Comparative Tests of Catalysts for Tar Reforming

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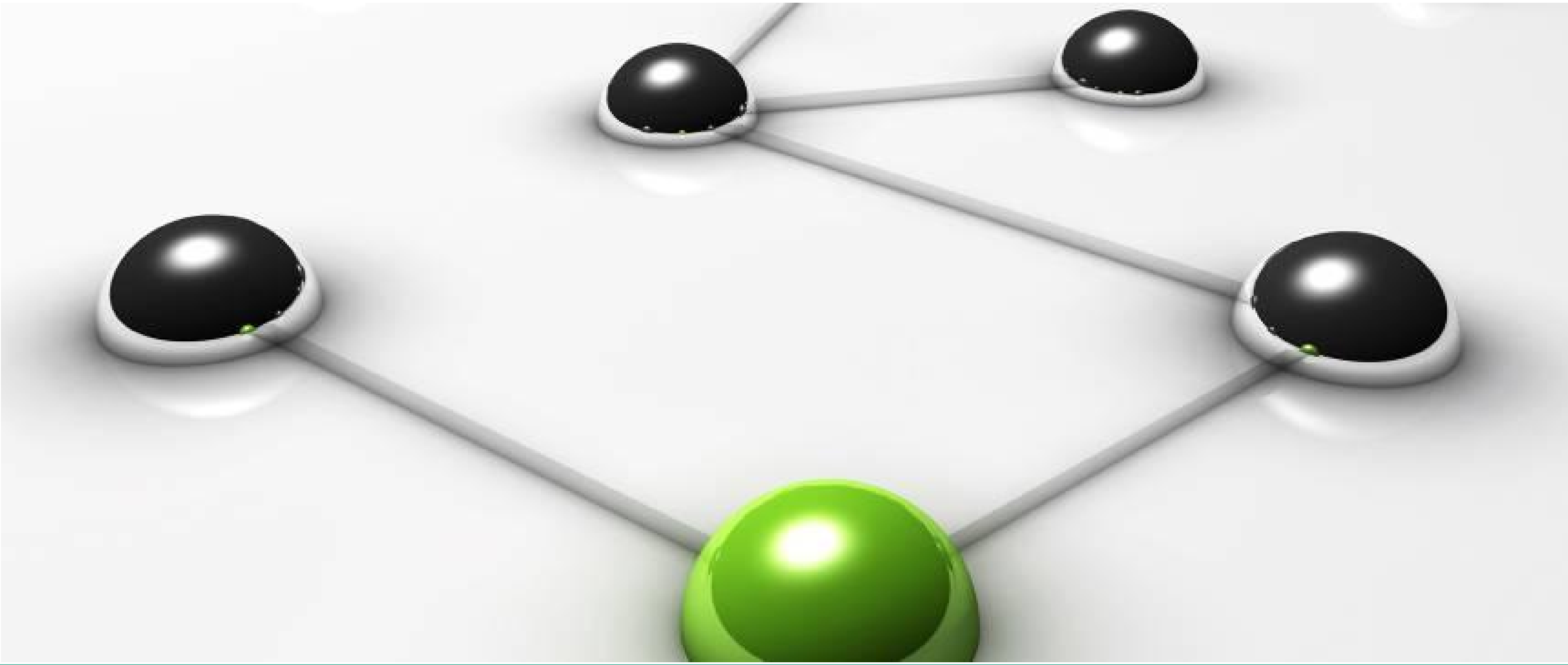

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Introduction

Background

- Shifting focus from energetic to material utilisation of syngas as consequence of rising biomass costs
- Gas from allothermal steam gasification (e.g. FICFB Güssing) with good prerequisites for material utilisation
- Lower process temperatures in comparison to other gasification systems
  - Ä Insufficient activity of available catalysts at these temperatures

Allothermal FICFB gasifier in Güssing (AT)

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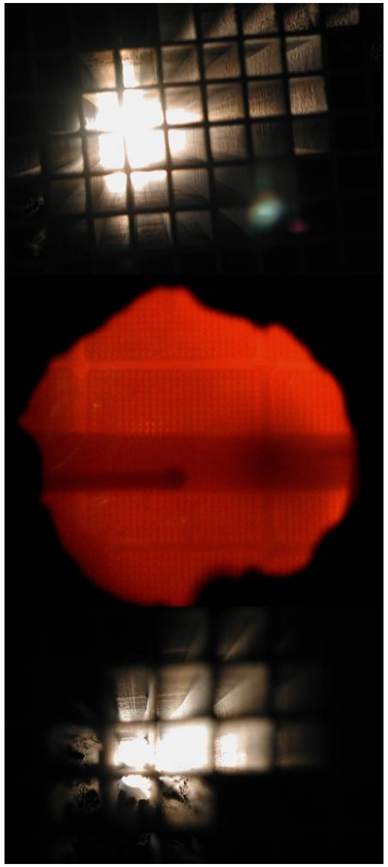
Introduction

