TARGeT

The influence of tar composition and concentration on fouling, emission and efficiency of micro- and small-scale gas turbines by combustion of biomass derived low calorific value gas.

Delft University of Technology

H Spliethoff, W de Jong, M van de Wel

- Goals and Structure
- Experiments and modeling of gasification, gas cleaning, gas compression and LCV gas combustion
- Conclusions

BIO-ENERGY
ENLARGED PERSPECTIVES

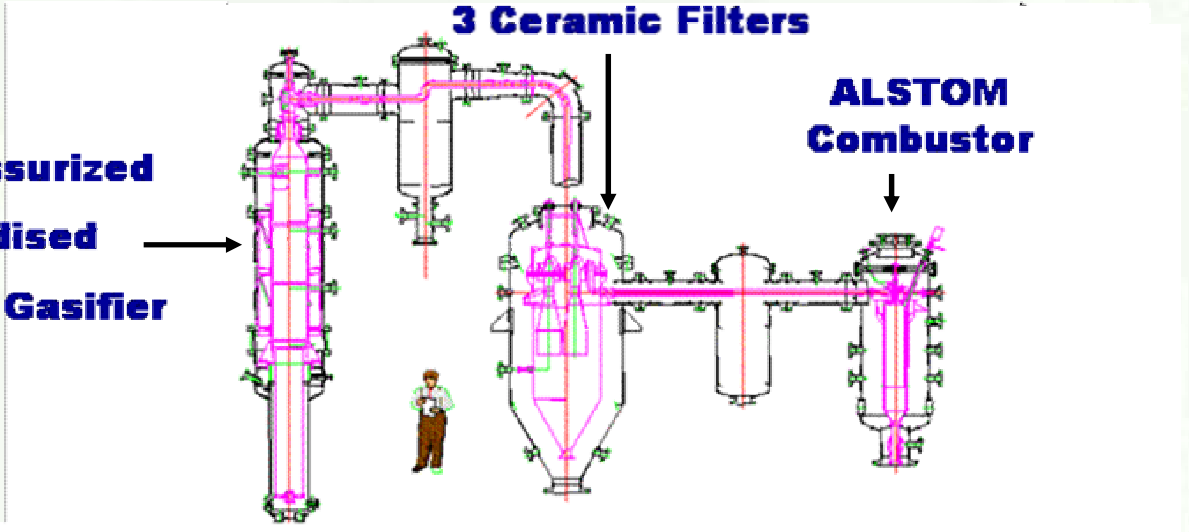
Budapest ,16-17 October 2003

GOALS.

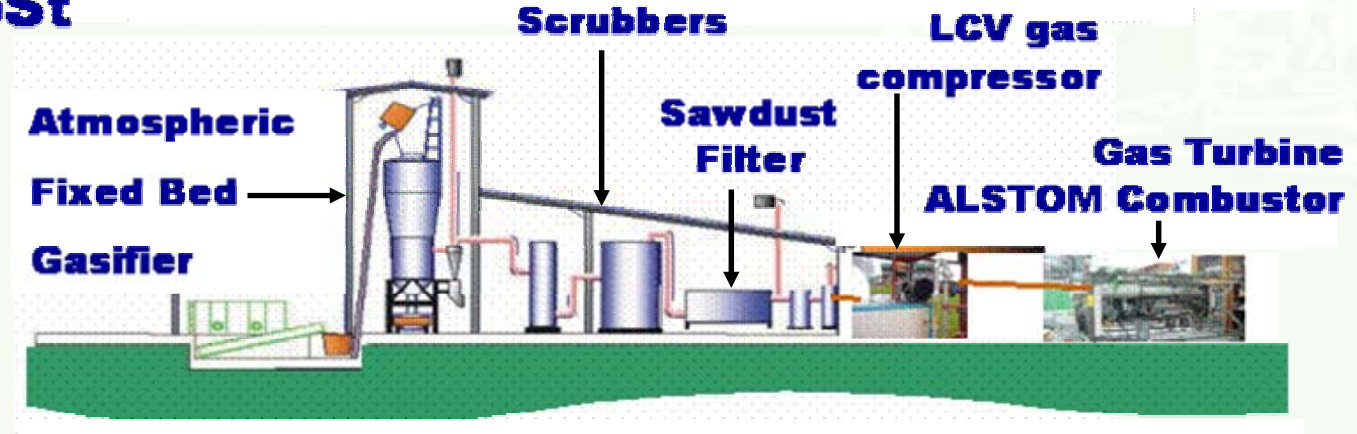
- Focus on tars in main process components:
  gasifier, gas cleaning, gas compression and gas turbine
- Minimize tar production
- Maximize gas cleaning
- Reduce impact of tars on fouling and emissions for pressurized and atmospheric installations
- Partners: TUD (NL), KTH (SE), IVD (D), HoSt (NL) and ALSTOM (UK & CH)
  (APUK & AAT)

