UK CCS workshop – CO_2 Capture *(including hydrogen production with CCS and amine based solvent reclaiming)*
Web meeting hosted by UKCCSRC
Date 31st January 2022, 2pm – 4pm
Chaired by Jeremy Carey, Exergetic
Presenters: Chet Biliyok, Petrofac; Suzanne Ferguson, Wood Plc; Mayowa Akinrinlola & Adam Wharton, Humber Zero; Alex Tait, Net Zero Teesside; Simon Gant, HSE

Key UK research needs highlighted through workshop

Research needs identified in the January/February 2022 workshop:

- Amines/Solvents
  - Long run performance (lab) testing of open-art solvents (MEA at various concentrations, CESAR & other alternatives) - degradation, emissions, corrosion, water treatment
  - Corrosion, material selection, resilience against potentially higher corrosion rates, inhibitors required and long-term corrosion
  - What are the non-proprietary, non-amine alternatives?
  - Review solvent management strategy including reclamation technology
  - Fluid characterisation: impurity analysis
- Design and operation of gas turbine power plants with CCS (including flexible "dispatchable" and abated combined cycle)
  - Flexibility vs efficiency
  - Dynamic modelling and simulation focused on turbo-machinery & system hold-up
  - Back-pressure turbine on steam draw
  - Rich solvent storage
  - Operational strategies
  - Identifying opportunities for energy integration
  - Reliability: alignment with process unit shutdown schedule and identification of areas of concern
  - Pilot plant feasibility testing
- Emissions and Environmental Impacts
  - Are industry designing to appropriate limits?
  - How much do the limits vary between each location?
  - Review of current limits across the UK and wider
    - Review of impact of each contaminant: data on environmental impact of components available to public
  - CO_2 emergency venting: what are the impacts of the impurities, accuracy of the models being used, strategies to minimise inventories that may need venting
- Hydrogen
  - What are the different H_2 purity requirements: materials of construction, fluid flow impacts of impurities, carbon footprint of impurities, user purity requirements
  - UK H_2 storage requirements: How much is needed i.e. winter peak heating demand? Where is this needed?
  - Alternative routes to produce ammonia: Decrease energy penalty, Increase flexibility (speed to turn up and down production to match PEM electrolysis from wind/solar)
  - Life Cycle Analysis of Blue/Green/Bio sources including a review of carbon footprint
  - Storage: Energy efficient and compact storage
    - Full chain flexible hydrogen storage study

- Market driven study of Hydrogen demand
- Modelling
  - Dense phase CO_2 modelling: prediction of risk contours
  - Supplier engagement and qualification for +/ 2.5% accuracy
- Measurements
  - Online measurement of impurities in dense phase CO
  - Online measurement of pollutants at very low concentrations
- CO_2 pipeline integrity
  - Are new correlations required to avoid overdesign of dense phase CO_2 pipelines?
- Flue Gas Composition
  - Understand contaminants and effect on amine
  - Determine pre-treatment requirements
  - Fan design technical qualification
  - Technical review of blower supplier designs
  - Absorber CFD modelling to ensure adequate gas distribution
- Other
  - Review of different CCU technologies available in the UK
  - O_2 removal and dehydration technology for compressed CO_2: CO_2 materials testing and start stop technology
    - Atmospheric Pollution: Amines chemistry and N-amines EALs, establish robust measurement methods, review of ADMS modelling and what is the ultimate environmental fate of species released from carbon capture processes?

Research needs identified in the March 2021 workshop that were categorised as high priority in 2022:

- Measurement/metering needs
  - Metering approaches for CO_2 that achieve objectives in the most cost-effective manner
  - Cost-effective/robust post absorber separation devices that curtail fugitive emissions
  - Capture needs identified by the NPL Energy transition report -CCS
  - Hydrogen needs identified by the NPL Energy transition report -H_2
- Independent technology review for hydrogen production technologies
  - Pros and cons of technologies, work to provide an unbiased view
  - Including but not limited to: ATR+GHR, SMR/GHR and POX for H_2 production
  - An independent review based on simulation of the completing pathways and their potential

Research needs identified in the March 2021 workshop that were categorised as medium priority in 2022:

- BECCS feedstock review
  - How much biomass or waste will be available in the context of a circular economy
  - Review of the potential feedstocks available in the UK and suitable for negative emissions hydrogen/ammonia generation, life cycle analysis basis
- Define system boundary for a complete capture or CCS plant
  - Including: amine selection, mass and energy balances, utility requirements, effluent stream and emissions, emissions points and compositions
  - How does this tie in with energy from waste (EfW) plants?
- Cost reduction of CCS
  - Potential biotechnology solutions
  - How can the capital costs be reduced? Design risks, operational & flexibility trade-offs, retrofit and capture ready costs
  - Meta study of cost reduction opportunities
- Hydrogen Storage
  - Validating techniques for hydrogen storage, flow rates and the associated support needed
  - Flexible and viable larger storage methods other than salt caverns
  - Optimisation of the hydrogen supply chain

Research needs identified in the March 2021 workshop that were categorised as lower priority in 2022:

- Environmental controls optimisation (holistic model of additional processes)
  - A tool that provides quantitative guidance to various environmental impacts to support technology, licensor and consent development
  - The above tool should address issues such as - adding Selective Catalytic Reduction (SCR) to minimise NOx (and solvent degradation), adding acid wash to reduce ammonia slip and adding treated flue gas heater to prevent visible plume and/or aid dispersion
- Retrofitting Aspects
  - Retrofit of CO_2 capture on existing H_2 facilities
  - Integration of next generation CO_2 capture technologies in hydrogen production
  - Flexible operation of hydrogen production plants: turndown, hydrogen storage
  - Hydrogen production with liquid and gaseous biogenic feedstock (i.e. ethanol, biomethane)

- Containment challenges for smaller emitters
    - Analysis of how adequate CO_2 purity can be attained to go into the network and storage
    - What is within the control of the network to mix streams to meet storage specifications
    - How can a capture plant be adapted accordingly including retrofit
    - How to decarbonise plants not in clusters
    - What does CCS and H_2 really look like for smaller plants
- Low concentration residual waste from processes at risk of causing environmental damage
    - Waste that cannot be re-used/recycled i.e. ash, water/atmospheric discharges
    - Assess acceptable concentrations of residual wastes in captured CO_2; depending on CO_2 stream destination (i.e. concrete curing, sequestration, carbonation) and, if any, short cycle CO_2 processes tolerating low concentrations of these wastes