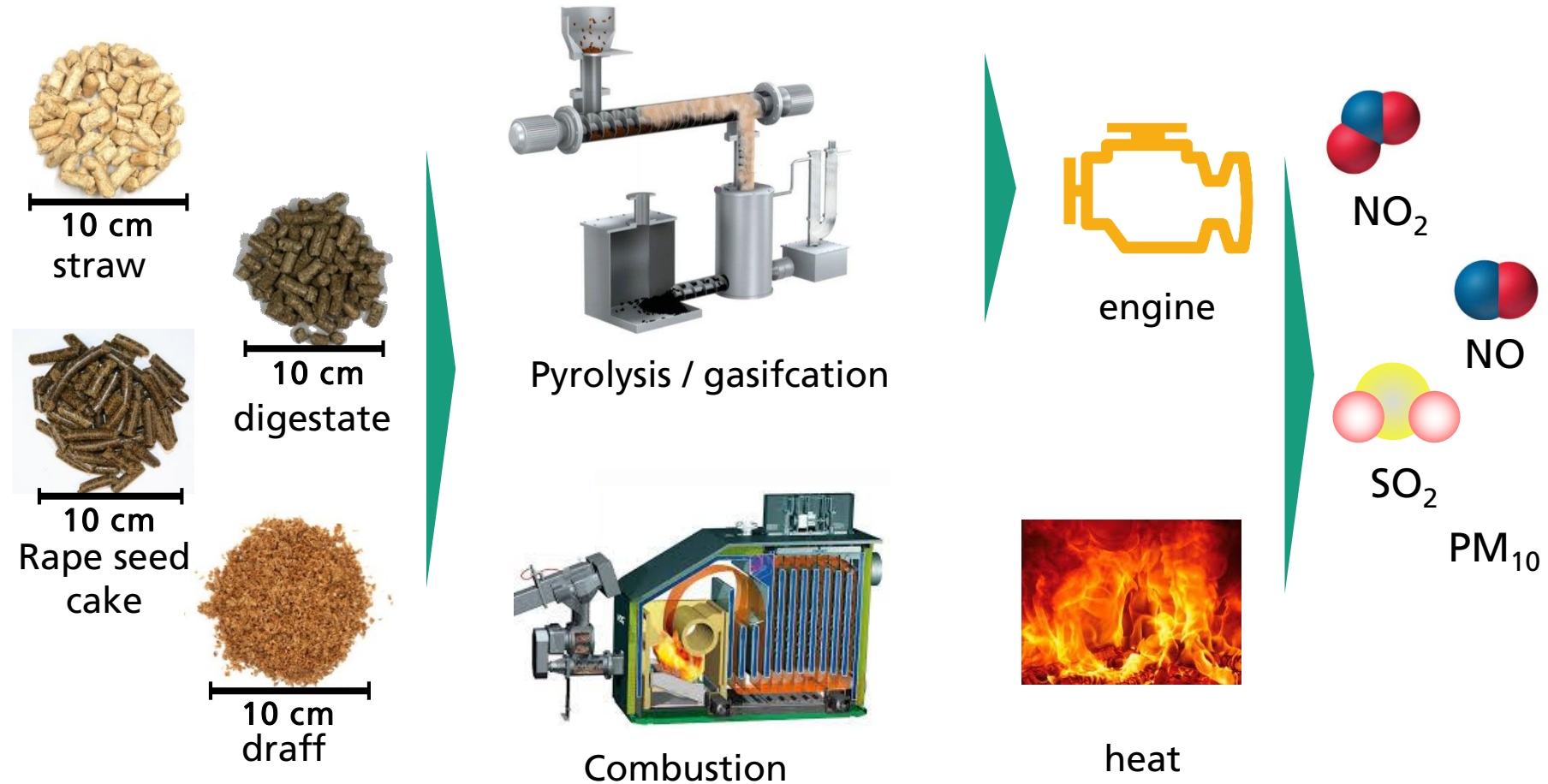
→ Stricter limits for biogenic residues and woody biomass