EXPERIMENTAL SET-UPS.

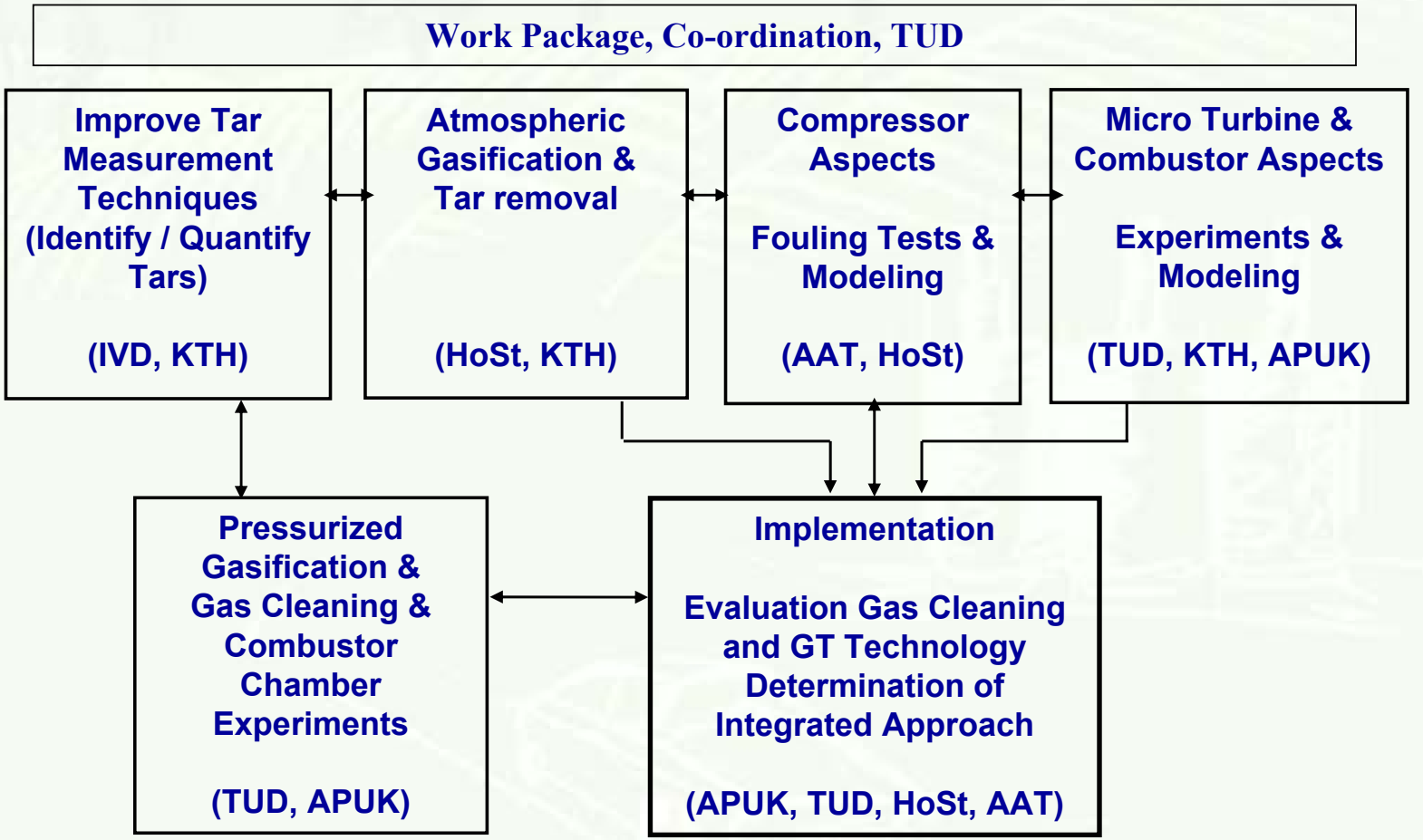
TUD



HoSt



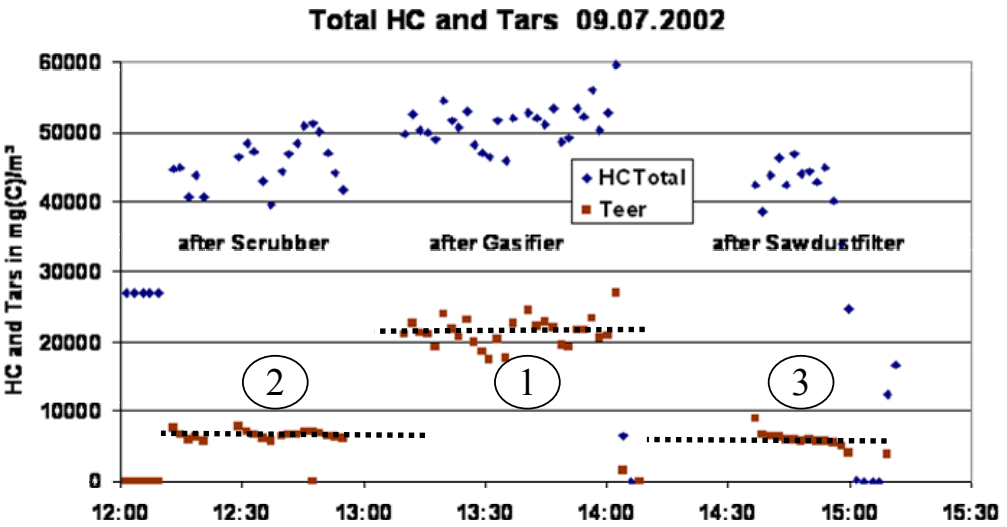