Recent Project at Fraunhofer UMSICHT

- Aim:
  Development of catalysts suitable for tar reforming / removal in sulfur-containing syngas at relatively low temperatures
- First step:
  Benchmark tests of a broad variety of different catalysts with sulfur-free synthetic syngas supplied by Süd-Chemie AG
- Second step:
  - Addition of substances like sulfur, NH_3 and ethylene
  - Long-term tests over at least 10 h
- Analysis of results to improve / find best preparation method and amount of active component
- Project is done in direct cooperation with industrial partner



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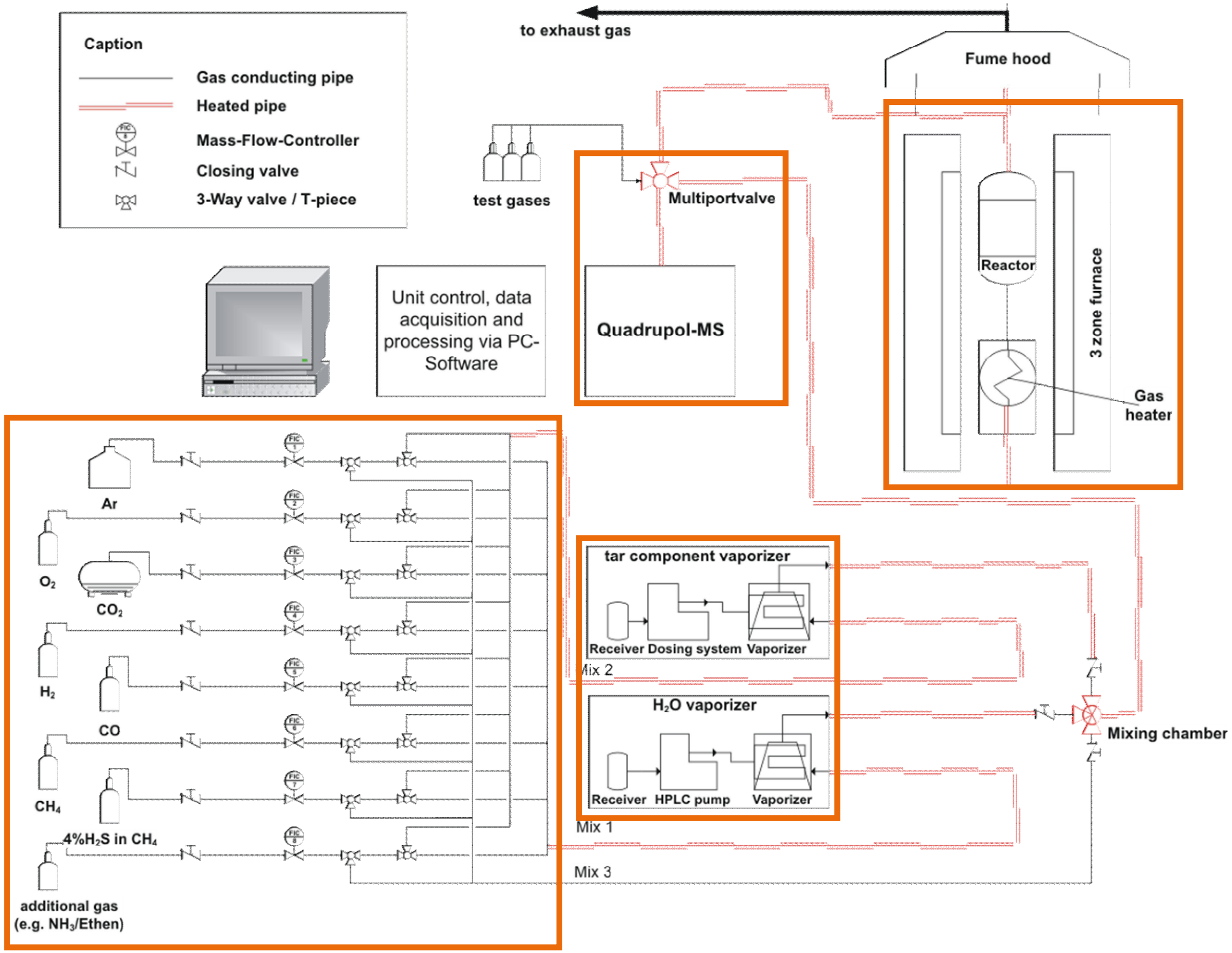
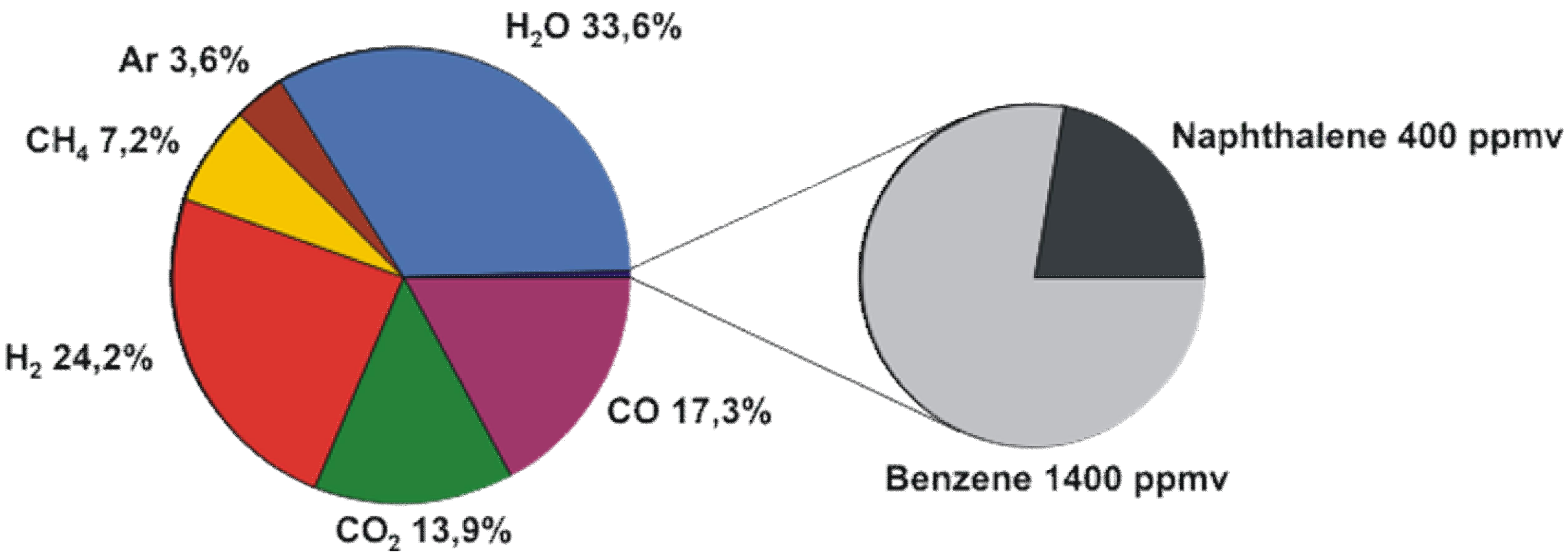
Test rig at Fraunhofer UMSICHT



