



# Separation of Xenon from Krypton in UNF Reprocessing Off-Gas

June 2019

*Changing the World's Energy Future*

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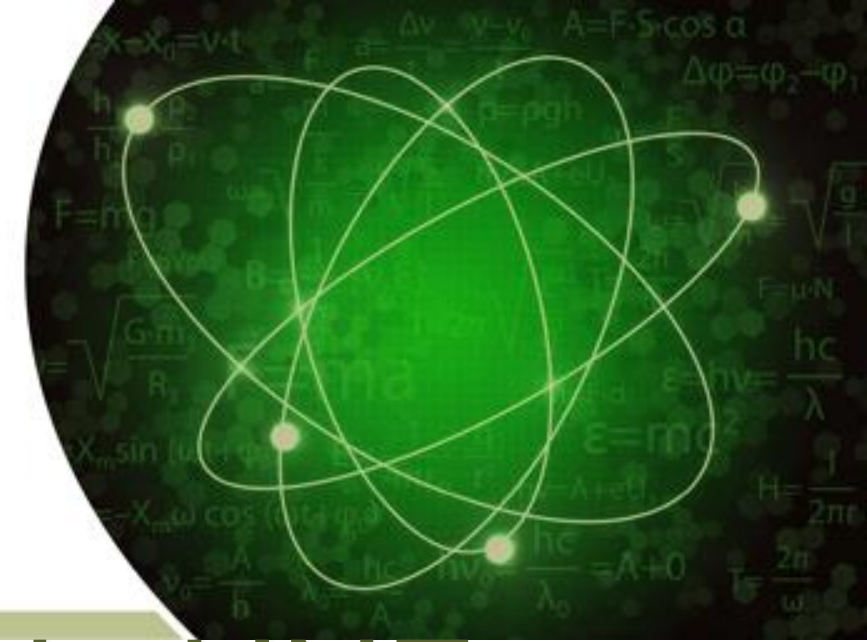
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Idaho Falls, Idaho 83415**

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

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THE VALUE  
OF NUCLEAR



# Separation of Xe from Kr in UNF Reprocessing Off-Gas

Amy K Welty  
Chemical Engineer

# Xe/Kr Separation Options

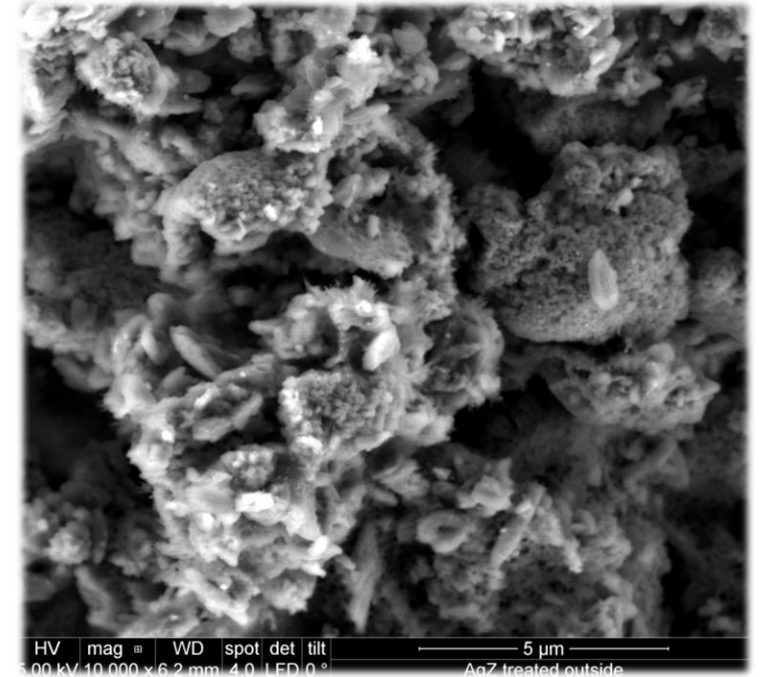
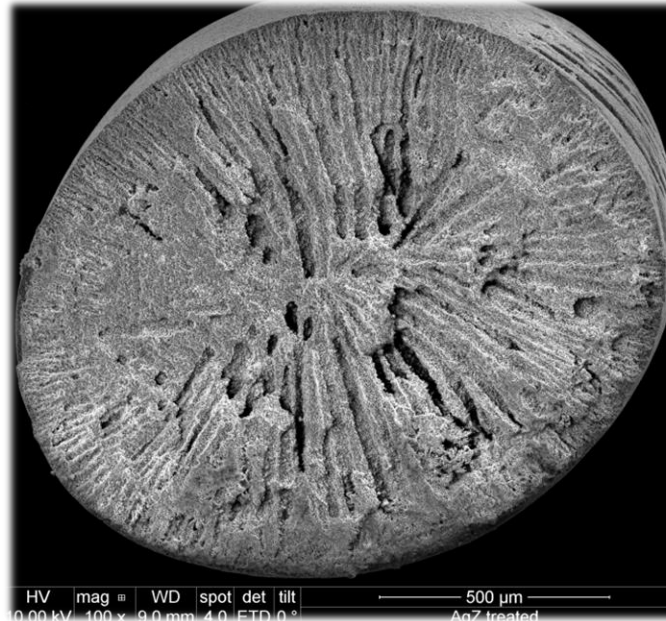
- Cryogenic Distillation
- Membrane Separation
- Adsorption
  - Granular activated carbon
  - Molecular organic frameworks
  - Inorganic frameworks (natural or synthetic)

