Liquid-Liquid Extraction Approaches to the Treatment of Alkaline High-Level Waste

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Although liquid-liquid extraction of radionuclides from acidic high-level waste has long been accepted by the nuclear industry, treatment strategies laid in place in the 1990s for the approximately 100 million gallons of stored alkaline U.S. defense waste have relied on other technologies. Part of the reason could be that the extractants and solvent chemistry possessing the needed extraordinary selectivity, strength, and robustness had not been demonstrated. Based on the simple proposition that the fundamental chemistry and inherent advantages of liquid-liquid extraction can apply as well on the alkaline side as on the acid side, we have recently introduced some new concepts for alkaline waste remediation. Using macrocyclic cation receptors, it has been possible to develop technology for removing radioactive fission products. Phenols and fluorinated alcohols also provide the means to extract and recycle sodium hydroxide, a bulk chemical in the waste. Generically, the challenge to making an impact has not only entailed pursuit of fundamental understanding, but conversion of understanding into working process concepts, which are then put to the test in engineering flowsheet demonstration. Recent results from development and testing of the CSSX process for cesium removal from the Savannah River Site high-level waste will be described.