



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

May 2024

*Changing the World's Energy Future*

Emma Rose MacLaughlin, Meghan S Fujimoto



#### **DISCLAIMER**

This information was prepared as an account of work sponsored by an agency of the U.S. Government. Neither the U.S. Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness, of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. References herein to any specific commercial product, process, or service by trade name, trade mark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the U.S. Government or any agency thereof.

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

**Emma Rose MacLaughlin, Meghan S Fujimoto**

**May 2024**

**Idaho National Laboratory  
Idaho Falls, Idaho 83415**

**<http://www.inl.gov>**

**Prepared for the  
U.S. Department of Energy  
Under DOE Idaho Operations Office  
Contract DE-AC07-05ID14517**



# 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.



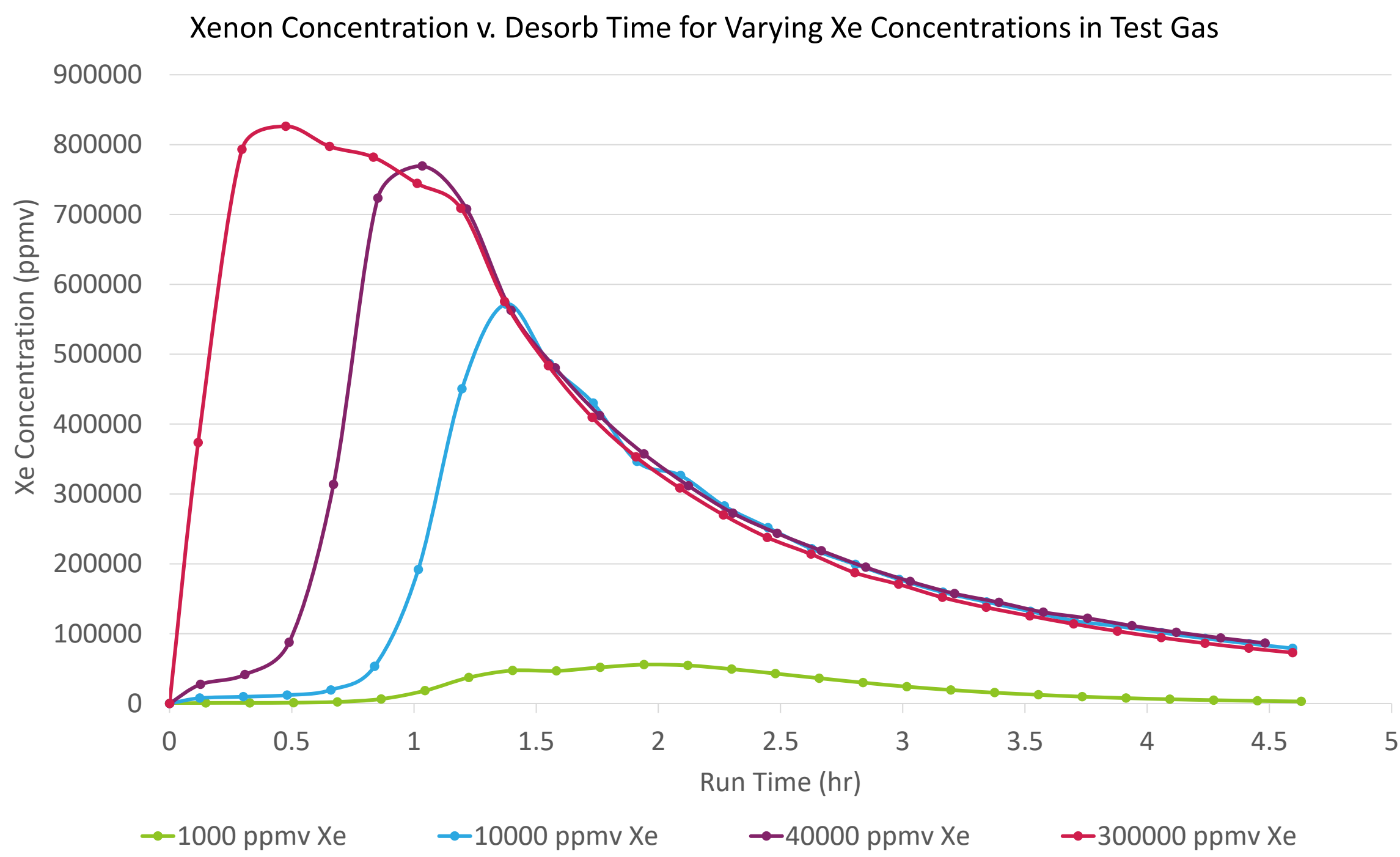
AgZ-PAN

**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 cycle
- Determine maximum purity achievable with AgZ-PAN

## 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.**

## 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

## Fractionating 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	$1.01 \times 10^4$	3.63	$1.13 \times 10^4$	3.16
10,000	$4.01 \times 10^4$	11.1	$1.26 \times 10^5$	3.39
40,000	$5.56 \times 10^4$	22.74	$3.01 \times 10^5$	1.88
300,000	$1.02 \times 10^5$	23.06	$6.31 \times 10^5$	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.

This work was supported by the Material Recovery and Waste Form Development Campaign, funded by my U.S. Department of Energy, Office of Nuclear  
[www.inl.gov](http://www.inl.gov)

Battelle Energy Alliance manages INL for the U.S. Department of Energy's Office of Nuclear Energy

