Contract No:

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SR19009 – Future Recovered Gas Dryer Development

Facility Need

The primary purpose of the Recovered Gas Dryers (RGDs) is to remove moisture. This is accomplished using 5A molecular sieve materials that can be regenerated by heating to moderate temperatures. Unfortunately, 5A molecular sieve materials do not selectively remove only water from a gas stream. Other tritiated compounds, such as ammonia, can also be absorbed and are not easily removed during conventional regeneration. Due to tritium decay heat energy, these tritiated impurities cause the bed temperatures to remain greater than 100 °C, even after regeneration. Further, high levels of adsorbed tritium complicate disposal of RGDs at their end of life. Previous small-scale testing indicates that full ammonia desorption can be achieved by heating to 600 °C, but such a high temperature bake-out is not currently an option for remediation. Alternative to high temperature bake-outs, moisture-ammonia isotope exchange could reduce tritium content in the 5A zeolite, but the SRTE RGD location does not have a moisture source to perform such a task.

Potential Benefits

☑ Cost Reduction	☑ Defect Reduction	☑ Material Optimization	☑ Mission Diversification
☑ Mission Viability	☑ Obsolescence Solution	☑ Process Optimization	☑ Safety

Project Summary

Building on our successful development of a water detritiation process, this project was extended to ammonia detritiation using a catalytic isotope exchange process with hydrogen (H_2) for the next generation of RGD materials. In these processes, isotopic exchange between flowing H_2 with adsorbed tritiated species is facilitated by trace amounts of an active catalyst component (e.g. Pt) that is loaded onto a zeolite. Since the catalyst loading may alter the zeolite pore size, Pt/zeolite performance for moisture and ammonia adsorption underwent verification in addition to characterization of the remediation process. The performance was evaluated for catalytic isotope exchange of deuterated water and deuterated ammonia (surrogates) with H_2 at ambient temperatures.

SR19009

Status

Started in FY19, continuing in FY20

Technology Readiness Level

Start of FY19: 2

End-of-FY19 Forecast: 3

End-of-FY19 Actual: 3

Financial

FY19 Project Cost: $135k

Cumulative Total Project Cost: $135k

FY20 Authorized Amount: $0

Credits

Principal Investigator: S. Xiao, P. Beaumont, L. Angelette, G. Larsen

Facility Engineering Co-Lead: H. Mentzer

Contributor:

Milestones/Findings/Accomplishments

Project Milestone	Expected End	Actual End
Future RGD bed material development, e.g. Pt/5A	06/2019	06/2019
Performance evaluation of catalytic isotope exchange	09/2019	09/2019
Performance evaluation of water and ammonia adsorption on the material	09/2019	09/2019

- Catalytic isotopic exchange was demonstrated successfully between hydrogen gas and deuterated water and deuterated ammonia over Pt loaded zeolites.
- No significant catalytic isotopic exchange was observed over the 5A zeolite without Pt.
- Four different zeolites with various Pt loadings were prepared. Within the evaluated samples, Pt/HY and Pt/5A, both appeared equally active in catalytic isotopic exchange as well as moisture and ammonia removal. Further studies are needed to quantify this conclusion.
- Tritium removal from tritiated ammonia and tritiated water is possible for future RGD beds using Pt loaded zeolites based on the experiments performed so far.

Future Work

- Redesign and modify manifold as needed to improve throughput efficiency
- Continue performance evaluation of catalytic isotope exchange H_2/D_2O, H_2/ND_3, and H_2 with D_2O/NH_3 mixtures
- Modify experimental design as needed to improve data collection and performance evaluation
- Begin designing future RGD based on collected data and results