Methanol Synthesis with Real Steel-Mill-Gases: Practical Performance Investigations in an On-Site Technical Center

K. Girod[1], S. Schlüter[1], T. Hennig[1], H. Lohmann[1], S. Kaluza[1/2]
[1]Fraunhofer UMSICHT,Oberhausen, Germany
[2]Faculty of Mechanical and Process Engineering, University of Applied Sciences Düsseldorf, Germany

Introduction

Steel-Mill-Gases are potential alternative sources for CO_2-, CO- and H_2-streams to provide synthesis gas for methanol synthesis. 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. 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 exhibiting fluctuating compositions. The ongoing experimental work is conducted in the laboratory of the technical center at the thyssenkrupp Steel Europe site in Duisburg, Germany. The investigations are funded by German Federal ministry of Education and Research (BMBF) within the scope of the project Carbon2Chem®.

Methods

First, a process simulation including a kinetic model was developed for the large-scale methanol synthesis using synthesis gas derived from steel mill exhaust gases. The theoretically identified operating points were subsequently applied in a test system that was installed in the technical center, providing direct access to cleaned and optionally conditioned steel mill gases. In order to evaluate, whether detrimental trace compounds remain in the cleaned synthesis gas, methanol synthesis is tested alternately with real gases and synthetic steel mill gases as reference.

Results

First tests with synthetic gas compositions revealed that the CO_2/CO-ratio has a crucial effect on the catalyst performance. As expected, methanol productivity decreased with increasing CO_2 concentration. A minimum CO_2 concentration is required for a high catalyst activity, as the lowest methanol productivity was obtained for pure CO. Apparently, high water and CO_2 concentrations reduce the lifetime of the commercial MeOH-synthesis-catalyst.

Conclusions

Direct access to pre-cleaned steel mill gases is crucial for a realistic assessment of catalyst performance and lifetime. A comparison between real gases and synthetic steel mill gases will reveal the effect of trace compounds might slipping through the gas-cleaning unit.