L2 | MeOH-Synthesis with Steel Mill Gases: Simulation and Practical Performance Investigations

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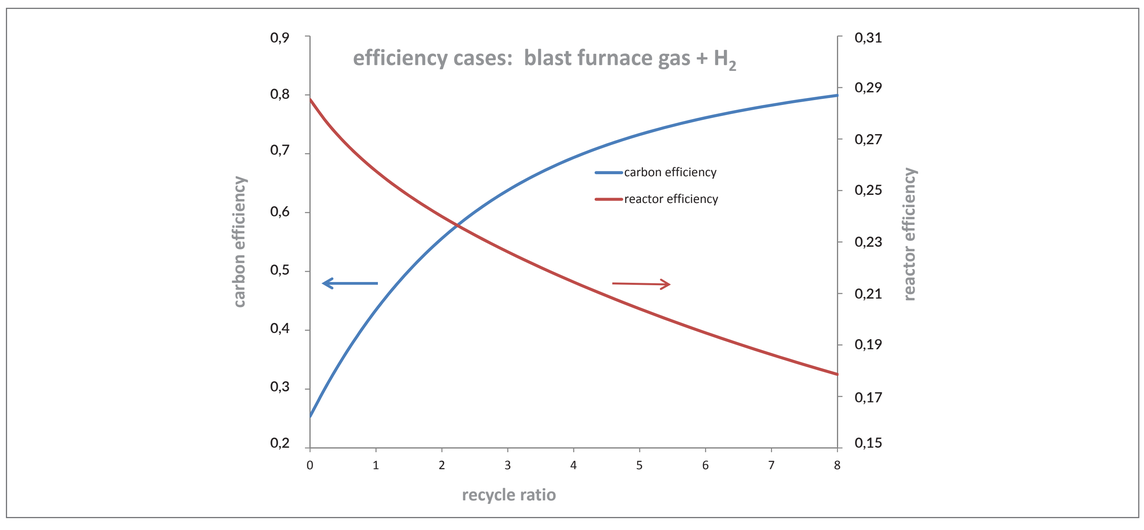
The commercial Cu-based catalysts applied in industrial methanol synthesis are optimized for constant gas streams of high purity and fixed composition. The scope of this work is to evaluate the possibility of applying a commercial methanol synthesis catalyst in the conversion of synthesis gas derived from steel mill exhaust gases exhibiting fluctuating compositions.

SIMULATION OF ALTERNATIVE LARGE SCALE METHANOL-SYNTHESIS

A large scale methanol synthesis process simulation was developed including a kinetic model for the heterogeneously catalyzed methanol synthesis reaction, a product separation procedure and the possibility to consider different syngas recirculation ratios. The model provides operating points depending on the composition of the steel mill gas and the recirculation mode. The theoretically identified operating points were subsequently applied in practice using two different test facilities.

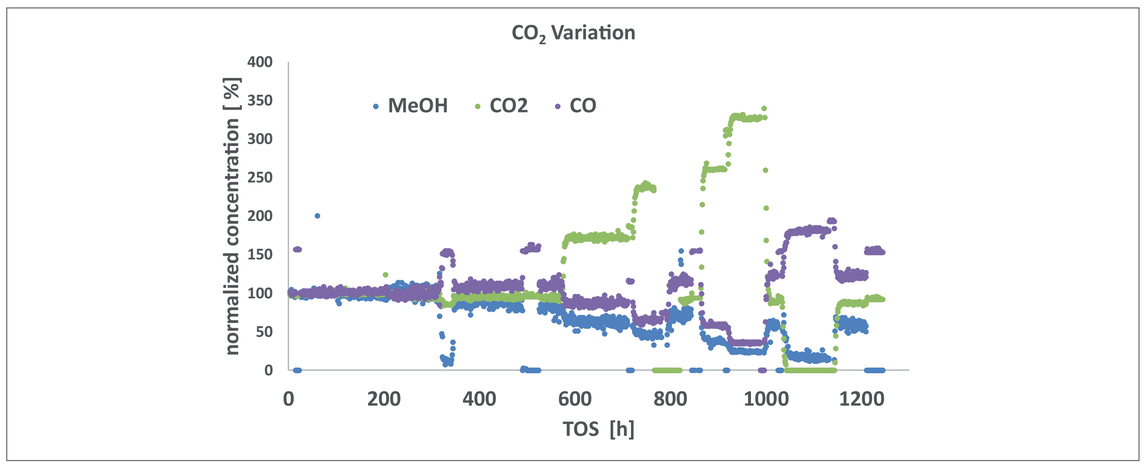


Simulation of a large scale methanol process with H_2 enriched blast furnace gas as syngas source

- The reactor inlet gas composition is characterized by excess of hydrogen, high CO_2 concentration and significant nitrogen content
- The recycle ratio has to be kept in an economically reasonable range in order to enable a beneficial methanol productivity
- High recycle ratios are favorable in terms of CO_2 utilization, but exhibit low catalyst productivity
- The model does not consider the stability of the industrial catalyst under reaction conditions

CLOSE-TO-PRACTICE TESTING OF METHANOL-SYNTHESIS CATALYST

The first system is close to the industrially applied geometry. A second complementary test system with a total reactor volume of 15 ml is characterized by a higher grade of automatization. Due to a high CO_2 concentration in steel mill gases its impact on the catalytic performance was examined systematically. Starting from a highly reactive gas composition the CO_2/CO ratio was increased stepwise while keeping the overall CO_x content constant. To investigate whether the methanol catalyst is irreversibly affected by high CO_2 concentrations, tests are subsequently conducted with the initial gas composition.



Commercial methanol synthesis catalyst from Clariant®- performance and stability

- Methanol productivity decreased with increasing CO_2 concentration
- A minimum CO_2 concentration is required for a high catalyst activity
- The lowest methanol productivity was obtained for a syngas without CO_2
- For H_2 enriched blast furnace gas **no significant deactivation** was observed within 8 weeks
- The influence of increasing water concentrations in the gas stream is currently under investigation

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