STRUCTURE OF THE PROJECT.

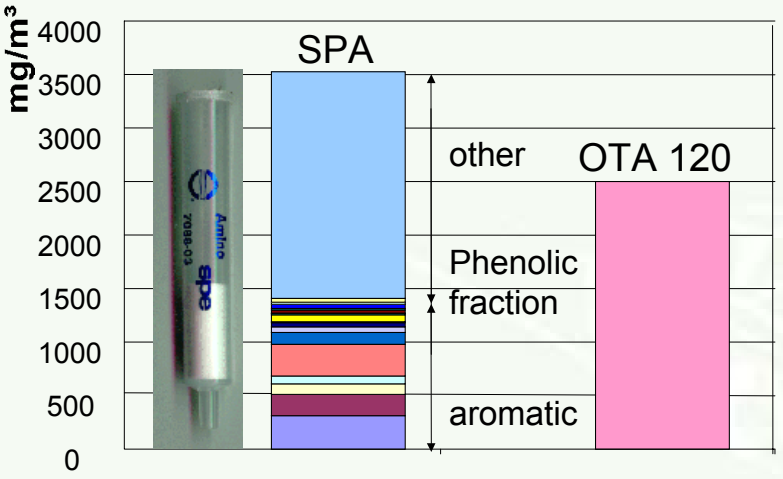


IMPROVE TAR MEASUREMENT TECHNIQUES.

