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.

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.

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 CO₂ concentration in steel mill gases its impact on the catalytic performance was examined systematically. Starting from a highly reactive gas composition the CO₂/CO ratio was increased stepwise while keeping the overall COx content constant. To investigate whether the methanol catalyst is irreversibly affected by high CO₂ concentrations, tests are subsequently conducted with the initial gas composition.

Commercial methanol synthesis catalyst from Clariant® - performance and stability
- Methanol productivity decreased with increasing CO₂ concentration
- A minimum CO₂ concentration is required for a high catalyst activity
- The lowest methanol productivity was obtained for a syngas without CO₂
- For H₂ 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

Keeping Carbon in the Loop

CO₂ reduction through cross-industrial cooperation between the steel, chemical and energy industries