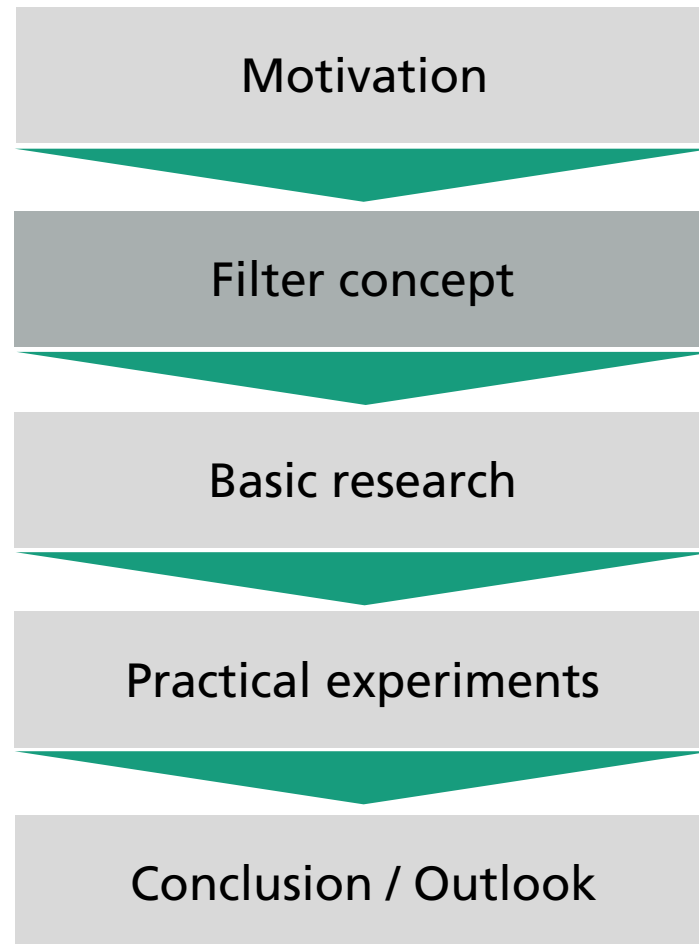
→ NO_x emission limits for furnaces < 1 MW

Quelle: <http://www.tageblatt.lu/nachrichten/dicke-luft-in-london-21385992/>
<https://www.duda.news/wissen/diesel-benzin-was-schadet-umwelt-mehr-probleme-stuttgart/attachment/demo-in-stuttgart/>
https://www.nwzonline.de/hintergrund/berlin-schadstoffe-sind-diesel-abgase-wirklich-toedlich_a_50,3,3326595712.html

Motivation

Utilization of residues / new technologies





State of the Art / Idea

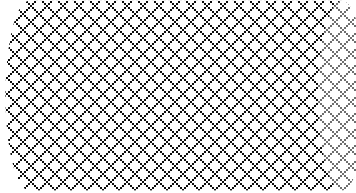
Common exhaust gas treatment

Dust reduction



Filtration

NOx reduction



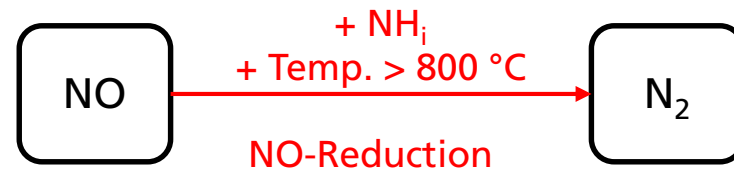
SCR or SNCR

Idea

Background

SNCR: → 850 - 900°C

- Position of AdBlue injection?
- Part load
- Ammonia slip



Quelle: ⁷Koger S., 2009

Idea

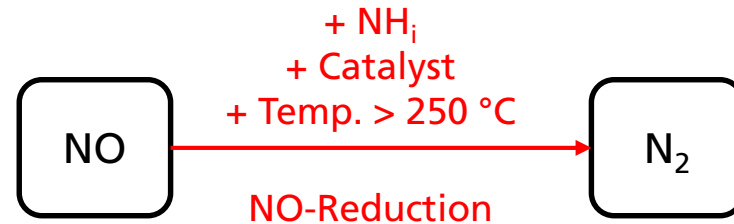
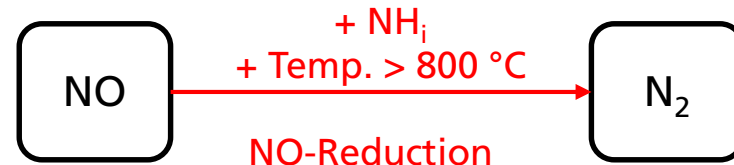
Background

SNCR: → 850 - 900°C

- Position of AdBlue injection?
- Part load
- Ammonia slip

SCR: → 250 - 400°C

- High Invest costs
- Efficiency losses
- Part load



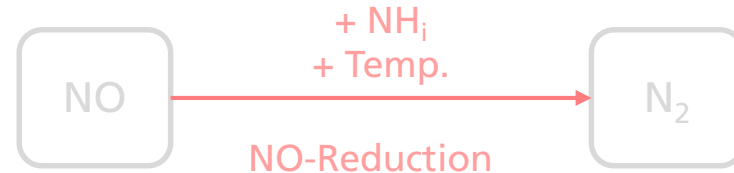
Quelle: ⁷Koger S., 2009

Idea

Background

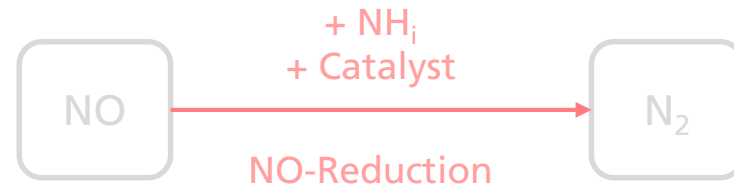
SNCR: → 850 - 900°C

- Position of AdBlue injection?
- Part load
- Ammonia slip



SCR: → 250 - 400°C

- High Invest costs
- Efficiency losses
- Part load



Goal: → 150 - 200°C

- Combined reduction of particulate matter and nitrogen oxides
- Use of inexpensive catalyst materials
- Concept for protecting the catalytically active centers