Comparison techniques

On-line tar analyzer





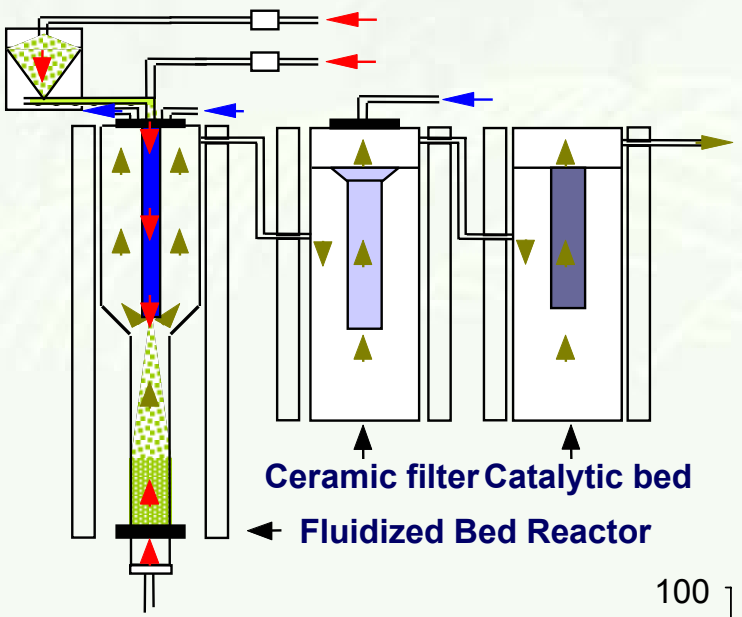
2 techniques have been refined:

OTA: On-line gas FID measurements but BTX (lights) not measured; New valves show sufficient life time

SPA shows high recovery of heavy tars (≈ 100 %) BTX are analyzed up to 65%

Methods should be used complementary

ATMOSPHERIC GASIFICATION & TAR REMOVAL.



Atmospheric tar cracking with iron

Tar cracking over iron is influenced by gas composition, temperature and residence time

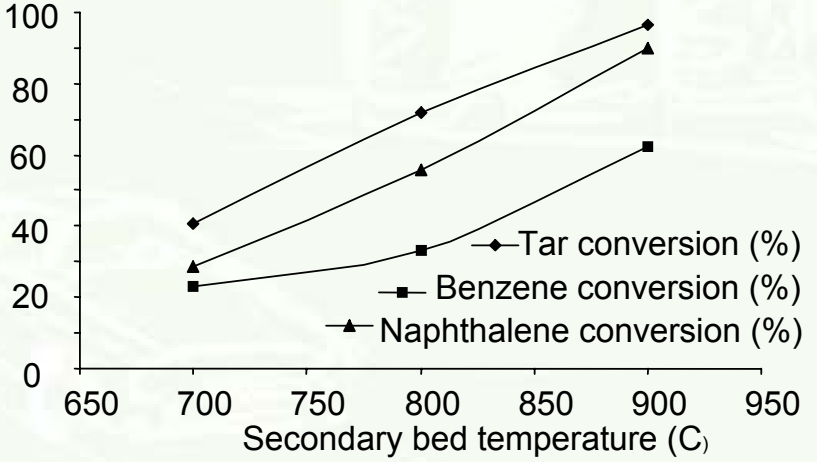
Iron must be in metallic form under working conditions (700 - 900 °C)

