Discussions and Wrap-Up

Summary and Takeaways from Workshop

Workshop Topics

- General overview for energy gas applications
- Gas sampling, measurement and analysis science
- Gas sampling, measurement and analyses on pilot, demonstrations and early commercials

General Overview for Energy Gas Applications

- **Overview of Energy Gas Specifications**
  Oliver Stankiewiz, Nordur Power Grid Assn, Switzerland
  - Renewable Energy and Security of Supply
  - Energy, including renewable energy, is globally available
  - The Global Grid
  - Swiss gas market
    - Primary users household, industry
    - Biogas growing rapidly
    - Power-to-gas offers interesting opportunities
  - Consideration of Net Impact Benefits is appropriate for analysis of gas alternatives

General Overview for Energy Gas Applications

- **Just Add Hydrogen – Making the Most of a Limited Resource**
  Ilkka Hannula, VTT Finland
  - Decarbonisation of transportation important
  - Will need significant biofuels to meet demand for transportation by 2050
  - Gasification offers good opportunity for production of fuels with reasonable carbon and energy efficiency
  - It is key that hydrogen input for biofuels production is generated from very low carbon source

General Overview for Energy Gas Applications

- **Gasification and Combustion – Comparison of the Potential**
  Thomas Nussbaumer, Verenum
  - Biomass is important energy source for building heat, electricity, industrial process heat and ultimately mobility, but is a limited resource
  - Combustion is important technology and advances such as staged “pre-gasification” combustion reduce emissions
  - Gasification offers potential improvements in particular in terms of particle emissions, also in terms of electricity production efficiency for small scale

Gas Sampling, Measurement and Analysis Science

- **Gas Analysis Working Group (GAW): Status and Perspectives**

  York Neubauer, TU-Berlin; Serge Biollaz, PSI

  - Different interpretations of ‘standard’ tar protocol
  - Series of workshops and webinars focus in gas analysis for gasification systems
  - Interaction between groups and internet collaboration is important to maintain knowledge base

Gas Sampling, Measurement and Analysis Science

- **Measurement and Characterization of Tars using the SPA Method: On-going Developments**
  Kevin Whitty, University of Utah; Klas Engvall, KTH
  - Tars are an operational challenge for biomass gasification
  - “Tar Protocol” originally developed through Task 33 is common method that employs cold trap to capture tars which can be weighed and analyzed
  - SPA is alternative that is simpler, faster, less labor intensive
  - Several variations/improvements of SPA method have been developed by research groups

Gas Sampling, Measurement and Analysis Science

- **Synergies in Gas Sampling Research T32 and T33**
  Thomas Nussbaumer, Simon Roth, Peter Zotter, Lucerne U of Applied Sciences
  - Pyrolysis gas sampling and analysis
    - Approach and methodology
    - Practical challenges such as e.g. probe clogging
    - Measurements of gas phase components
    - Data from analysis useful for e.g. simulation validation
  - Flue gas measurements
    - Analyze for gas species, dust
    - Also sampling for toxic components
  - Synergies with gasification

Gas Sampling, Measurement and Analyses on Pilot, Demonstrations and Early Commercial Installations

- **GSMA on the Bioliq Process**
  Mark Eberhard, KIT
  - Process GC is a workhorse and problem-free
  - Slag analysis is important for bioliq process
  - Use analyses to develop material balances around the system
  - Developing online residence time measurement
    - Two argon inlets, one before reactor and one after to correct for dead time
  - Implementation of optical ports for e.g. laser-based analysis techniques
  - Optical borescope/camera for flame visualization

Gas Sampling, Measurement and Analyses on Pilot, Demonstrations and Early Commercial Installations

- **GSMA in Güssing**
  Reinhard Rauch, TU-Wien
  - Standard analyses
    - CO, CO_2, O_2 by IR/paramagnetic
    - Engine oil analysis indicates quality of syngas treatment
  - Specific analyses for optimization, etc.
    - GC for permanent gases
    - Tars using tar protocol, but with toluene as solvent
    - Bed material, ash, filtered particulates, etc, are analyzed to help understand material balance
    - For catalysts, measure both online and post-mortem, and also perform long term tests in case catalyst poisons are not analyzed

Gas Sampling, Measurement and Analyses on Pilot, Demonstrations and Early Commercial Installations

- **GSMA at the CHP-Plant Stans**
  Berhard Böcker-Riese, BR Engineering
  - Development of technology from lab to industrial scale 1993–today
  - Stans plant is 1 MW operating on relatively clean demolition wood
    - Two identical trains with 4 gasifiers each
  - Syngas quality is inferred from analysis of engine oil
  - Volumetric gas flow determined from blower speed, temperature, suction pressure
  - Gas composition by standard analyzer for CO, CO_2, H_2, CH_4
    - Back pressure regulation is important

Gas Sampling, Measurement and Analyses on Pilot, Demonstrations and Early Commercial Installations

- **Laws and Proof of Legal Emissions from Biomass Conversion Installations (Wood Gasifier)**
  Christoph Baltzer, BECO (Dept. Environment Bern Switzerland)
  - Measurement of different types of emissions from various types of commercial installations in Kanton Bern area
  - Measurements from a wood gasifier
    - Calculations for pumping speed for collection tube
    - Measure dust, CO, NO_x
  - Practical application of GSMA

Gas Sampling, Measurement and Analyses on Pilot, Demonstrations and Early Commercial Installations

- **Gas Quality and Conversion of Biogas (Gas Turbines, Gas Engines)**
  Jürgen Karg, Siemens AG Power and Gas Division, Germany
  - Gasification installations have long development
    - First biomass-based IGCC several decades ago, but none currently in operation
    - Most for chemicals production processing coal
  - Gas turbines have become large, flexible, reliable
  - (Biomass-based) syngas creates challenges associated with high H_2, low heating value, large volume flows
  - Gas engines likely more suitable for power generation from smaller biomass-based systems

Observations and Thoughts

- Sampling/measurement can be time consuming and labor-intensive; usually requires a meticulous expert that has an appreciation for challenges
- Commercial plants use combination of off-the-shelf analyzers and process data to infer performance and gas quality during normal operation
- Different GSMA needs for commercial industrial plants vs research reactors
- Will the day come when we have e.g. tar analyzers that are as reliable and trouble-free as the process GC?
- Would be useful to have readily-available, specific document or series of documents, “blessed” by experts in the field, explaining how to best perform sampling, analysis, interpretation