Materials Science & Engineering Graduate Seminar

Wednesday, January 15 2020, 4:10-5:00PM, FASB 295

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PhD Metallurgical Engineering

Dechlorination of Radioactive Electrorefiner (ER) Salt Waste via Ion Exchange Using Ultrastable H-Y Zeolite

Abstract: Argonne National Laboratory developed a ceramic waste form process for the immobilization of radioactive salt waste generated from electrorefining Experimental Breeder Reactor-II spent fuel, which can hold only up to 7.5 mass% salt into a glass-bonded sodalite waste form. It has been estimated that disposal of Idaho National Laboratory's electrorefiner salt waste into glass-bonded sodalite would take three to five years of full-time hot cell operation and result in an estimated 52 metric tons of waste from only 25 metric tons of original fuel waste. The ceramic waste process suffers from lengthy processing times, costly equipment, and a large waste form volume, which is due to the low waste loading capacity of this waste form. This could discourage commercial use of electrochemical processing for closing the commercial nuclear fuel cycle. Since around 60 mass% of used electrorefiner salt is chlorine (mostly in non-radioactive Cl-), it is, therefore, intriguing to consider dechlorination to assist in waste mass reduction prior to waste form fabrication.

This work aimed to achieve complete dechlorination of electrorefiner salt via the selection of ultrastable H-Y (USHY) zeolite drying conditions, zeolite ion-exchange efficiency, and the temperature cycle. A LiCl-KCl eutectic surrogate electrorefiner salt with various fission product chlorides was used to verify that the process works effectively for a wide range of chloride salt compounds. The ion-exchange reaction was carried out at 625 and 650°C, temperatures well above the melting point of eutectic LiCl–KCl. Experiments were carried out to optimize zeolite drying temperature, estimate maximum ion-exchange capacity, and determine the thermal stability of USHY zeolite. The results indicated that over 90% dechlorination can be achieved without zeolite structure collapse at 625°C in a continuously fluidized particle reactor using 45–250 μm USHY particulates.

Manish joined what was then the Department of Metallurgical Engineering (now Materials Science Engineering) as a PhD student in 2016 under Dr. Simpson. He defended his dissertation in December, 2019 and is currently living in Idaho Falls.