Therefore, high values of CO/CO_2 and H_2/H_2O ratios are required

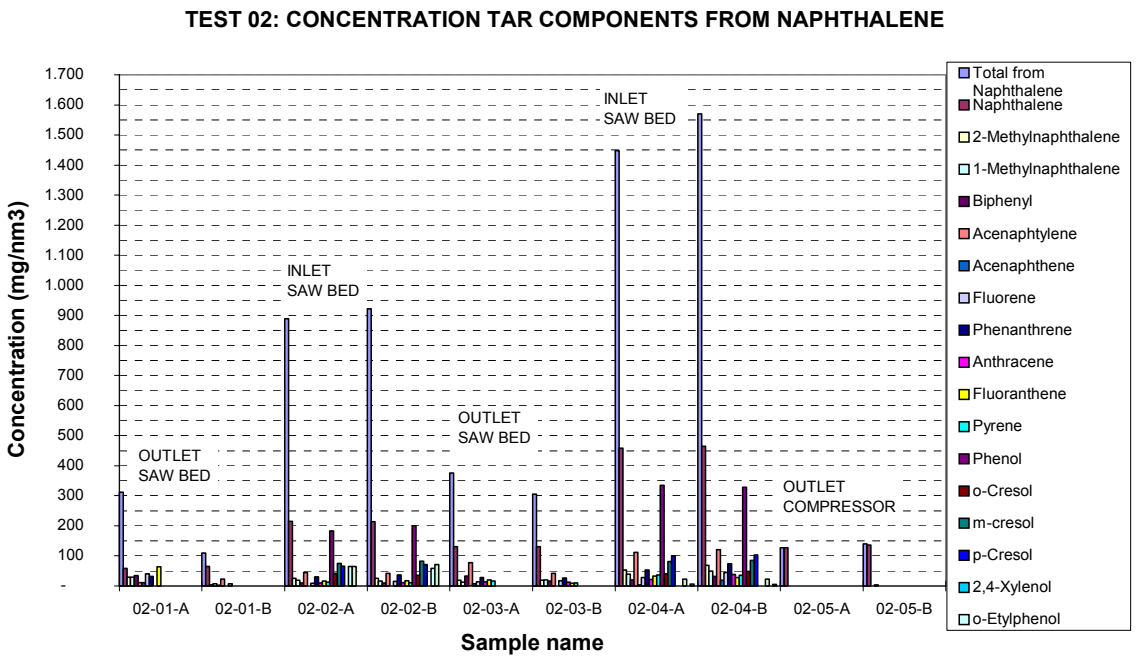
Tar conversion increases with temperature and residence time

Catalyst deactivation caused by carbon fouling

Cracking capability of metallic iron slightly better than dolomite



ATMOSPHERIC GASIFICATION & TAR REMOVAL.



Saw-bed filter

New organic scrubber

New automatic feeding system allows 24-h production of synthesis gas at capacity of 250 m^3_n/h

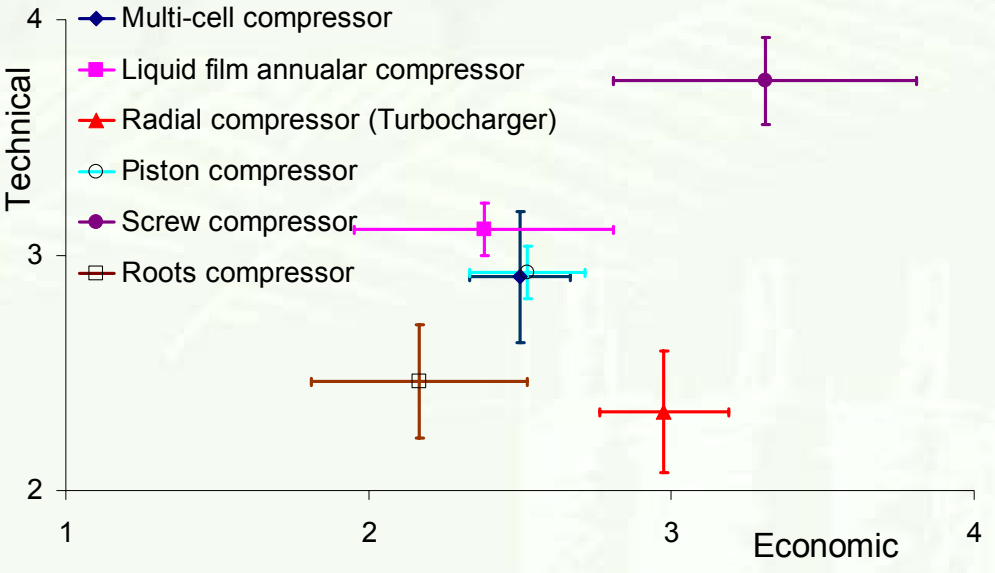
Saw bed also acts as tar remover

New organic scrubber shows very promising results

COMPRESSOR ASPECTS.

