Sabatier based CO\textsubscript{2}-Methanation under oxyfuel conditions

K. Müller, F. Rachow, J. Israel, and D. Schmeißer

Brandenburgische Technische Universität Cottbus, Angewandte Physik-Sensorik, Konrad-Wachsmann-Allee 17, 03046 Cottbus, Germany

The “Power to Gas” approach is based on the catalytic conversion of CO\textsubscript{2} with H\textsubscript{2}. At a moderate temperature of around 350°C, hydrogenation of CO\textsubscript{2} into CH\textsubscript{4} is possible by the Sabatier reaction CO\textsubscript{2} + 4H\textsubscript{2} \rightarrow CH\textsubscript{4} +2H\textsubscript{2}O. This approach gives a basis for the reintegration of secondary products like CO\textsubscript{2} into the energy supply. The CO\textsubscript{2} is transferred into a reusable energy source, this offers a possibility of a chemical energy storage procedure when the produced CH\textsubscript{4} is fed into the existing network of natural gas.

As part of the BMBF project Geo Energy Research (GeoEn, grand No. 03G0767B), we study the Sabatier reaction in the context of the oxy-fuel process. Here, one important aspect is the stability of the performance of catalysts for Sabatiers reaction against typical contaminations of flue gas, generated in the power plant. Oxyfuel-CO\textsubscript{2} carries SO\textsubscript{x} (3ppm) and NO\textsubscript{x} (15ppm) which are known to be deleterious for the performance of catalysts. We have tested mixtures of pure CO\textsubscript{2} with increasing content of either SO\textsubscript{x} or NO\textsubscript{x}. We also studied synthetic mixtures of both, SO\textsubscript{x} and NO\textsubscript{x} with pure CO\textsubscript{2}. Finally, we used real processed oxy-fuel CO\textsubscript{2}. In all systems we find that the conversion rate remains above 80%, with ~100% selectivity within the first 24h. Also, the temperature window for the catalytic performance is not changed.

In addition we report on important parameters for an upscaling from laboratory scale into technical application considering the flow density, temperature and content of catalyst.

The characterization of catalysts for the Sabatier reaction is completed with morphological (SEM) and chemical (XPS) characterizations. Kinetic investigations by thermodesorption (TDS) are further interpreted in relation to the measured catalytic performance.