# Xenon Adsorbant: AgZ-PAN



Activated AgZ-PAN

100x magnification



10,000x magnification

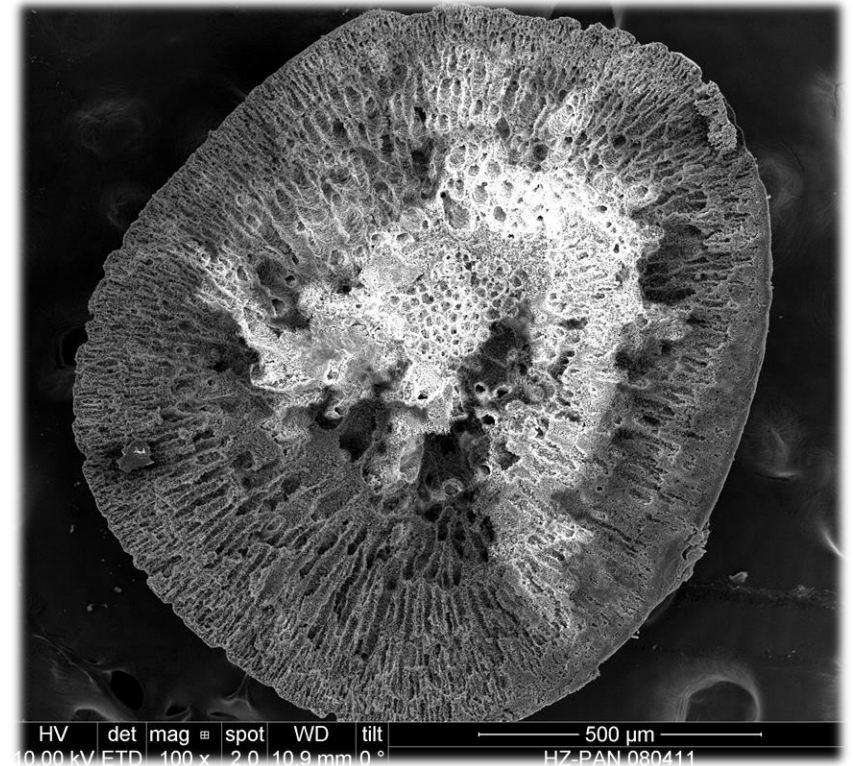
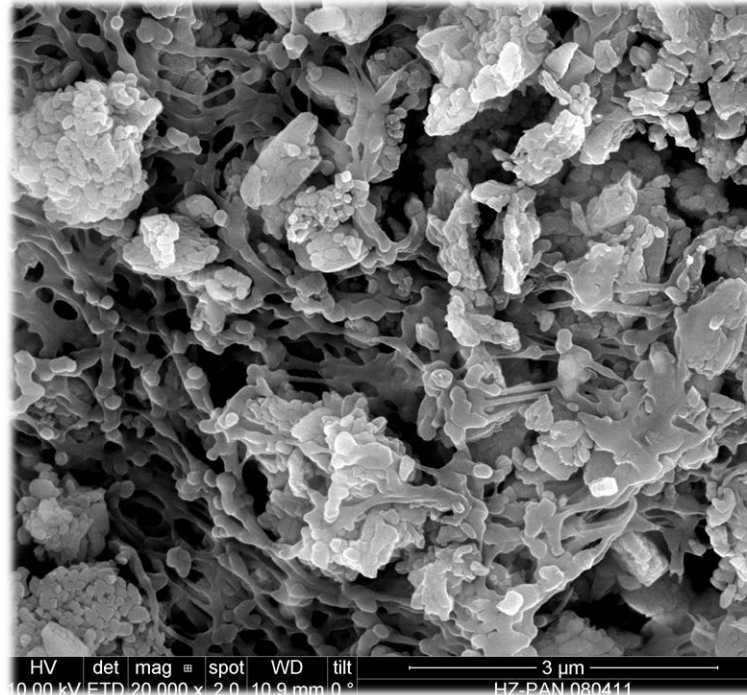