Evaluation results

Screw compressor



Without suction and pressure valves

Especially suitable for strongly polluted gases

Flow range up to 68 000 m^3_n/h (here 250 m^3_n/h)

Low maintenance and operating costs

Compact and low purchase price

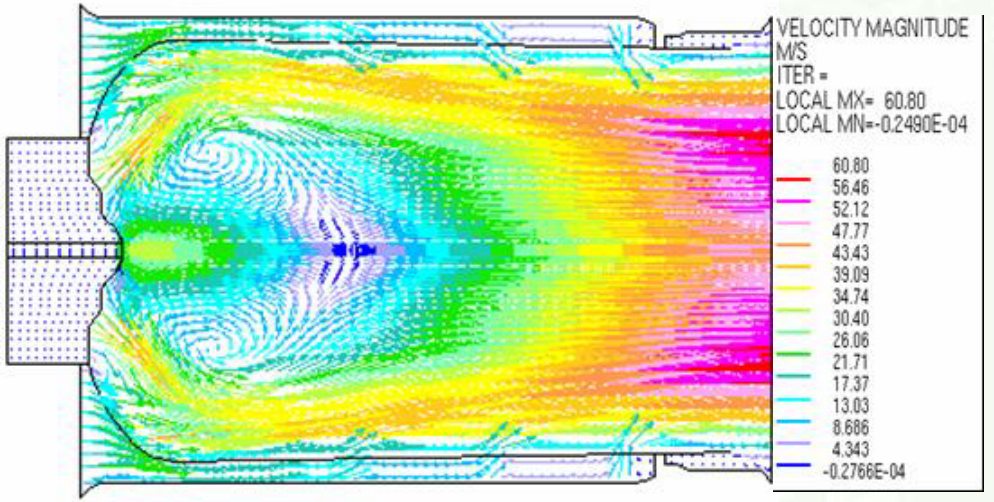
SPA showed tar accumulation in compressor

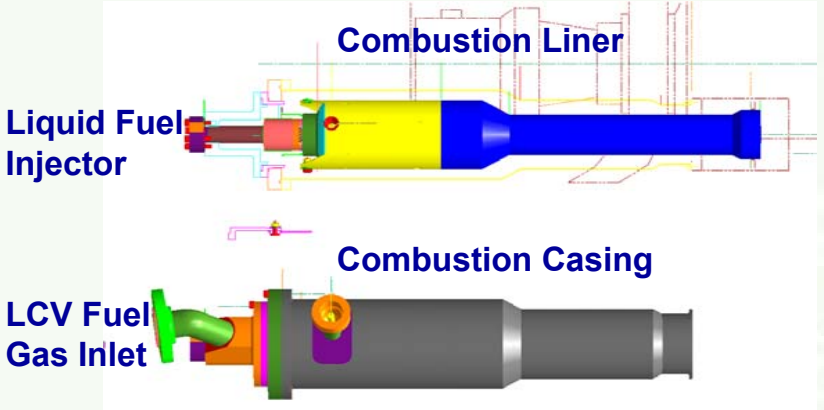
Compressor at HoSt

MICRO TURBINE & COMBUSTOR ASPECTS.

ALSTOM Combustor

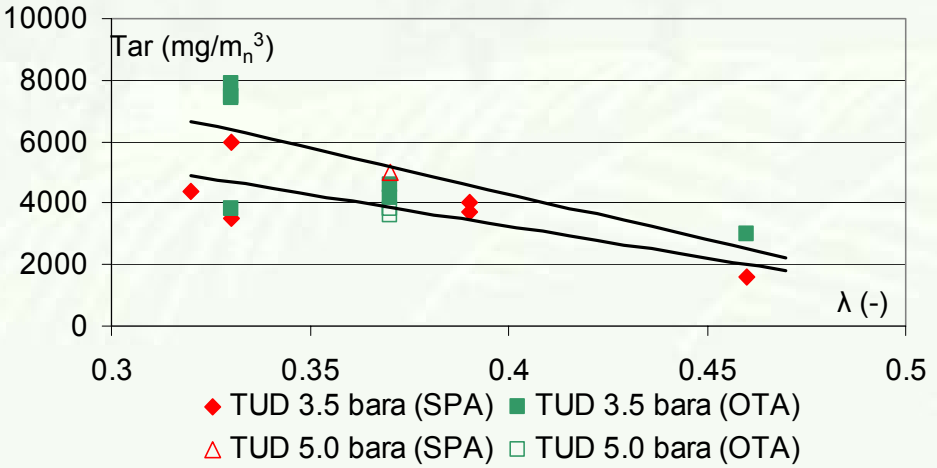
New ALSTOM Combustor installed on turbine at TUD