Materials and Methods

Synthetic Syngas Composition

- Gas composition typical for allothermal gasifiers
  à like Güssing (AT)
- Benzene and naphthalene taken as model tar substances



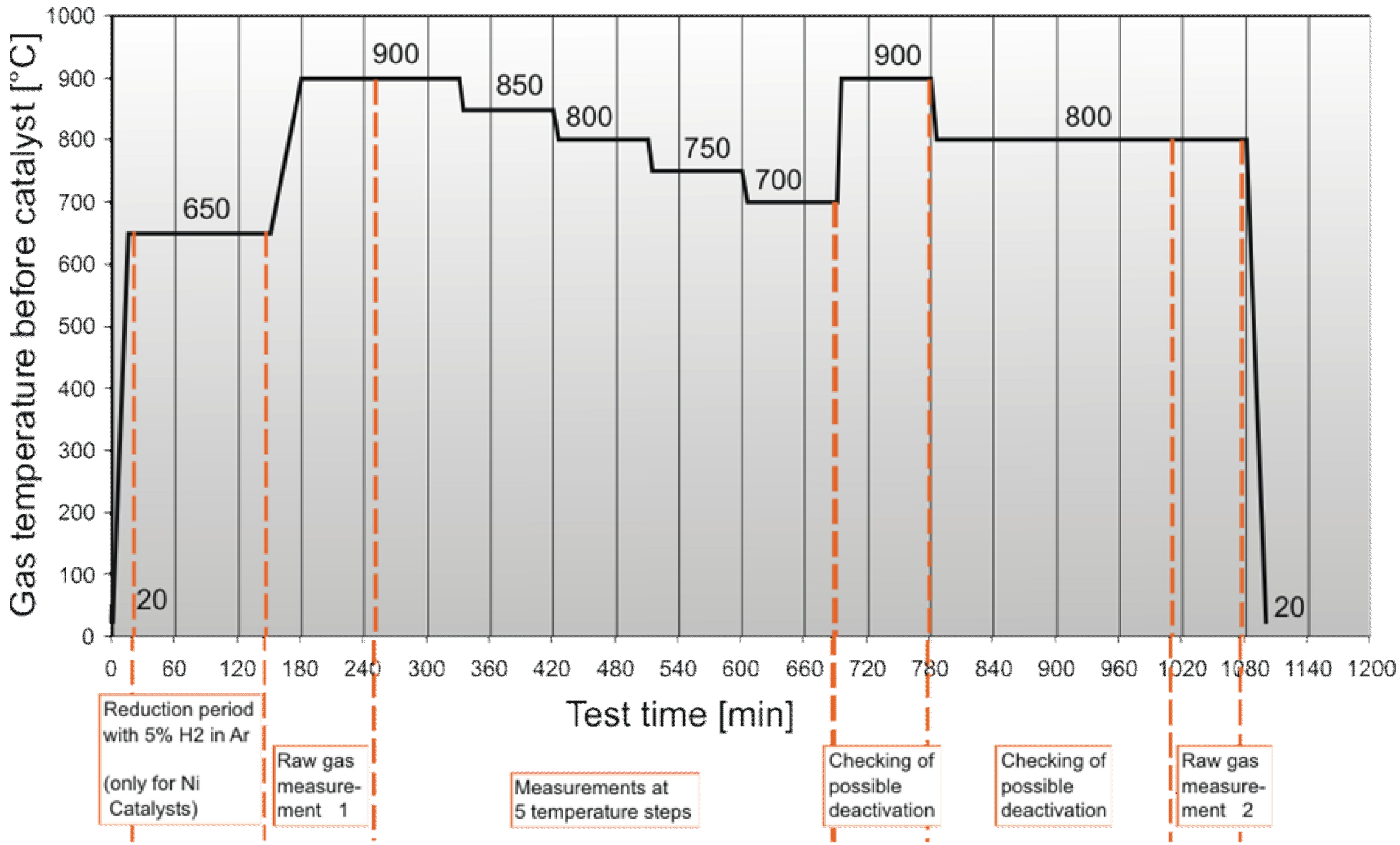
Materials and Methods

Details about testing conditions

Fixed-bed reactor for monolithic and bulk samples		
Reactor inner diameter (ID)	17	mm