Quelle: ⁷Koger S., 2009

State of the Art / Idea

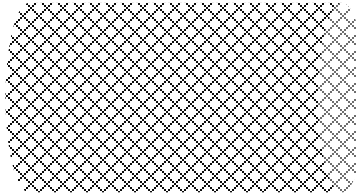
Common exhaust gas treatment

Dust reduction



Dust filter

NOx reduction



Low temperature
SCR catalyst

SO2 reduction



Dry Adsorption

State of the Art / Idea

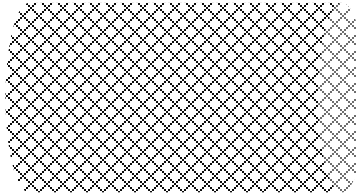
Common exhaust gas treatment

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Dust filter

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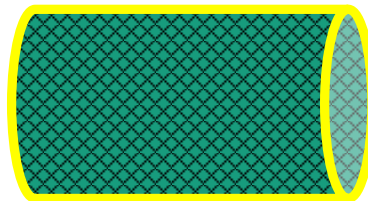


Low temperature
SCR catalyst

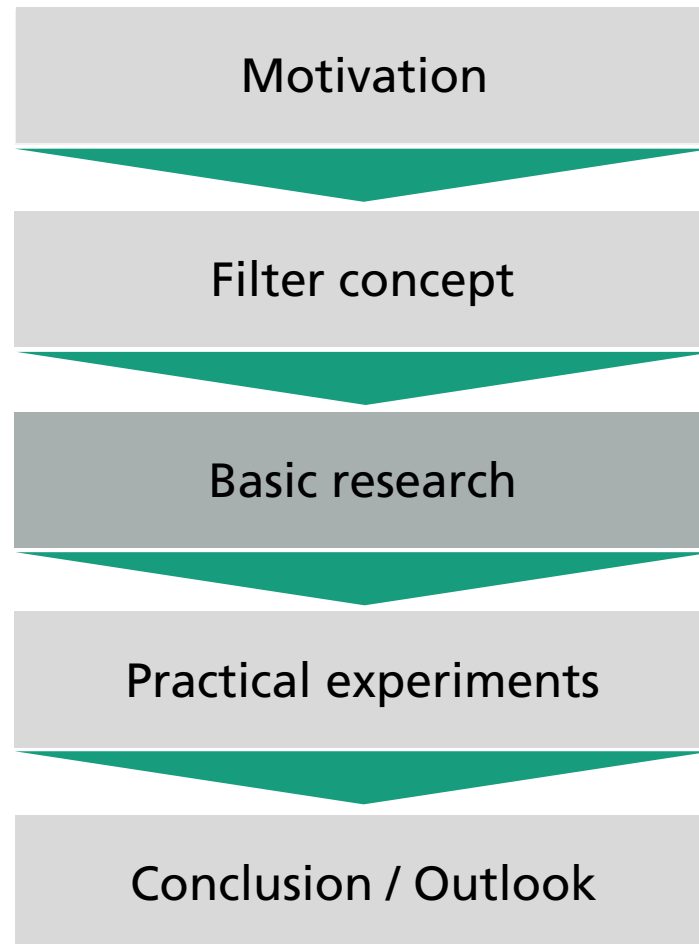
SO2 reduction



Dry Adsorption



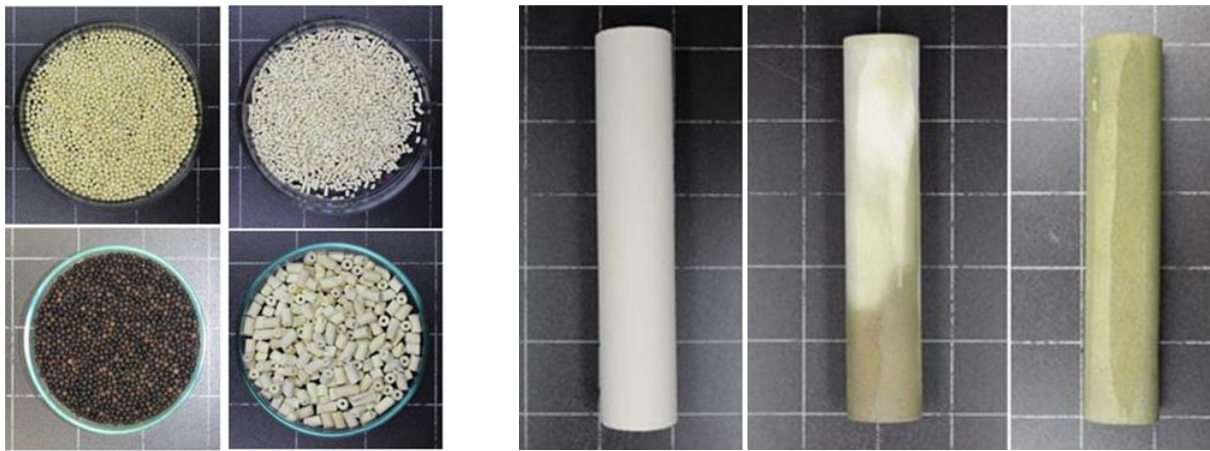
Combined filter for dust, NOx, and SO2 reduction