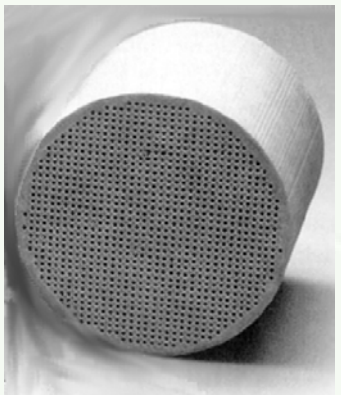
- New ALSTOM Combustor is installed on turbine at TUD
- First start is performed on liquid fuel
- Transfer is planned to HoSt site
- October 2003 complete system is ready
- 2D- and 3D-CFD modeling is performed of the ALSTOM combustors

PRESSURIZED GASIFICATION & GAS CLEANING.

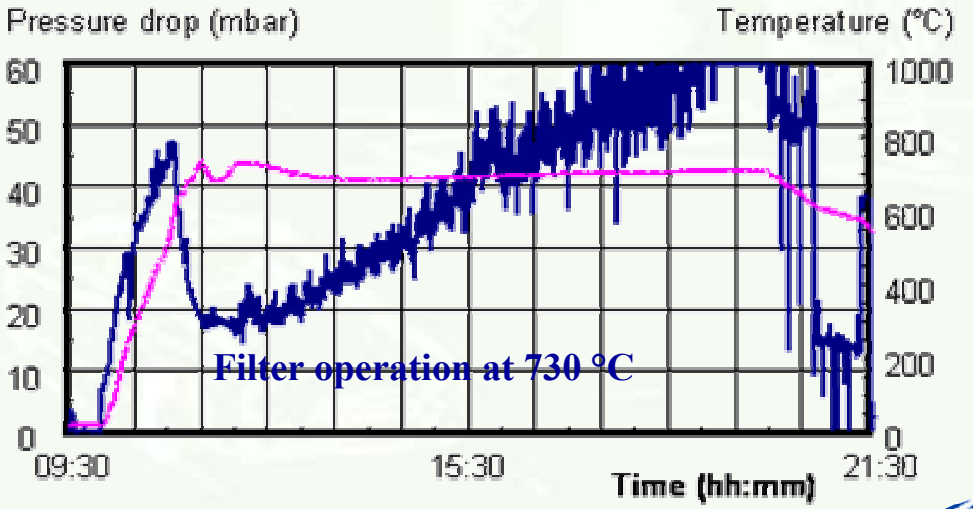


- Tar production decreases with λ
- Without steam injection filter blinding is observed [fuel=wood]
- Filter efficiencies are higher than 99.67 %
- Tars measured by SPA and OTA
- Little effect of high temperature in ceramic filter on tar contents