Catalyst length-to-diameter ratio (L / D)	2	-
Volumetric flow rate	2	Nl / min
Space velocity (GHSV) at standard conditions	ca. 16 000	1 / h
Steam-to-carbon ratio (S/C)	0.86	-

Materials and Methods

Test program



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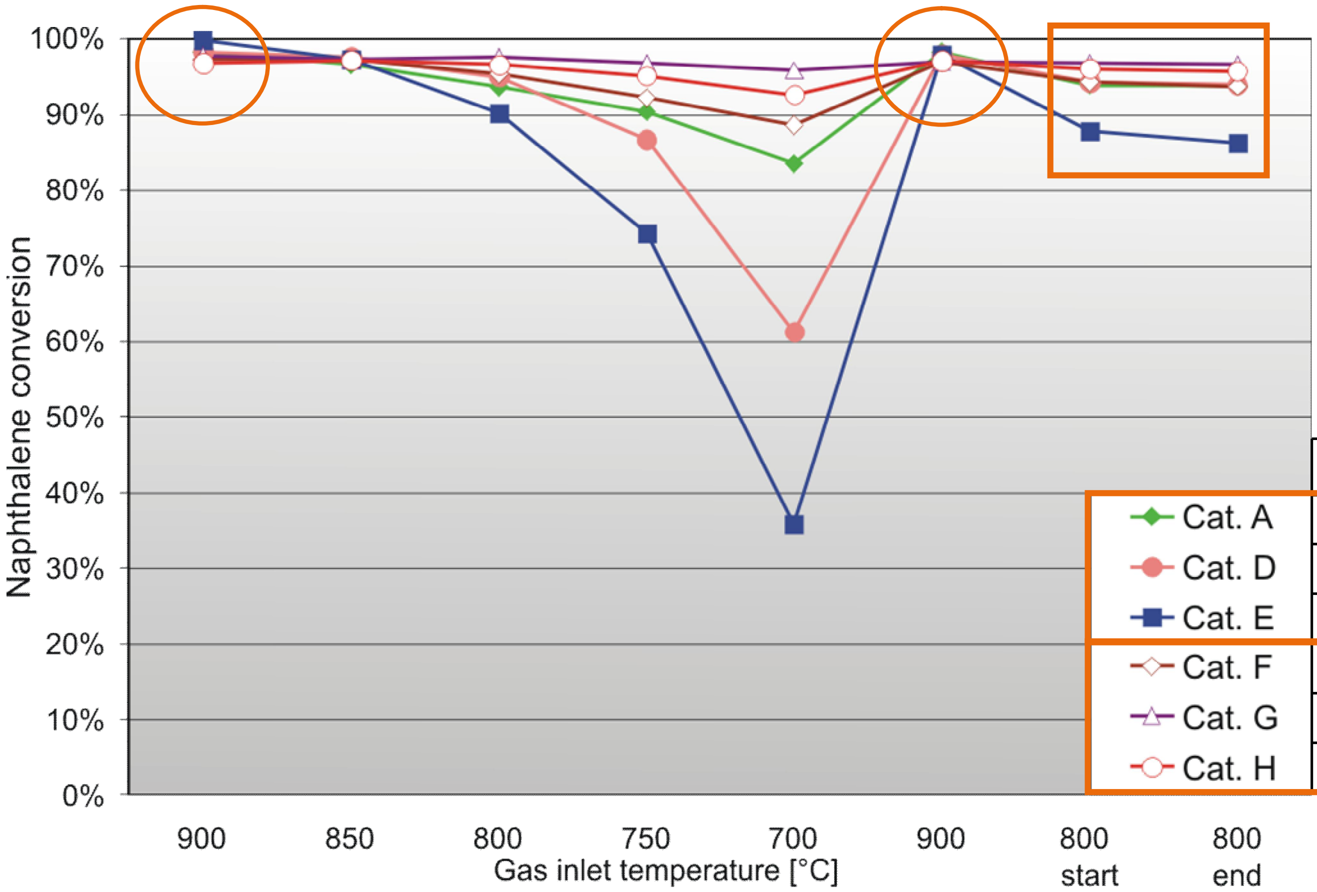
Comparison of PM catalysts

