Masters Thesis

Removal of Trace Sulfur Compounds from Biogas for Catalytic Processes

Project location: Paul Scherrer Institut (PSI), Villigen, Switzerland
Laboratory for Thermal Processes and Combustion
Energy and Environment Research Division

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Time frame: March-Sept. 2018. Can be undertaken as a 4 or 6 month thesis project.

Research background and context:

According to the new Swiss energy strategy, the energetic use of biomass will need to increase significantly in the coming years. The use of high-efficiency converters such as fuel cells or of Power-to-Gas converters such as methanation reactors can help achieve this transition. However, widespread use of fuel cells or methanation reactors for biogas still faces a few hurdles. In particular, naturally-occurring sulfur contaminants in biogas poison the catalytic elements in these converters. While much is known about removal of the primary sulfur compound H_2S, less is known about removing other volatile organic sulfur compounds (dimethyl sulfide, carbonyl sulfide, etc.), especially to levels required for catalysts.

This project is being conducted in the context of an SFOE-funded (Swiss Federal Office of Energy) project focused a pilot scale demonstration showing that biogas can be cleaned to fuel cell quality over long-duration operation at a Swiss farm.

Objectives of the research project:

This is an experimental project focusing on testing various commercially-available catalytic and sorbent materials for their ability to convert or adsorb several sulfur compounds present in biogas. Lab work will be performed in our facilities at PSI. The work will be used as the basis for selecting materials for the field demonstration after completion of the masters thesis.

Tasks:

- Design a set of experimental conditions (contaminant concentrations, flow rates) which give results which are appropriate for future modeling and scale-up
- Perform breakthrough experiments with sorbent and catalytic materials under the chosen conditions, monitoring the system with chemical analytical devices (e.g. GCs, MS)

Benefits for the student:

- Development of experimental design skills, especially in the context of reducing complex “real world” flows to simplified but representative lab conditions.
- Training and support on use of gas sampling techniques and analytical devices (e.g. MS, micro-GC, GC-SCD) which are appropriate for trace sulfur compounds.
- Learning to write scientific reports and communicate results, including at webinars and/or workshops with national and international collaborators and stakeholders.

References:

[1] S. Biollaz, A. Calbry-Muzyka, T. Schildhauer, J. Witte and A. Kunz, "Direct Methanation of Biogas: Final Report," Swiss Federal Office of Energy SFOE, Biomass and Wood Energy Research Programme, Villigen, AG, 2017.

[2] A. Lanzini et al., "Dealing with fuel contaminants in biogas-fed solid oxide fuel cell (SOFC) and molten carbonate fuel cell (MCFC) plants: Degradation of catalytic and electro-catalytic active surfaces and related gas purification methods," Progress in Energy and Combustion Science, vol. 61, pp. 150-188, 2017.