Basic research

Catalysts and carrier material

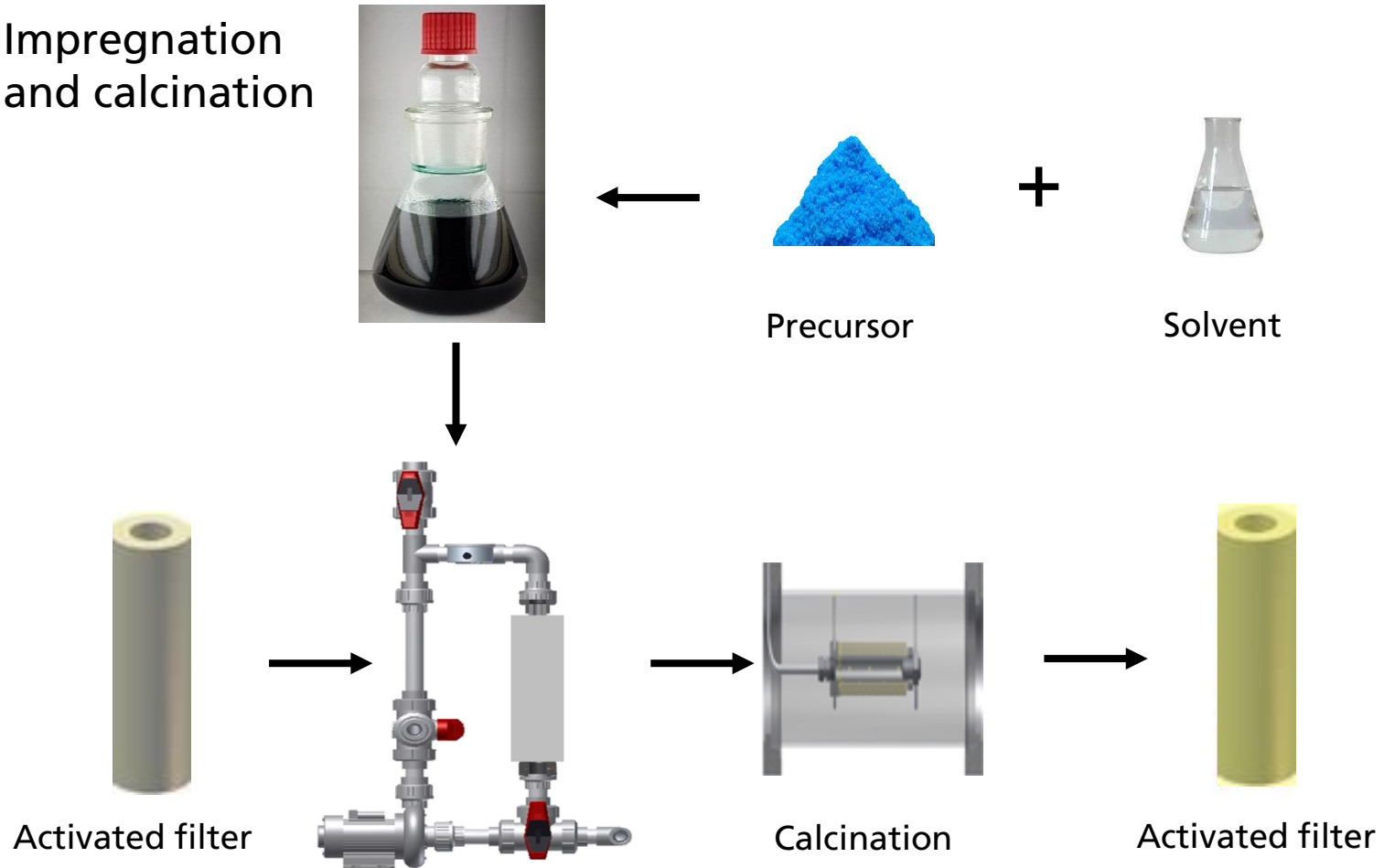
- Tests of different catalysts (V, Ti, W, Mn, Fe, Cu, Zeolites)
- Variation of production and process parameters
 - Loading
 - Calcination atmosphere, temperatures
 - pH
- Variation of different support structures



