480e 238pu Anion Exchange Column Safety during Flow Interruptions

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Anion exchange processes have historically been operated to recover and purify 238Pu. Runaway chemical reactions between nitric acid and anion resin have caused a number of over-pressurization accidents in various facilities over the years. Due to the radiolytic heating of 238Pu loaded on the resin, columns are vulnerable to temperature excursions during flow interruptions. Under normal operating conditions, the column temperature can be monitored and the flow through the column carefully controlled. Flow through the column removes the radiolytic heat and prevents a significant temperature rise from occurring. If flow were to be stopped, the radiolytic heating would cause the column temperature to rise. At temperatures in the range of 80 to 100C, the heat from the chemical reaction between the resin and nitric acid becomes significant relative to radiolytic heating and the rate of temperature rise starts to accelerate. In a well vented column, significant pressure rise does not occur. Venting allows the temperature to rise only up to the boiling point of the nitric acid mixture. As water preferentially evaporates from the solution, the nitric acid concentration increases and the boiling point slowly rises from about 110 to 121C. Since the rate of reaction depends on both the temperature and the nitric acid concentration, the reaction will continue to accelerate during this time, but most of the heat will be dissipated by the evaporation of water and nitric acid. As long as the resin is covered by an aqueous layer the resin will not ignite. In an inadequately vented column, the column pressure will suppress evaporation and the temperature will rise uncontrollably. Based on kinetic model data taken on the reaction between irradiated anion resin and nitric acid, a simple model has been developed to establish safe recovery time for a flow interruption in a 238Pu loaded column. This model estimates that the time required for the column to heat from 50,,aC to boiling is at least 111 min. The time required for the column to heat up and evaporate to dryness is estimated at 4 to 10 hours.