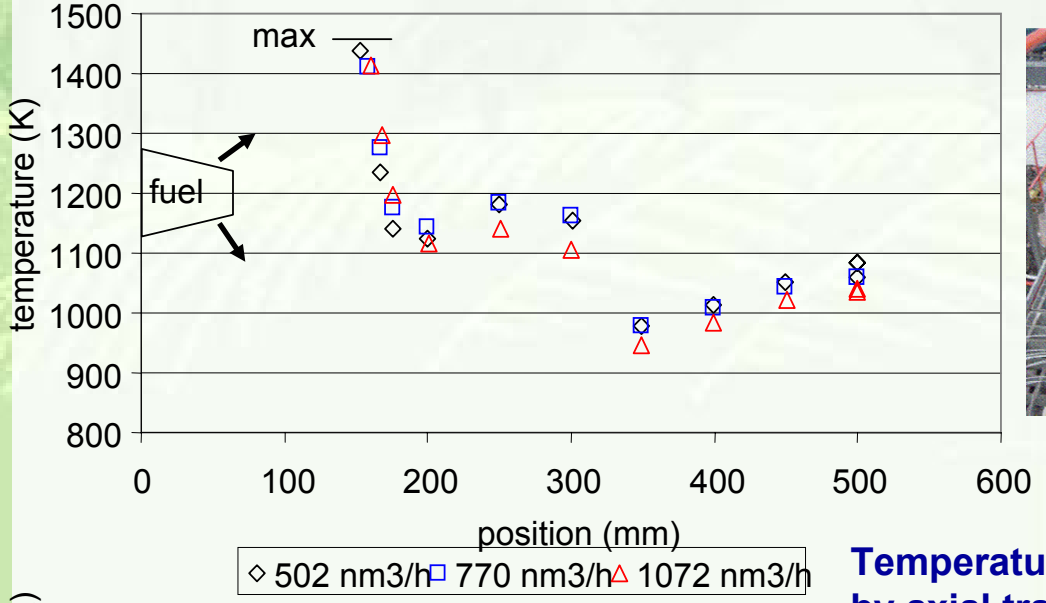
Filter operation

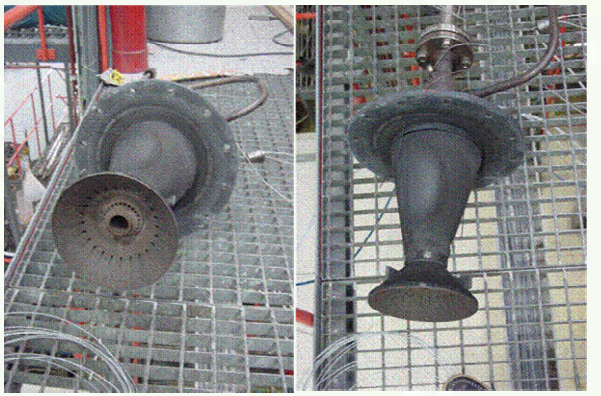


Honeycomb filter

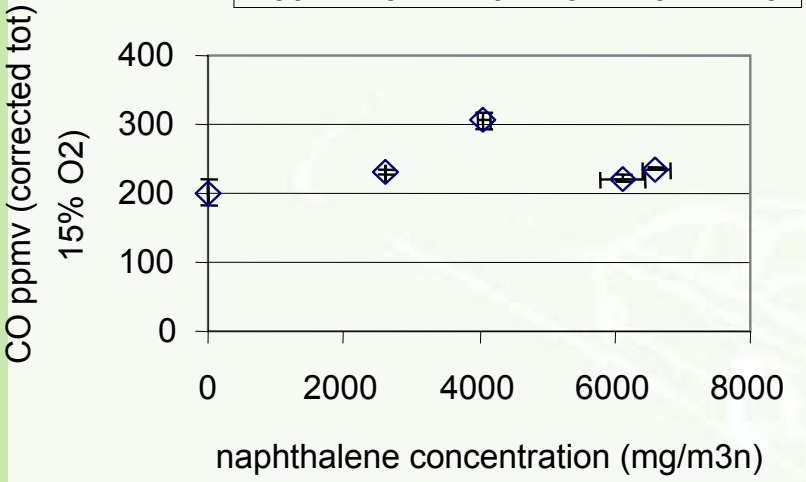


COMBUSTOR CHAMBER EXPERIMENTS.





No fouling of combustor parts



Temperature and species measurement by axial traversing inside ALSTOM combustor operated on (diluted) NG

No dramatic increase in CO-emission with injection of Naphthalene up to 10 g/m^3_n and constant fuel HHV.

Combustor operation on real LCV gas at high temperature causes no tar or alkali condensation in the combustor parts

CONCLUSIONS AND RECOMMENDATIONS.

- Integrated design of gasifier, gas cleaning and gas turbine is required
- Minimization of tar production and gas cleaning is the key to success of gasification technology



- Demonstration started of integrated system of atmospheric gasifier, gas cleaning, gas compression and micro turbine operation
- Further examination required of cost effective gas cleaning