Basic research

Activation

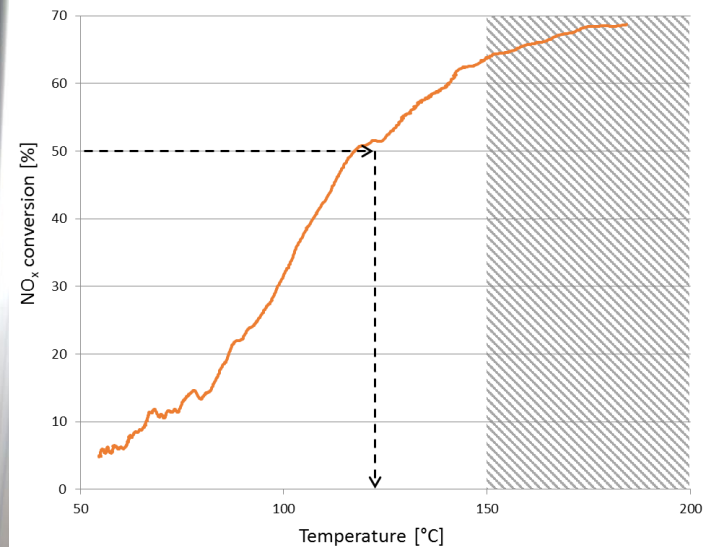
- Impregnation and calcination



Basic research

SCR-test rig

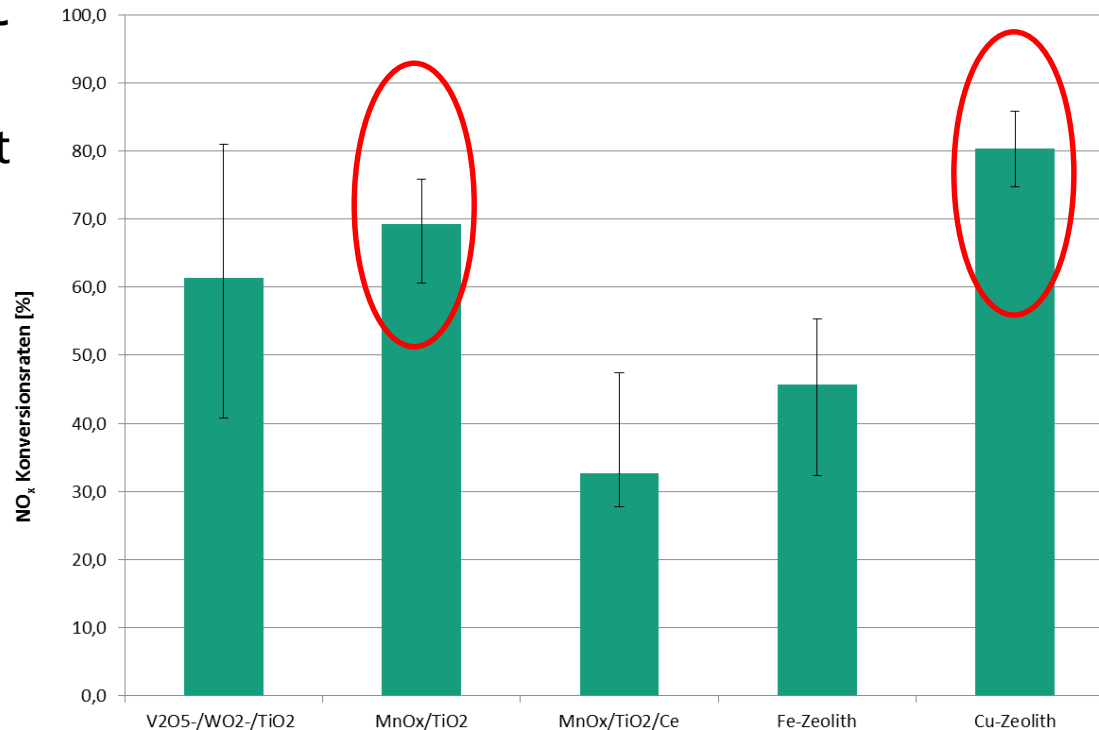
- Simulation of different gas mixtures (N_2 , CO_2 , H_2O , NO , NO_2 , NH_3 , CO , HCl , SO_2)
- Effects of catalysts poison
- Parallel measurement of raw gas and clean gas
- Light-off curves

