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ASC Poster - Concentration of Xe from Simulated Dissolver Off-gas Streams Utilizing a Solid Sorbent, AgZ-PAN

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Changing the World's Energy Future

Emma Rose MacLaughlin, Meghan S Fujimoto

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Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

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Concentration of Xe from Simulated Dissolver Off-gas Streams Utilizing a Solid Sorbent, AgZ-PAN

Emma MACLAUGHLIN and Meghan FUJIMOTO | Idaho National Laboratory, USA

Separation/Capture of Volatile Fission Products

- Volatile radionuclides in the off-gas from UNF processing must be mitigated to meet US-EPA requirements
- Xe and Kr can be difficult to separate, historically done through cryogenic distillation.
- INL has developed sorbents for Xe and Kr Capture, and adsorption studies have been successful in separating and capturing Xe from carrier gas streams.
- These studies assumed non-radioactive Xe could be released to atmosphere.

AgZ-PAN

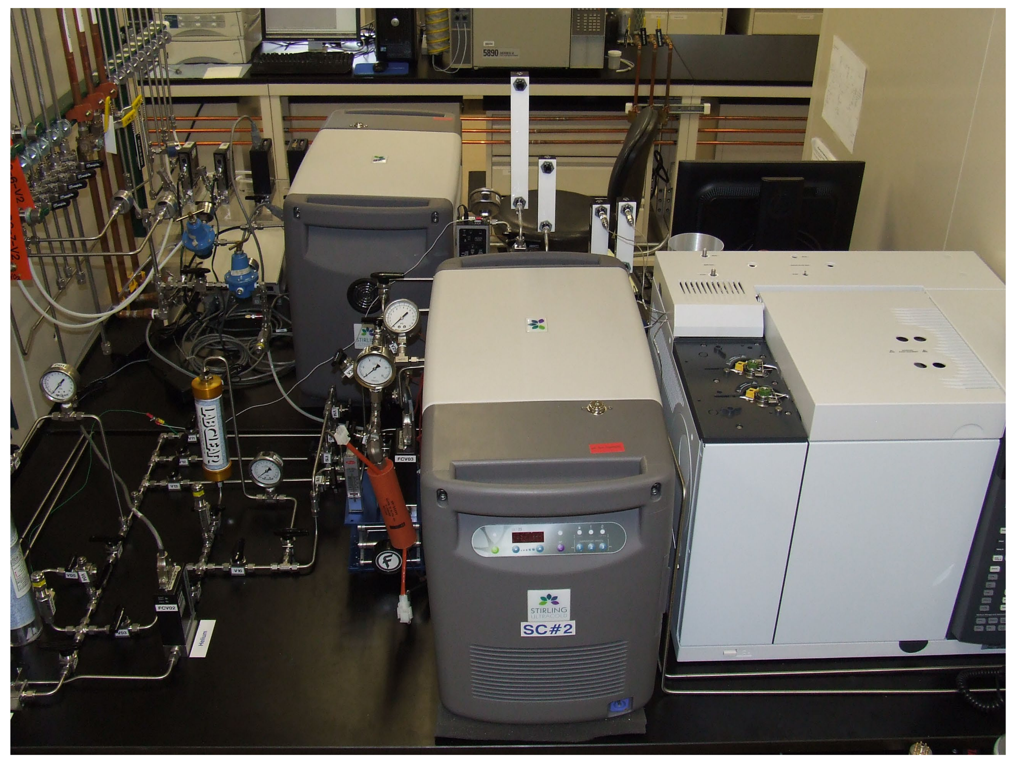
Concentration Xe is necessary to produce Xe that can be used for commercial and research applications.

Goals

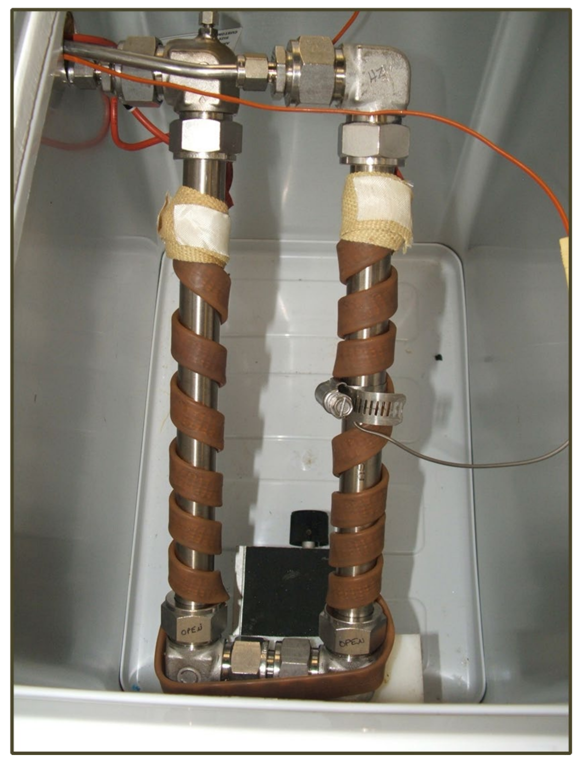
- Investigate multiple cycles of adsorption/desorption
- Increase Xe feed concentration each cyle
- Determine maximum purity achievable with AgZ-PAN

Deep-Bed Column Testing

- 1.9 cm ID x 50.8 cm stainless-steel column packed with 45 g of AgZ-PAN
- Temperature controlled (Adsorption: 298 K, Desorption: 420 K)
- Gas Delivery System (100 sccm test gas flow, 5 sccm He flow)
- Agilent 7890B Dual Gas Chromatograph with Thermal Conductivity Detectors for effluent stream monitoring