Conversion of Naphthalene vs. Temperature



Relative concentration of PM amounts on catalysts

	PM 1	PM 2
Cat. A	1	1
Cat. D	0.4	1
Cat. E	0.2	1
Cat. F	4	0
Cat. G	8	0
Cat. H	0	1

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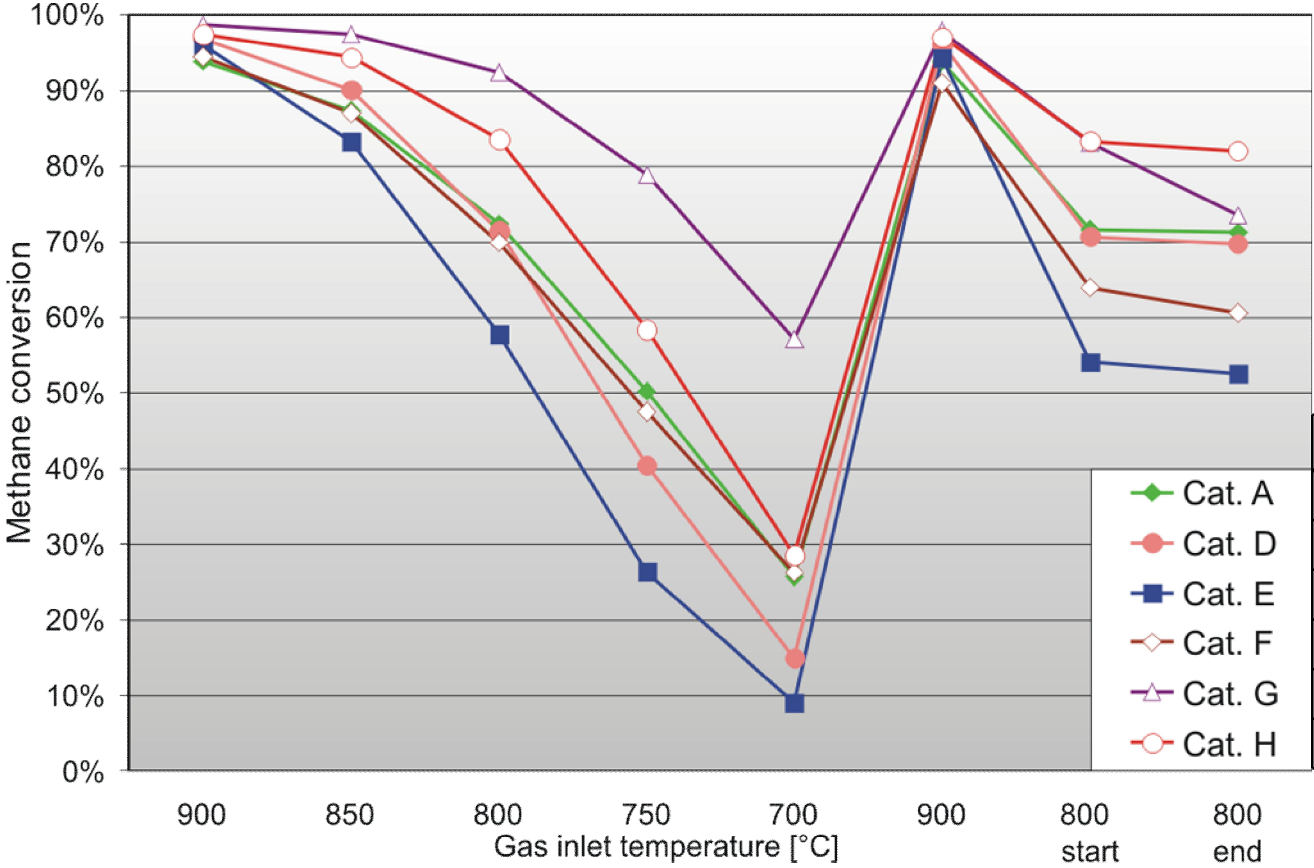
Comparison of PM catalysts