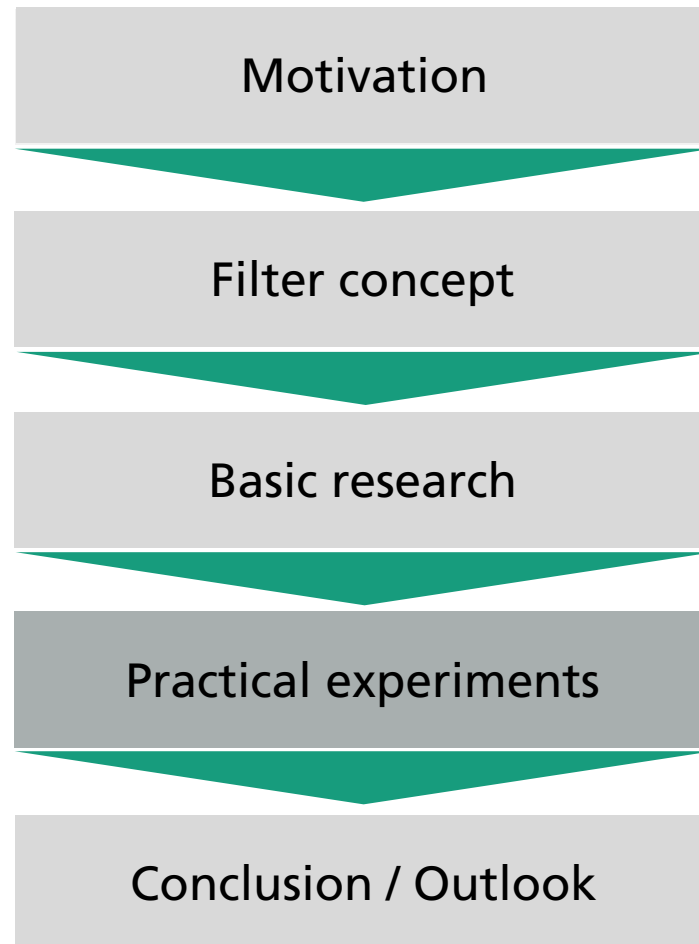


Versuchsergebnisse

SCR-test rig

- NO_x -conversion at 200 °C of activated filters
- over 30 different catalyst where activated and tested
- MnO/TiO₂ and Cu-ZMS are the most promising catalysts

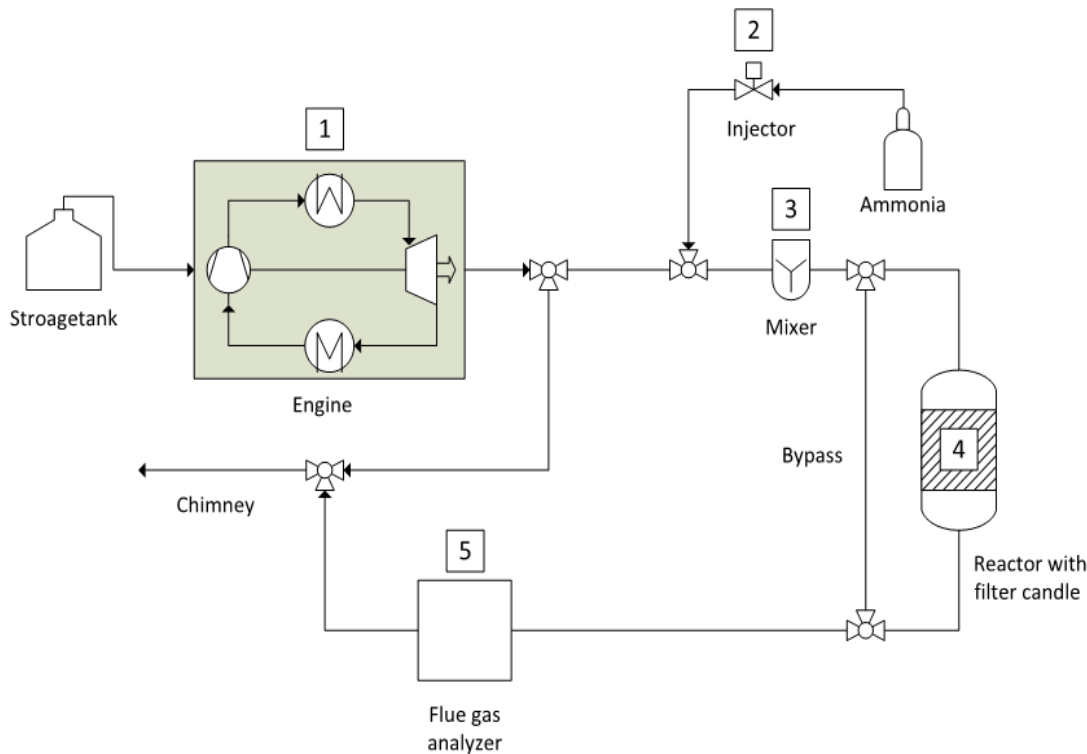




Practical experiments

Experimental setup

- Test in an internal combustion engine running with biofuels



Engine		Generator	
Manu- facturer	Kubota Corporati on	Manufacturer	Leroy- Somer
Type	V 3300 BG	Type	Synchr onous genera tor
Displace- ment	3318 cm3	Max. electrical output	25.2 kW
Combustion technology	swirl chamber, NA engine	Thermal output	30 kW