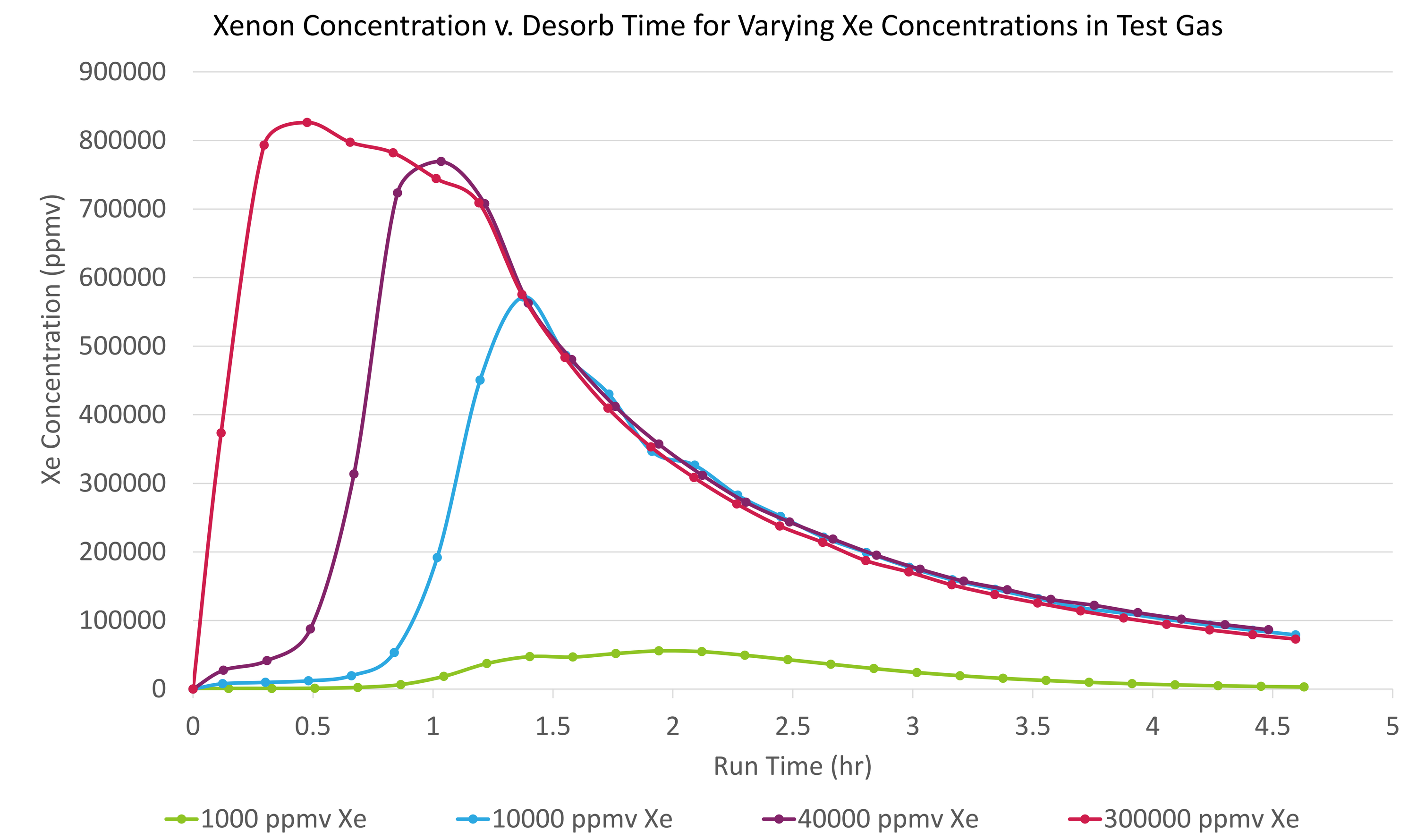


INL Test Apparatus



Packed column in Cooler

Adsorption/Desorption Cycle Results



During sequential cycles with increasing Xe feed concentration →

- ↑ Xe Effluent Concentration
- ↓ Time for Xe Peak to Occur

Xe Concentration Factors

Table 1. Concentration Factors

Xe Feed Gas Concentration (ppmv)	Concentration Factor Based on Desorption	Concentration Factor Based on Collection of ~90% of Xe Peak
1000	10.1	11.3
10000	4.0	12.5
40000	1.4	7.5
300000	0.3	2.1

Concentrated a 1000 ppmv Xe feed stream to a 63% pure Xe stream through four Adsorption/Desorption cycles.

Fractioning Effluent to Increase Stream Purity

Xe Feed Gas Concentration (ppmv)	Based on Collection of the Entire Xenon Stream during Desorption		Based on Collection of ~90% of the Xenon Stream during Desorption	
	Average Xe Concentration (ppmv)	Total Volume of Effluent Stream (L)	Average Xe Concentration (ppmv)	Total Volume of Effluent Stream (L)
1,000	1.01×10^4	3.63	1.13×10^4	3.16
10,000	4.01×10^4	11.1	1.26×10^5	3.39
40,000	5.56×10^4	22.74	3.01×10^5	1.88
300,000	1.02×10^5	23.06	6.31×10^5	1.68

Initial Cycle: Selective collected 90% of the Xe, the average air content in the desorb stream was reduced from 5% to 0.1%, creating a purer stream.

This means the initial carrier gas can effectively be replaced by a more desirable carrier gas in one adsorption/desorption cycle, while also concentrating the Xe.

Study Conclusion

- AgZ-PAN can be used to produce a concentrated Xe product.
- Xe can be purified through concurrent adsorption/desorption cycles with concentration.
- This should be considered a proof-of-concept demonstration. Further refinement is necessary to develop optimum operating schemes to integrate into UNF off-gas treatment.

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