K_d AND TITRATION TESTING OF SPHERICAL RF RESIN

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Background

- Small Column Ion Exchange (SCIX) System proposed for cesium removal at Hanford and Savannah River
- SCIX is deployable in- or near-tank to reduce capital cost and expedite remediation
- Reported work used elutable Spherical Resorcinol Formaldehyde Resin (RF)
- Resin geometry is intended to mitigate column packing/pressure drop issues associated with granular RF and SuperLig®
- Testing was performed to obtain data for SCIX system design

Basic K_d Measurements

- Equilibrium isotherm data needed for column prediction model
  - Used to design equipment and predict operating performance
  - Two isotherm predictors have been created
- Additional data collected over a broader range of cesium and hydroxide concentrations
- Kd Tests Performed
  - Method Validation Test (ICP/MS)
  - Method Verification (Cs-137 spike)
  - Method Diagnosis (duplicate samples tested at ORNL and SRNL)
  - Effect of contacts with Hanford AP-101 Simulant

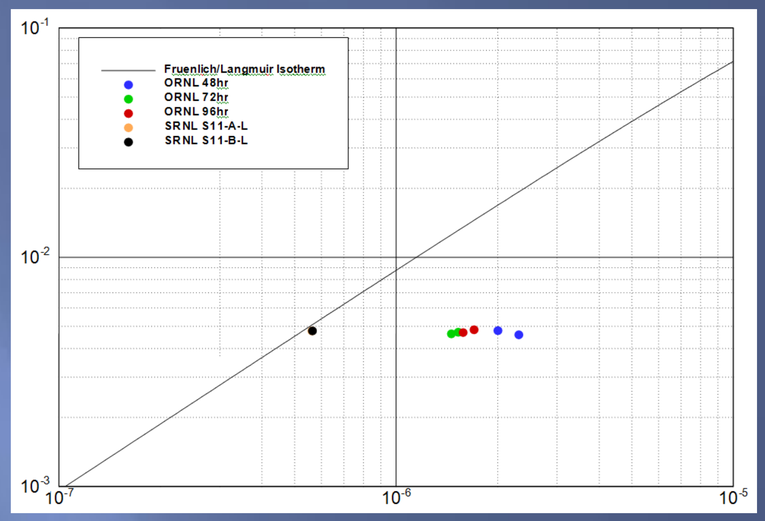
Radiolysis K_d Measurements

- K_d measurements taken on resin samples irradiated at HFIR or the Co-60 Source
- Ambient temperature for Co-60 source was 30°C for two weeks (at SRNL) and 25°C at ORNL
  - Control samples were used for the Co-60 source
- Ambient Temperatures for HFIR samples ranged from 48°C to 51°C from 4 to 80 hours depending on dose

Cesium distribution data from HFIR and Co-60 source

Liquid	Dose (Mrad)	HFIR samples D_{Cs}	Co-60 source samples D_{Cs}	Co-60 source controls [a] D_{Cs}
Nitric Acid	300	3770	2575	6124
	250	3003		
	200	3000		
	150	4930		
Water	300	3271	7780	9914
	250	4773		
	200	1866		
	150	1755		
	100 (new)	14489		
	50 (new)	6580		
	100 (used)	8172		
	50 (used)	8105		
	300	4433	N/A	N/A
	250	2976		
	200	4894		
	150	5186		
SRS	300	2764	3164	12423
	250	3096		
	200	4331		
	150	4418		

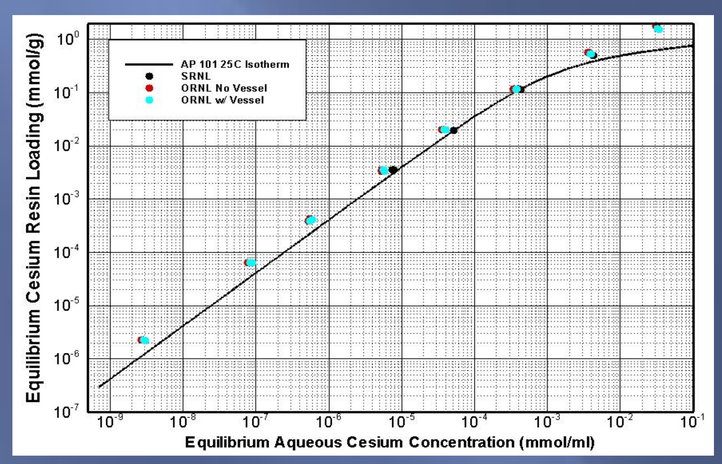
[a]Duplicate control sample: used the same resin and simulant and experienced the same temperature as the Co-60 source samples



Results of Method Verification Test

Contact time, h	Equilibration temperature, °C	Cs Distribution coefficient, D_{Cs} [a]
48	25	2185.9
72	25	3129.9
96	25	2901.3
48	45	1218.3
72	45	1122.1
96	45	1091.7

[a]Simulant consisting of 2*M* NaOH, 3*M* NaCl, and containing stable cesium at a nominal concentration of 4.95×10^{-5} *M* was used.