Practical experiments

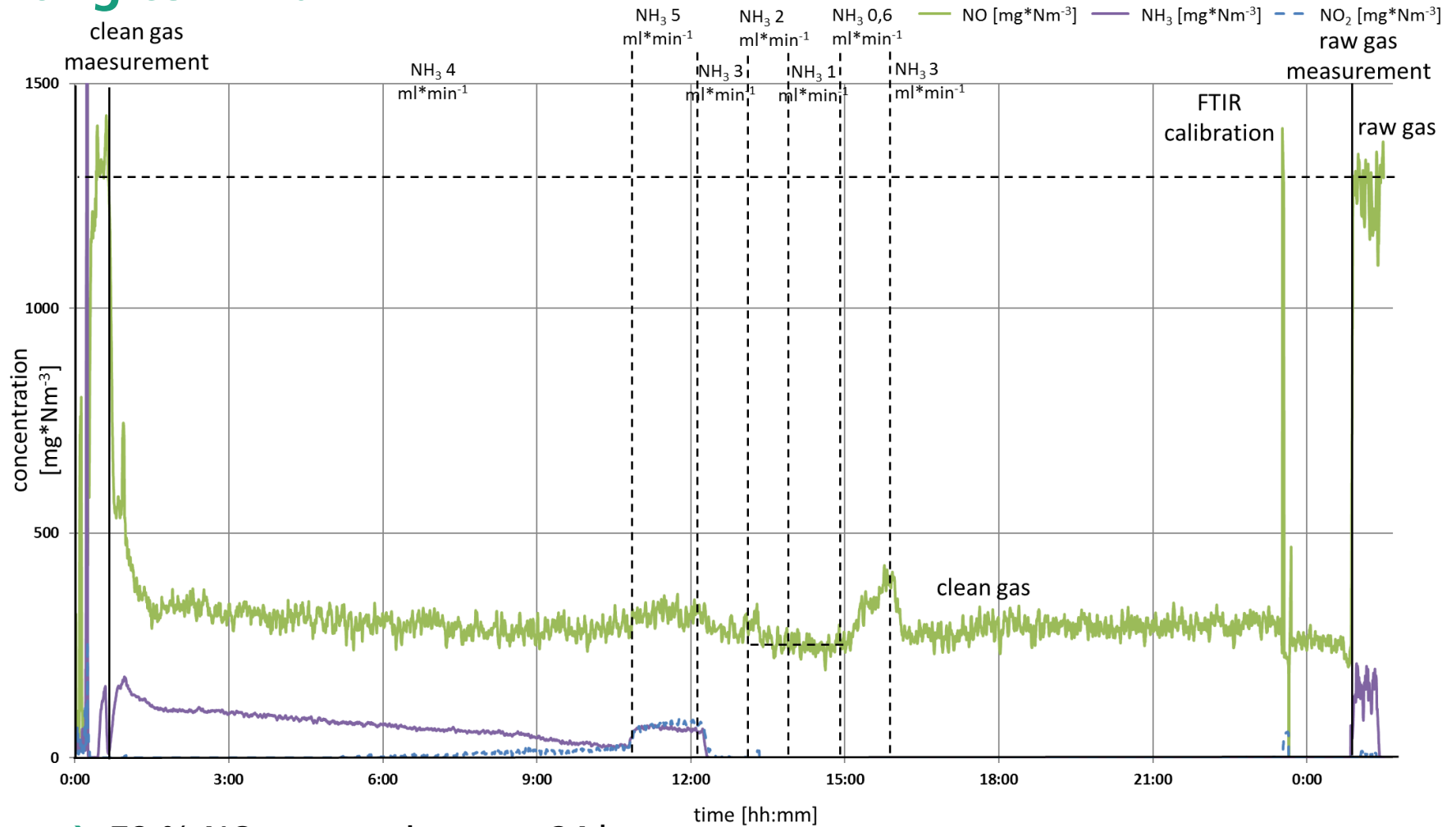
Experimental procedure

- Test with TCR[®]-fuels
- Test with TCR[®]-like fuels using DMSO for sulfur contain
- Long term run (FAME)
- Precoating of the filter candles with $\text{Ca}(\text{OH})_2$



