CASE STUDY
#CS_SM015-0

SiliaMetS®

Separation of Various Metal Ions from High-Level Liquid Waste

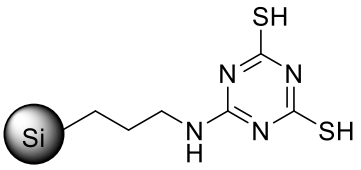
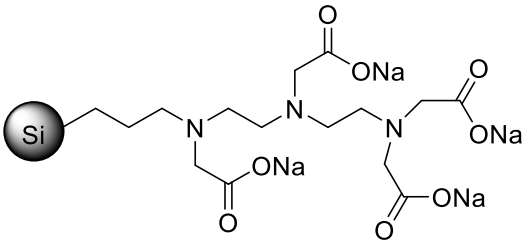
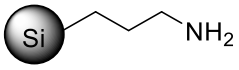
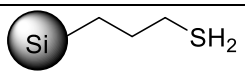
High-level liquid waste (*HLLW*) is nuclear waste created by the reprocessing of spent nuclear fuel, and is contaminated by various metal ions, such as platinum metal group for example. In this study, researchers have demonstrated the efficiency of metal scavengers to get rid of Pd(II) and 14 others metal ions in this type of waste, and eventually recover them. Silia*MetS* TAAcONa has proven to be the most efficient one in the required scavenging conditions.

LEARN MORE about Silia*MetS* in our brochure "*Solutions for Scavenging of Metal & Organic Impurities*".

Various metal elements have proven essential in the nuclear industry, and the management of high-level liquid waste (*HLLW*), generated by fission reactions, stays a challenge. HLLW contains various metal ions which can be removed by several methods such as solvent extraction, ion exchange, precipitation, and extraction chromatography. The latter has many advantages, for example requiring less handling of organic solvents and opening the possibility of making a more compact device than the liquid-liquid extraction method. That is why extraction chromatography was chosen to be explored in this study using various functionalized silica gels.

Four scavengers have been selected to conduct this study: Silia*MetS* DMT, Silia*MetS* TAAcONa, QuadraSil™ AP, and QuadraSil™ MP (*Table 1*). The simulated HLLW had 15 metals to be scavenged using a chromatographic separation in a glass column: Ru, Rh, Pd, Zr, Mo, Re, Cs, Sr, Ba, La, Ce, Nd, Sm, Eu, and Gd.

Table 1: Features of the scavengers used

Features of the Scavengers Used		
Products	**Particle Size (*µm*)**	**Structure**
Silia*MetS* DMT	40 - 63	
Silia*MetS* TAAcONa	40 - 63	
QuadraSil AP	49	
QuadraSil MP	53	

In order to evaluate their scavenging performances and their recovery yields, various parameters were modulated such as the effect of HNO_3 concentration, the contact time, and the temperature. However, after adsorption selectivity tests conducted in HNO_3, QuadraSil AP was ruled out due to its poor Pd(II) adsorption capability under these conditions.

The purpose of this study was not only to remove the 15 metal ions from solution, but also to recover them. The results obtained using Silia*MetS* DMT, Silia*MetS* TAAcONa, and QuadraSil MP in a chromatographic column are presented in Table 2. If the metal was not retained at all, it was recovered in the “feed + washing” fractions. Conversely, if the metal was retained by the scavenger, but impossible to recover, it remained on the column. Finally, if the metal was retained by the column and could be recovered, then it was found in the elution fractions (*eluents 1 to 3*).

Table 2: Recovery yields (%) of the 15 metal ions at each step of the chromatographic method

Scavenging Yields (%) of the 15 Metal Ions								
Products	Steps	Quantity in the Phase (%)						
		Ru(III)	Rh(III)	Pd(II)	Zr(IV)	Mo(VI)	Re(VII)	Others
SiliaMetS DMT	Feed + Washing solution	91	90	0	86	98	97	95 - 100
	Eluent 1	0	0	24	1	0	0	0
	Eluent 2	0	0	0	2	0	0	0
	Eluent 3	0	0	0	6	0	0	0
	Remained on column	9	10	76	5	2	3	0 - 5
SiliaMetS TAAcONa	Feed + Washing solution	95	92	0	13	0	99	93 - 99
	Eluent 1	0	0	100	0	0	0	0
	Eluent 2	0	0	0	14	0	0	0
	Eluent 3	0	0	0	2	0	0	0
	Remained on column	5	8	0	72	100	1	1 - 7
QuadraSil MP	Feed + Washing solution	92	92	0	12	97	98	94 - 100
	Eluent 1	0	0	0	1	0	0	0
	Eluent 2	0	0	0	78	0	0	0 - 5
	Eluent 3	0	0	0	9	0	0	0 - 1
	Remained on column	8	8	100	0	3	2	0

CONCLUSION

This study opens possibilities of using functionalized silica-based adsorbents to eliminate and recover various metals from HLLW. SiliaMetS TAAcONa has proven to be really efficient to remove and recuperate Pd(II) giving a recovery yield of 100 %.

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