# Krypton adsorption: HZ-PAN



Activated HZ-PAN

20,000x magnification



100x magnification

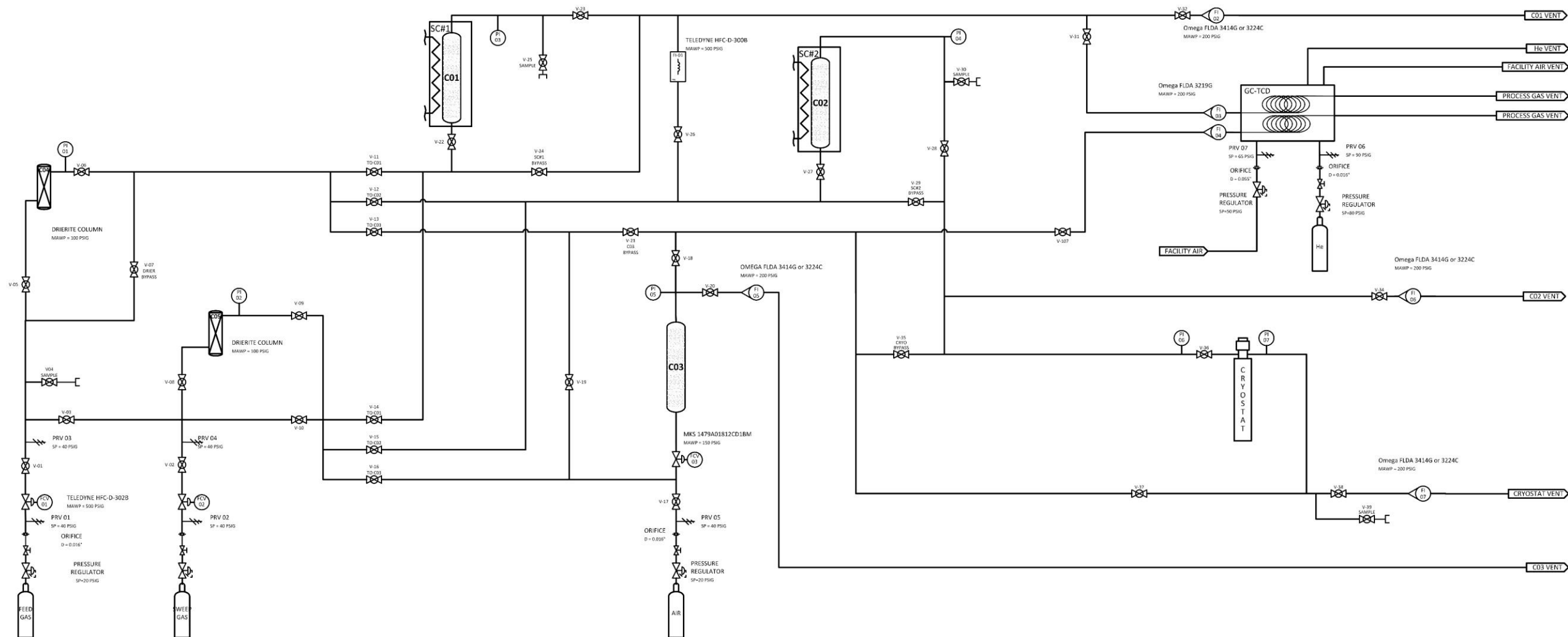
# Test System

- 3 columns
  - Up to 1.5" diameter columns
  - Up to 10" length (or longer at room temp)
- 2 Sterling coolers
  - Control form  $-20^{\circ}\text{C}$  to  $-194^{\circ}\text{C}$
- 1 dual-detector GC-TCD with automated sampling
- Flexibility to direct flow through 1, 2, or all three columns

