Methanol from Steel-Mill-Gases: Long-Term Catalyst Testing with Real Cleaned Gas Streams and Separated CO_2

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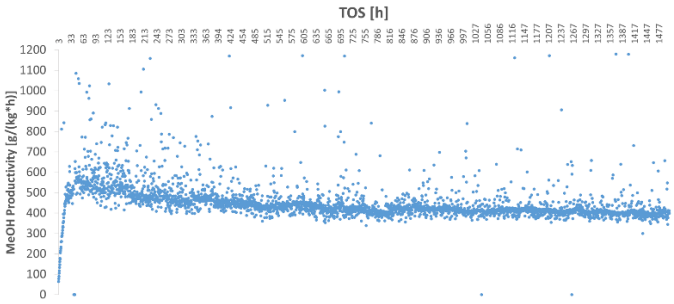
Introduction

Steel mill gases are potential alternative sources for CO_2-, CO- and H_2-streams to provide synthesis gas for an alternative methanol synthesis. Besides the current energetic utilization, these gases provide promising potential to be utilized as feedstock for bulk chemical production, while simultaneously reducing the CO_2 footprint of the steel mill. Commercial Cu-based catalysts applied in industrial methanol synthesis are optimized for constant synthesis gas streams of high purity and fixed compositions. The scope of this work is to evaluate the possibility of applying a commercial methanol synthesis catalyst in the conversion of synthesis gas derived from steel mill exhaust gases. The ongoing experimental work is conducted in the laboratory of the technical center at the thyssenkrupp Steel Europe site in Duisburg, Germany. The influence of different syngas compositions on the productivity of Clariant´s methanol synthesis catalyst MegaMax®800 was investigated applying test rigs in lab scale and pilot scale with synthetic and real synthesis gases. Process simulation was used to obtain realistic test conditions.

Methods and Results

The practical tests were performed with real cleaned blast furnace gas and basic oxygen furnace gas. The quality of the CO_2 separated by amine wash is of particular interest. Long-term methanol synthesis was performed with real separated CO_2. The practical tests were performed in a lab-scale test set-up with direct access to the on-site gas-cleaning unit. In the test system used, the catalyst is exposed to a higher gas load, compared to demonstration scale test set-ups with product separation and gas recycle. If catalyst poisons are present in detrimental concentrations, poisoning of the catalyst can be observed earlier. All tests were performed with Clariant´s methanol synthesis catalyst.



Methanol from CO_2 separated by amine wash from basic oxygen furnace gas

After a slight initial decrease of catalyst activity which always can be observed cleaned blast furnace gas was converted to methanol within a test period of more than 3500 h TOS without showing a significant loss of activity. The observed catalyst productivity was overlaid by the effect of a fluctuating feed-gas composition regarding the main compounds. Feed gas measurements were used to distinguish the causes of the observed changing catalyst productivity. Tests with CO_2 separated from pre-cleaned basic oxygen furnace and blast furnace gas were performed for more than 1400 h and exhibited a stable activity of the catalyst. The successful lab-scale tests proved a high degree syngas purity. Long-term tests with real synthesis gases generated from steel mill gases will be continued. Additional to the lab set-ups, a pilot-scale methanol synthesis plant has been installed. It comprises a boiling water-cooled reactor of 6 m length 34 mm inner diameter. The dimensions relate to a single tube of an industrial tube-bundle reactor. Real gas tests on demonstration-scale have started.