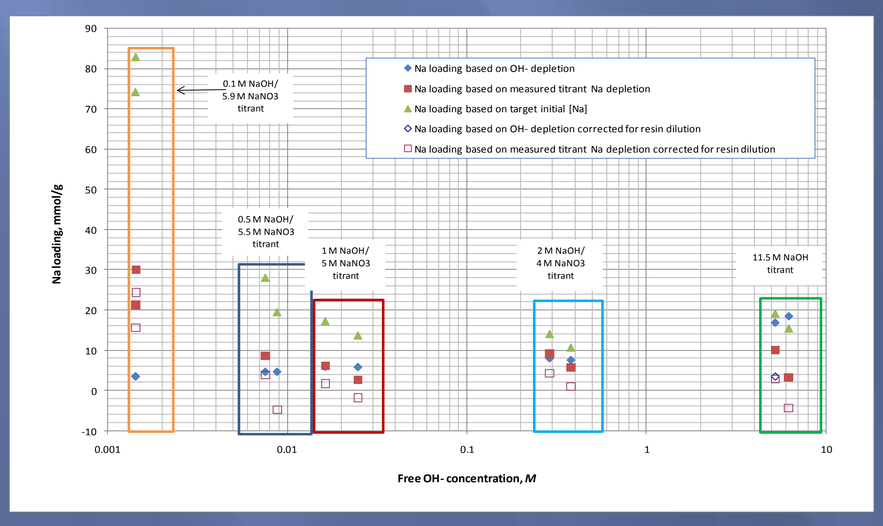


Results of Method Diagnosis Test

Contact time, h	Equilibration temperature, °C	Resin source	Analysis method	Cesium distribution
48	25	SRNL	γ-counting	1860.2
72	25	SRNL	ICP/MS	1526.4
72	25	SRNL	γ-counting	1682.4
72	25	ORNL	γ-counting	2027.2
48	45	SRNL	γ-counting	943.2
72	45	SRNL	γ-counting	880.3
72	45	SRNL	ICP/MS	922.9
72	45	ORNL	γ-counting	1088.2

Titrations

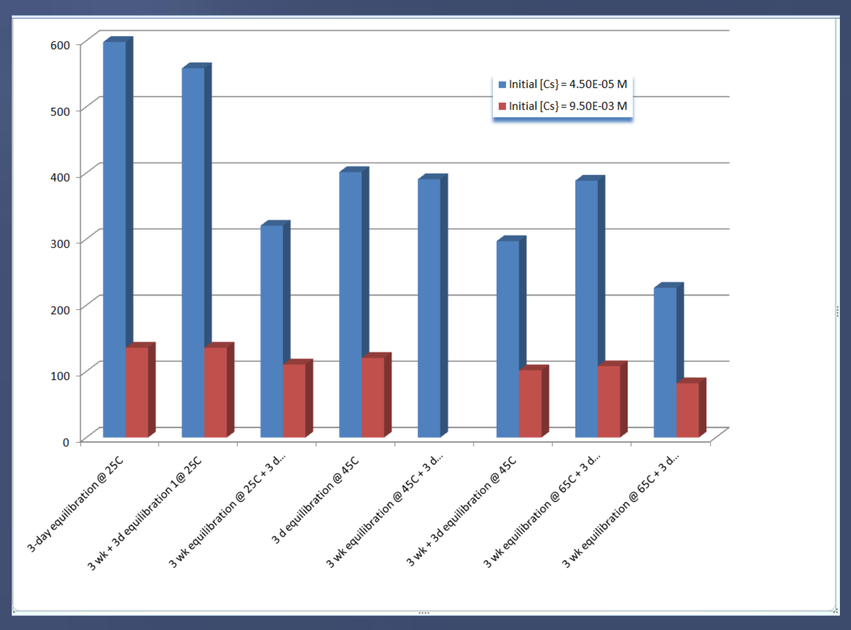
- Sodium uptake data needed for performance model
  - Specifically for conversion of RF resin from hydrogen form to sodium form
- This work obtained data over expanded titrant compositions
- Three testing phases needed
  - Identify an appropriate background salt used for high ionic strength testing
  - Establish a titration curve at lower sodium concentrations using only sodium hydroxide
  - Effects of increased sodium concentration in the titrant on cation exchange

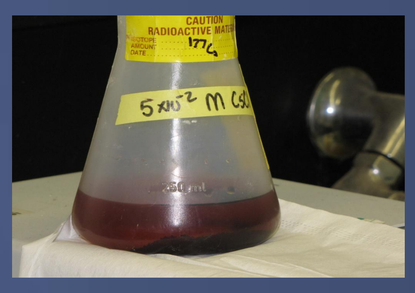


Extended Contact Tests

- Three week extended contact test
  - Hanford AP-101 Simulant with 5 *M* NaOH
  - Temperatures: 25°C, 45°C, 65°C
  - Three day equilibration after extended contact at 25°C or 45°C

Resin and simulant after 3 day contact with SRS simulant





Resin and simulant after 3 week contact with AP-101 simulant

Conclusions

- Data will be used to improve the model to predict column performance
- Reduction in cesium adsorption with increased temperature
- Extended contact testing resulted in minimal differences from the 3-day contact tests

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