Conversion of Methane vs. Temperature



Relative concentration of PM amounts on catalysts

PM 1	PM 2
1	1
0.4	1
0.2	1
4	0
8	0
0	1

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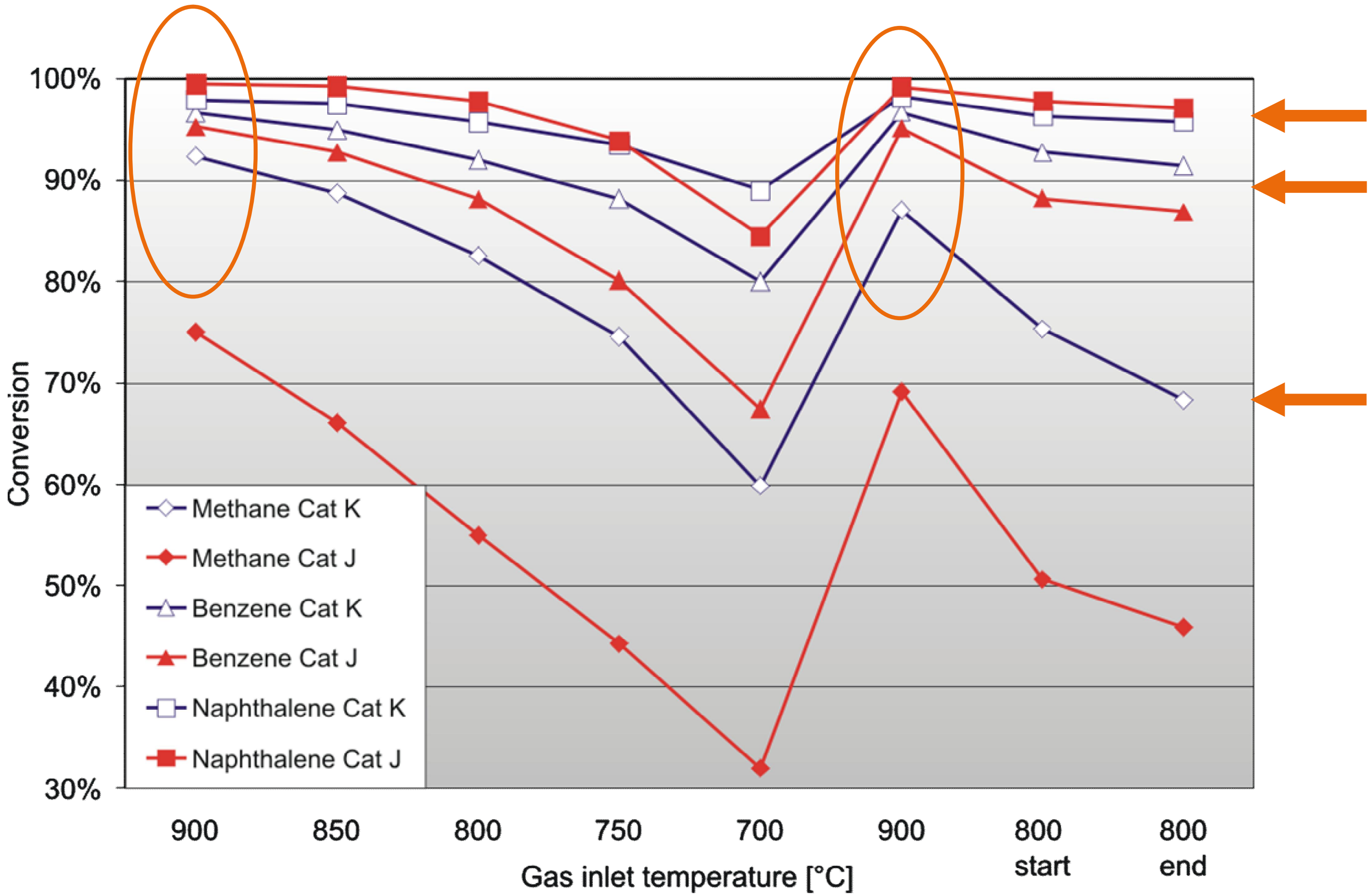
Comparison of Ni Bulk Catalysts