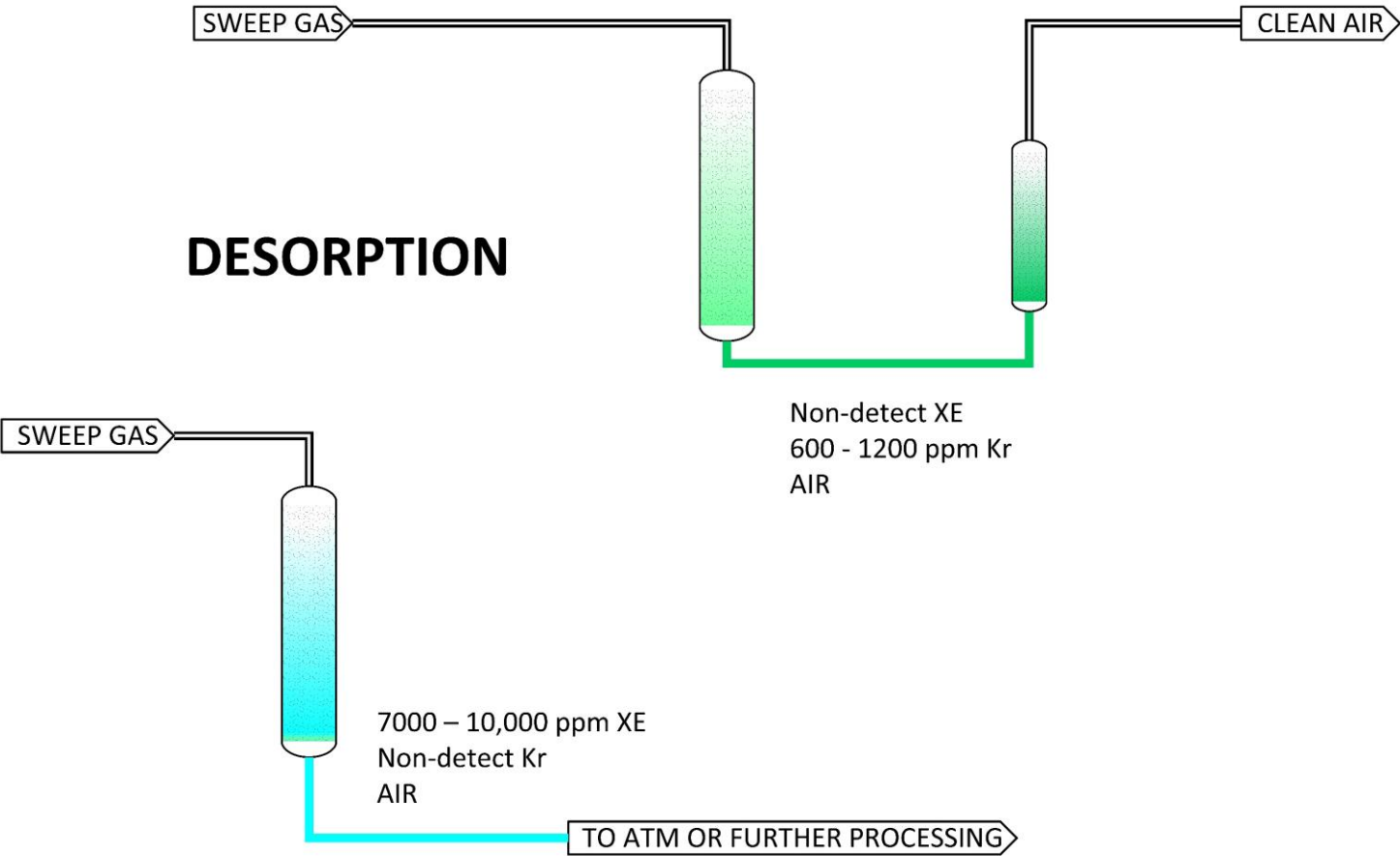
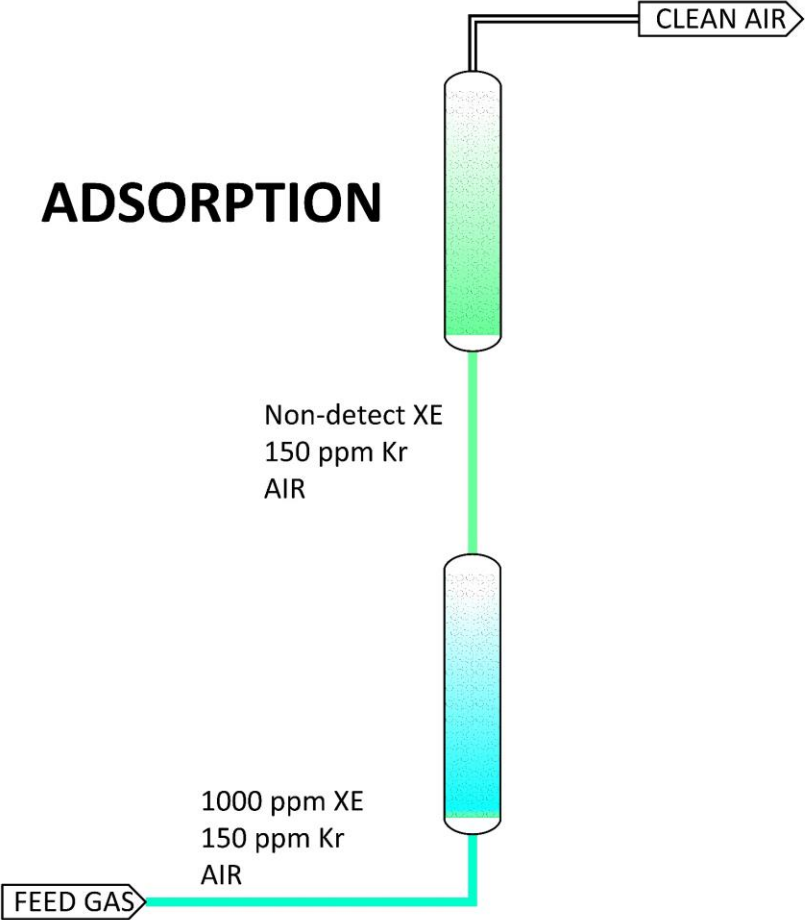




