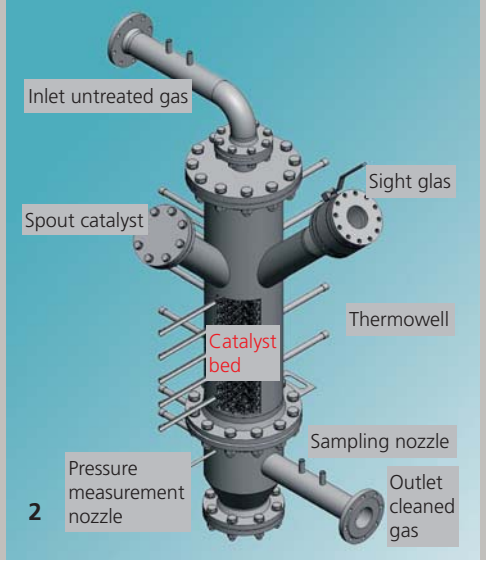
1



2

CATALYST AND O_2 CARRIER SYSTEM FOR THE PROCESSING OF TAR-CONTAINING GASES

Dr. Jörg Richter, Dr. Ralf Kriegel

Initial situation

The gasification of biomass allows the combined generation of electricity and heat with high overall efficiencies in small, decentralized systems which can provide a significant contribution to the realization of local supply structures. Particularly during the one-step gasification in small-scale plants hydrocarbons with high boiling points (e.g. tars) are generated which seriously limit the utilization of these gases in combined heat and power plants. Currently, the required gas quality cannot or can only be achieved by installing additional technical equipment and costly process steps, e.g. by catalytic oxidation with air or by methanol washing. The applied catalysts tend to coking and the introduction of nitrogen decreases the heating value. Furthermore, the handling of toxic solutions and by-products places high demands on the plant safety.

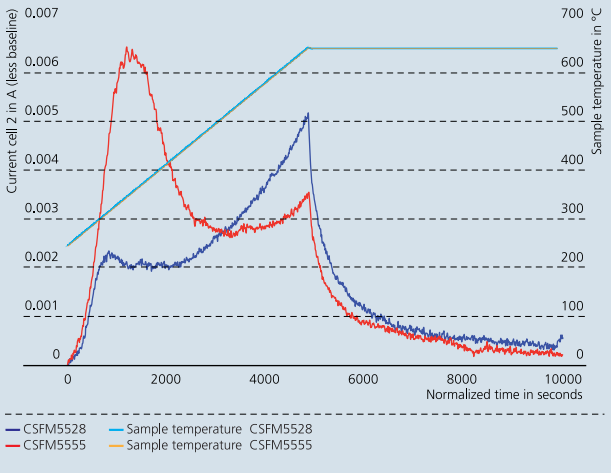
Approach

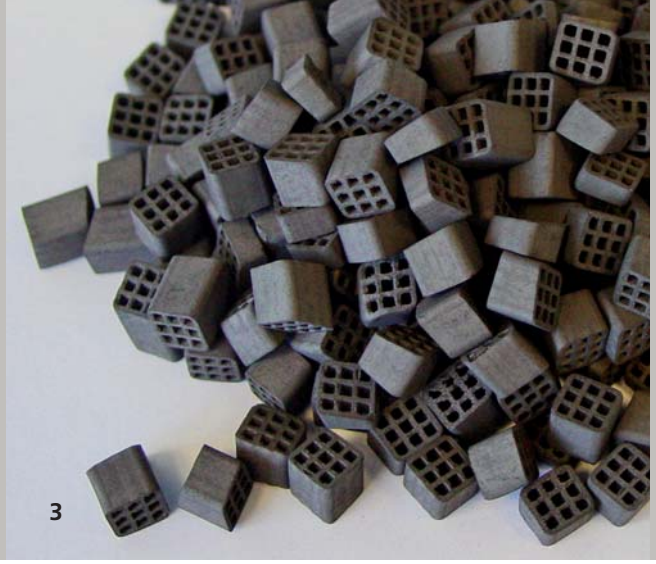
At Fraunhofer IKTS ceramic oxygen storage materials (OSM), which are covered with ceramic catalysts, are used. Thus, the necessary oxygen for partial oxidation of tar is released exactly at the location of its demand. Hence, the additional introduction of nitrogen and the decrease of the heating value can be avoided. Due to the time-dependent depletion of the OSM the process is cyclically run using parallel reactors. The partial oxidation of tar occurs in the first reactor, while the oxygen depleted OSM will be recovered by purging the second reactor with air. Modeling shows that tar components condense at the material surface. The released oxygen primarily oxidizes the tar components, while the components of the fuel gas contributing to the heating value of the gas remain unaffected.