Practical experiments

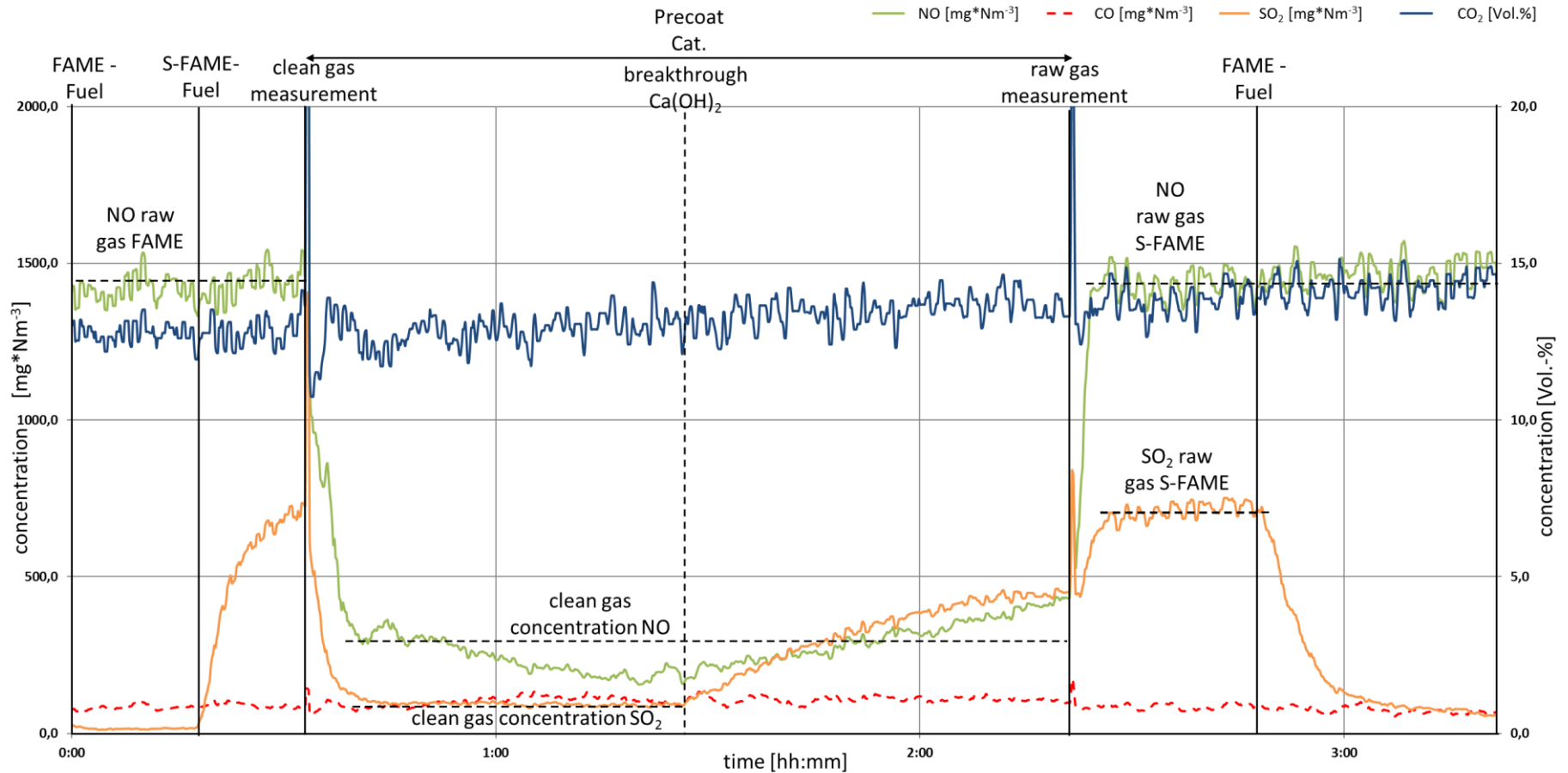
Long term run



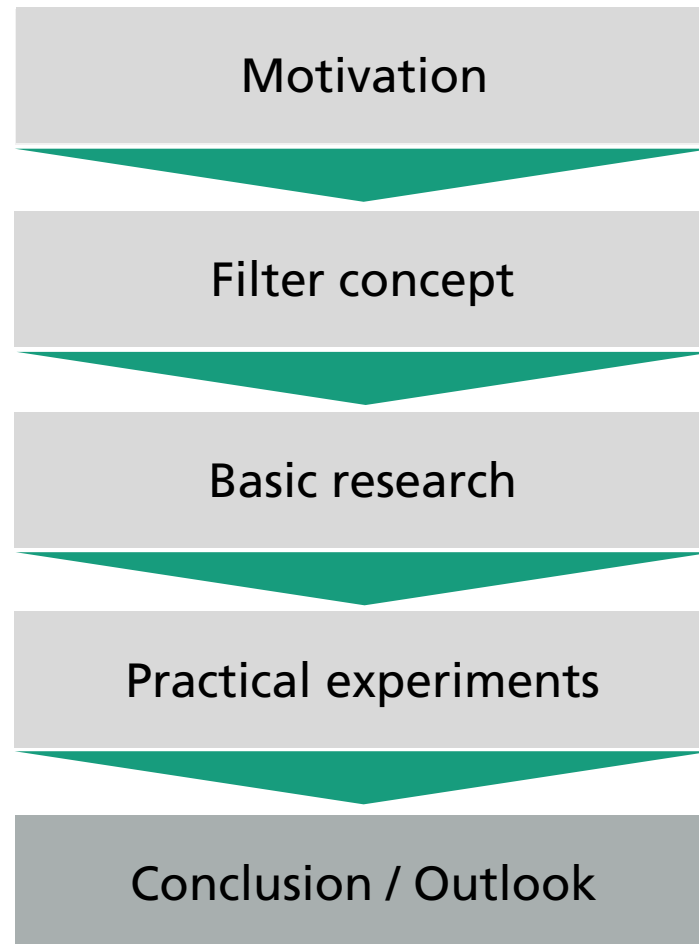
→ 78 % NO_x conversion over 24 h

Practical experiments

Test with TCR[®]-like fuel



→ 81 % NO_x conversion and 86.9 % reduction of SO₂



Conclusion / Outlook

Highlights

- Stricter limits for biomass combustion plants and small/medium scale application
- Compromising solution → combined filters
- Over 30 different catalyst combination tested
- High NO_x conversion at temperatures between 150 – 200 °C (over 60 % at 150 °C, over 80 % at 200 °C)
- Additional precoating of combined filters reduces SO₂ components
- DAnKEE project

Projekttitel: **Demonstration einer Anlage zur kombinierten Entstaubung und Entstickung**



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Thank you for
your attention!

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Founded from



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Wirtschaft und Medien, Energie
und Technologie