Conversion vs. Temperature of two different bulk catalysts



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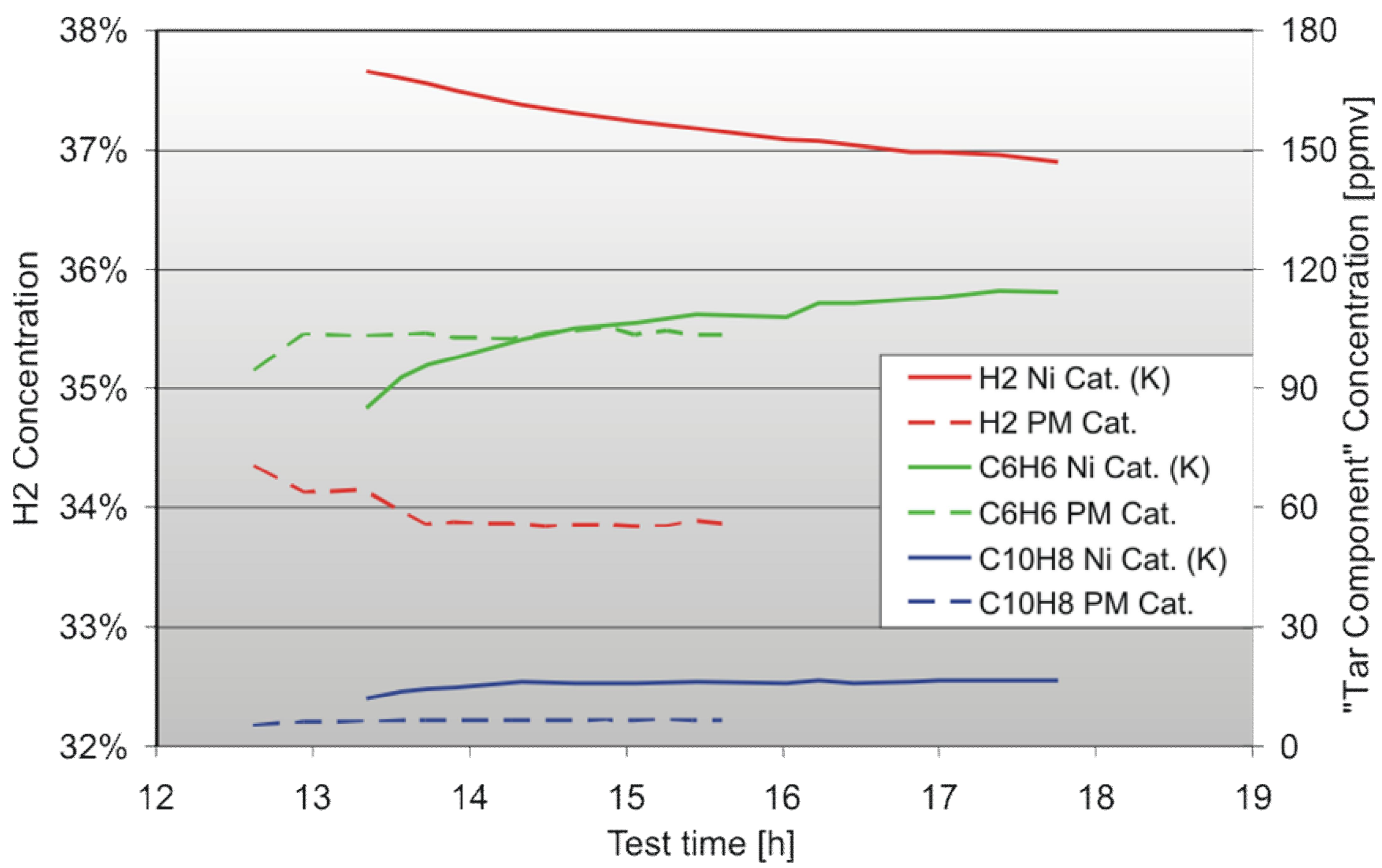
Nickel vs. PM Catalyst – Long-term Test