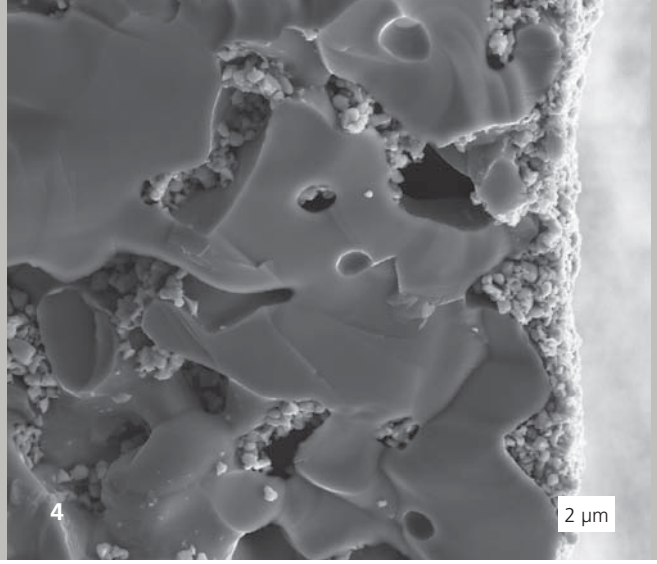
Development of oxygen storage materials (OSM)

Perovskite materials are preferably used as OSM since their oxygen exchange properties (uptake and release) can be adjusted to the expected process conditions. Potential candidate OSM have been characterized by O_2 TPD (temperature programmed desorption) and TG (thermogravimetry). Selected materials have been shaped to mini-honeycombs (miniliths) by extrusion and can be used as packed bed for future pilot plant scale tests.

Temperature programmed desorption:
Comparison of two oxygen storage materials







Development of catalyst materials

Perovskite catalysts have already proved to be the appropriate solution for miscellaneous oxidation reactions. Their catalytic activity can be adjusted in a certain range. Naphthalene ($C_{10}H_8$) was chosen as model substance for tar.

The conversion of naphthalene was recorded by FTIR (Fourier transformed infrared spectroscopy) and MBMS (molecular beam mass spectroscopy) for different oxidation catalysts.

A catalyst made of $LaCoO_{3-\delta}$ has already shown naphthalene conversions of more than 80 % at 500°C. The naphthalene conversion increases to 90 % at 600°C and to 100 % at 700°C.

Development of the catalyst and O_2 carrier system

Miniliths of a chosen OSM were coated with a perovskite catalyst material. In this process the fine-grained catalyst granules infiltrate into the pores of the OSM. No reactions between these two materials were observed during the necessary annealing process. Further coatings of oxygen storage materials with different catalyst are prepared for technical tests on the pilot plant of the Technical University of Dresden.

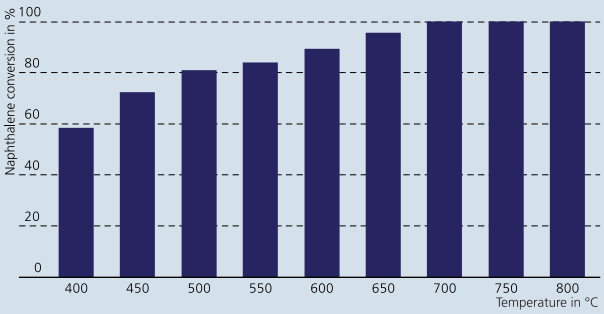
Acknowledgments

This project was funded by Deutsche Bundesstiftung Umwelt (AZ 27087).

Services offered

- Development of oxygen storage materials
- Development of ceramic catalysts for total and partial oxidation
- Characterization of the oxygen storage behavior

Naphthalene conversion of a $LaCoO_{3-\delta}$ catalyst (characterized by molecular beam mass spectrometry)



1 *Reactor for biogas production at TU Dresden.*
2 *Diagram of a reactor with catalyst bed.*
3 *Miniliths of an oxygen storage material.*
4 *SEM image of a minilith with catalyst coating.*