The Future Role of Hydrogen in Petrochemistry and Energy Supply
DGMK Conference October 4 – 6, 2010, Berlin, Germany

Accelerating Process and Catalyst Development in Reforming Reactions with High Throughput Technologies under Industrially relevant Conditions

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Abstract

The generation of hydrogen via reforming of a variety of carbon containing feed-stocks in the presence of water is up to date one of the most versatile technologies for the production of hydrogen and syngas. Although these reforming technologies are in principle well established, understoood and commercialized, there are still a number of technological challenges that are not solved up to a satisfactorily degree and there is a constant demand for appropriate answers to the challenges posed.
High throughput experimentation can be a valuable tool in helping accelerate the development of suitable solutions on the catalyst and process development side. In order to be able to generate test data that are close or identical to process relevant conditions, hte has developed a new technology portfolio of test technologies named Stage-IV technology.
In contrast to earlier developments which address more small scale testing on the basis of catalyst volumes of 1ml up to 10 ml under isothermal conditions, our new technology portfolio offers the advantage of test volumes at sub-pilot scale also realizing reactor dimensions close to technical applications.
This does not only ensure a good mimic of the hydrodynamic conditions of the technical scale, but also allows a fingerprinting of features like temperature gradients in the catalyst bed which play a large role for catalyst performance. Apart from catalyst tests with granulates when screening for optimized catalyst compositions, the units are designed to accommodate tests with shaped catalysts.
In order to demonstrate how these technologies can accelerate catalyst and process development we have chosen technically challenging application examples:
I) Pre-reforming and reforming of methane based feeds which accelerate coking and catalyst deactivation. Higher reaction pressures, high CO_2 contents in the feedgas (which occur typically in sources like bio-gas or certain types of natural gas), the presence of higher alkanes like ethane or propane are challenging compositions for hydrogen and syngas production as enhanced catalyst deactivation can be observed in a lot of cases. In our case study we will illustrate how the right choice of reaction conditions and new catalyst developments can open up alternative process options.
II) Reforming of higher carbon containing feed-stocks like ethanol or naphta containing feeds are difficult to process as the feed-stocks are easily subject to cracking reactions and olefin formation does lead to enhanced coking and ageing of the catalyst. In this case study we intend to illustrate how alternative catalyst concepts and operation under suitable process conditions can lead to improved materials that can operate in reaction corridors of interest.