# Test System P&ID



# Simplified Process

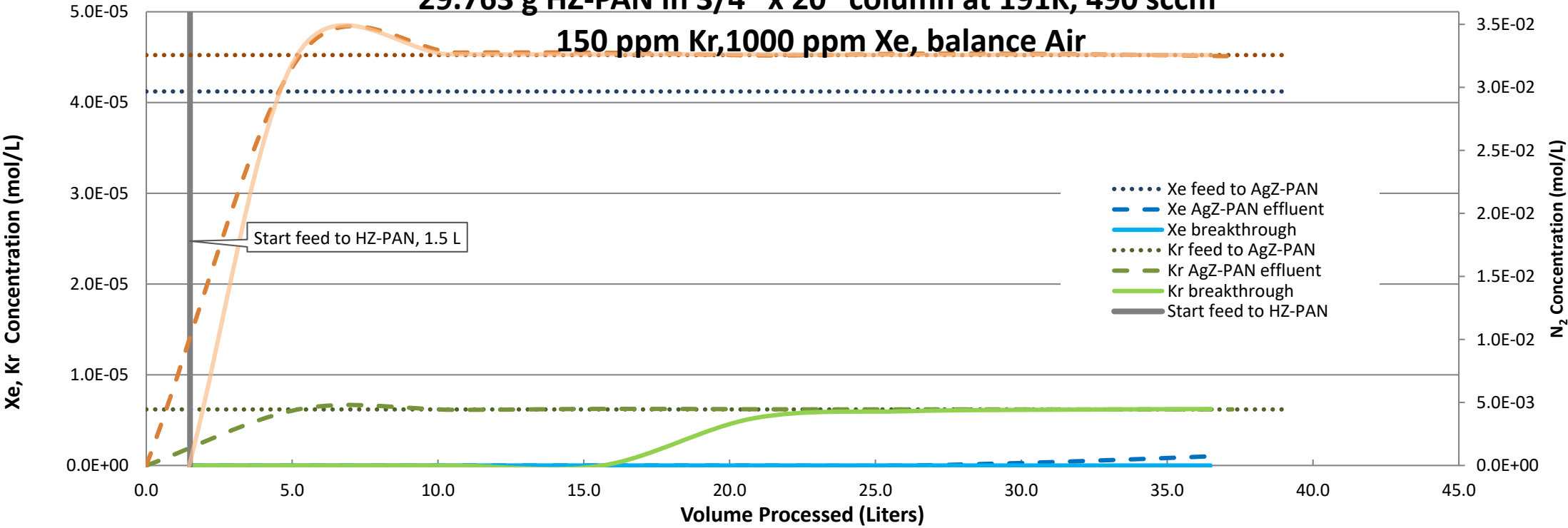


# Separation Results

## Multi-Column

44.7996 g AgZ-PAN in 3/4" x 20" column at 295K, 500 sccm,  
29.763 g HZ-PAN in 3/4" x 20" column at 191K, 490 sccm