Concentration over test time



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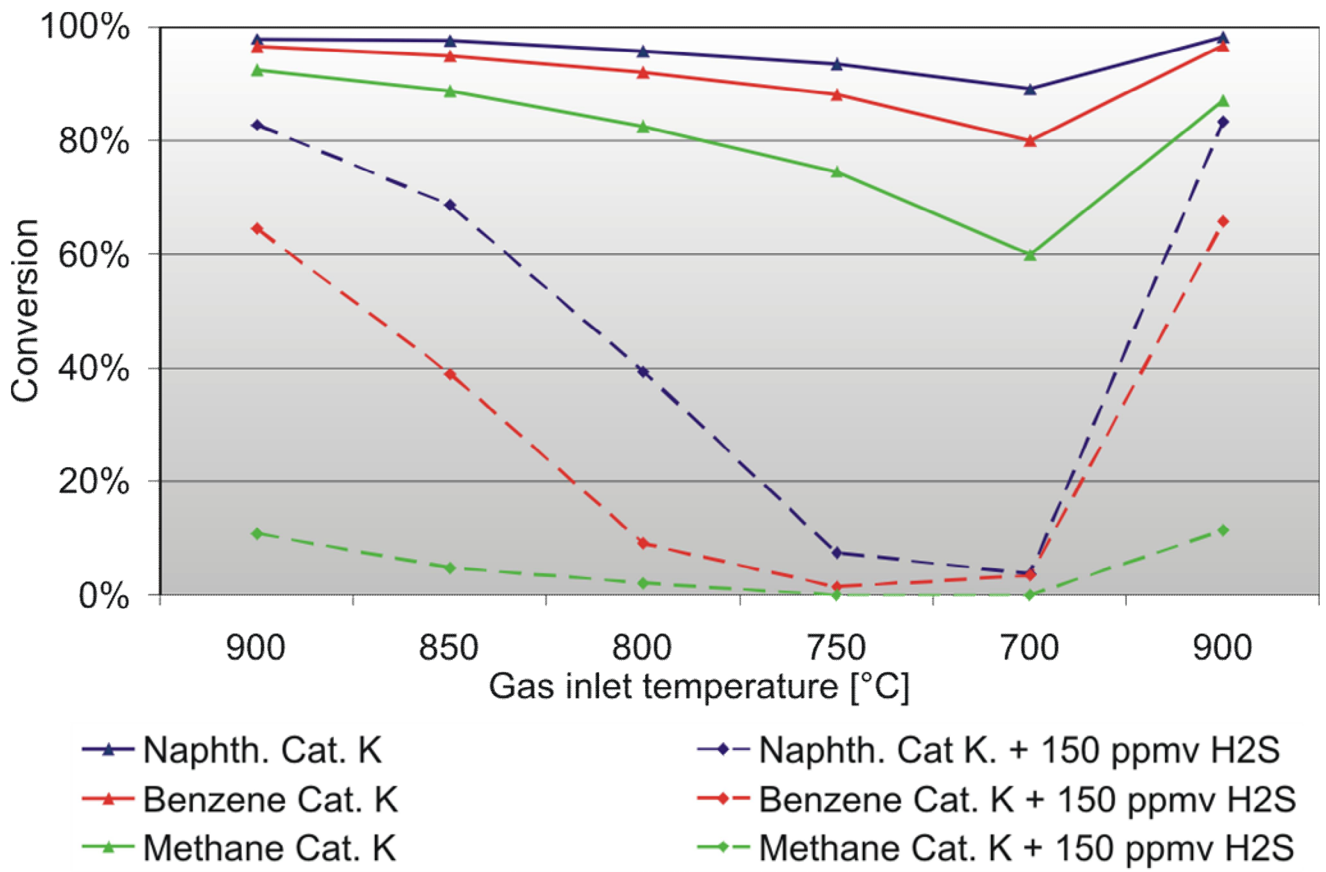
Nickel Bulk Catalyst – Influence of sulfur

Concentration versus temperature



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Summary & Outlook

Overview of Results

- Precious-Metal catalysts
  - Almost complete removal of tars down to 700 °C possible
  - Very little non-reversible deactivation due to lower temperatures
  - Nearly no loss in activity over 5 h at 800 °C
- Nickel Catalysts
  - Total removal of tars difficult
  - Lower temperatures result in deactivation; only completely reversible for naphthalene
  - Detectable loss in activity over 5 h at 800 °C for all hydrocarbons
  - Some catalysts show selective activity for aromatic hydrocarbons
  - Significant influence of 150 ppmv H_2S

Summary & Outlook

- More than 25 different catalysts were tested during the benchmark tests
  - Significant influence of preparation route as well as amount of active component on performance
  - Total cleanup of tar components was not achieved with Ni catalysts at lower temperatures

  Ä Sequential combination of Ni and PM catalysts
- Next project steps
  - Addition of poisoning or competing substances (e.g. sulfur, NH_3)
  - Increased duration of long-term tests
  - Variation of tar load

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Project Partner

We would like to thank Süd-Chemie AG for supplying the catalyst samples and for the financial support.

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Thank you for your attention!

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