150 ppm Kr, 1000 ppm Xe, balance Air



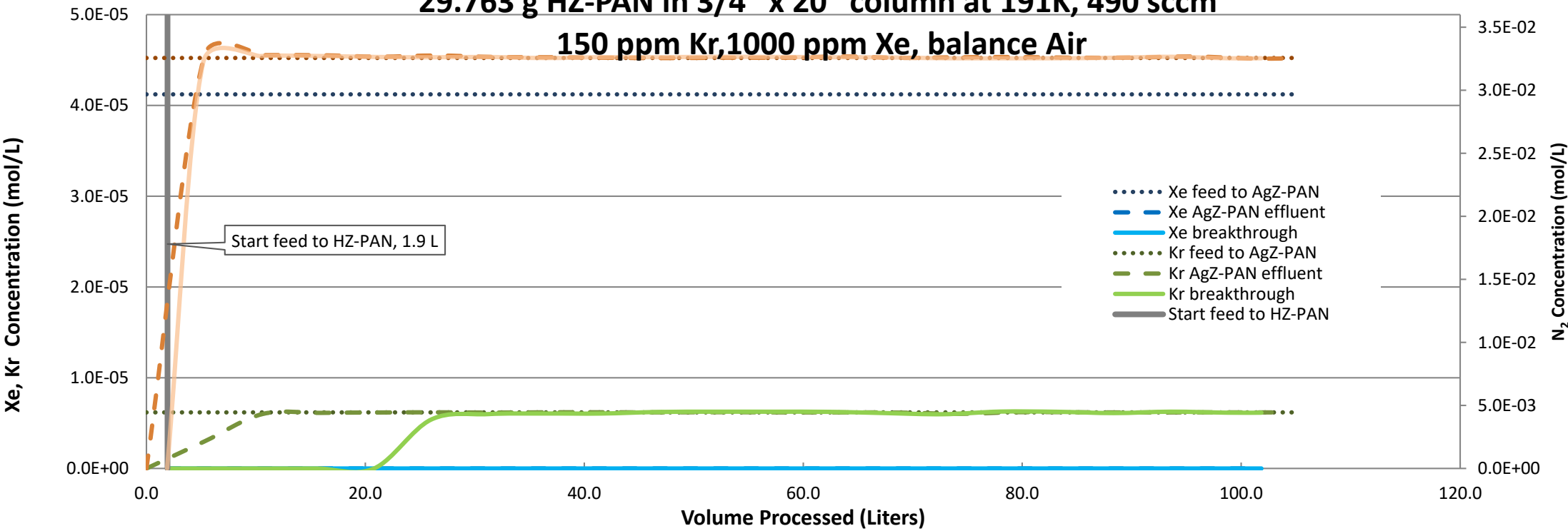
# Separation Results 5/9/17

## Multi-Column

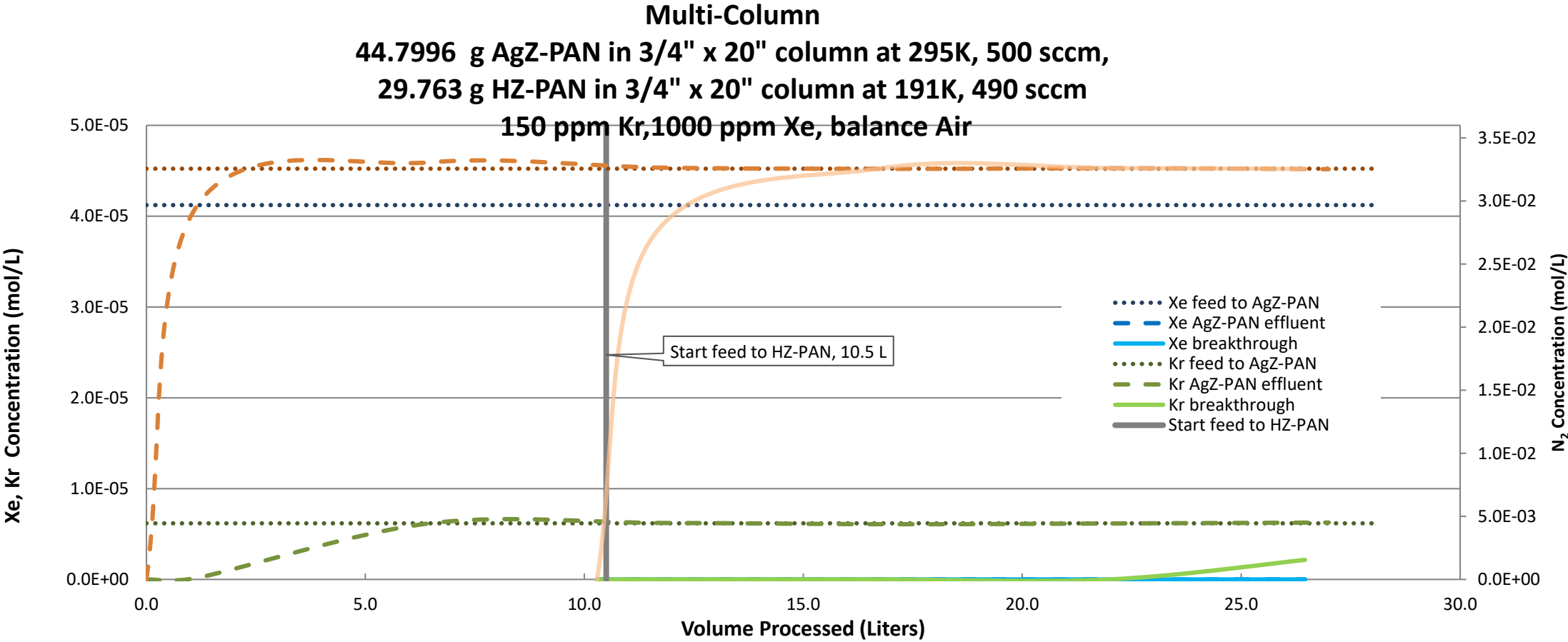
44.7996 g AgZ-PAN in 3/4" x 20" column at 253K, 500 sccm,

29.763 g HZ-PAN in 3/4" x 20" column at 191K, 490 sccm

150 ppm Kr, 1000 ppm Xe, balance Air



# Separation Results





# Current focus

- Desorption
  - Optimizing temperature
  - Investigating sweep gas
- Multi-column testing of other sorbents

# Other Projects

- GAIN voucher with GE-Hitachi
  - Improving off-gas system performance
  - Improving economics and performance of existing LWR and BWR plants
- NASA Phase II S<sup>2</sup>BIR with TDA Research
  - Testing sorbent performance for Nuclear Thermal Propulsion ground testing off-gas cleanup
- Licensed patent with Global Phosphate Solutions
  - Received R&D100 Special Recognition Green Tech Award for “Phosphate Sponge”
- Supporting gas adsorption modeling efforts at Georgia Tech

# Acknowledgements

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