Application of Process Chemical Modeling to Optimize Radioactive Waste Disposal at the Savannah River Site - 24242

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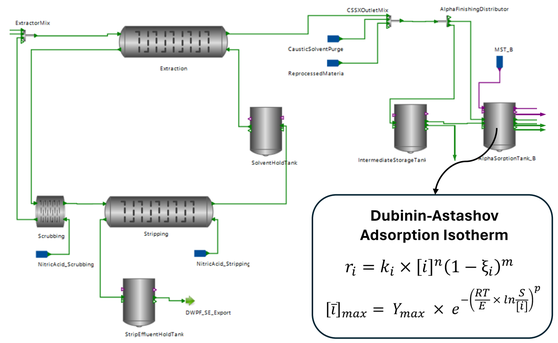
Introduction

The Technical Optimization Model (TOM) is used by Savannah River Mission Completion (SRMC) to carry out facility-wide material balance and validate chemistry-dependent processes for the purpose of their System Plan.



Dubinin-Astashov Adsorption Isotherm

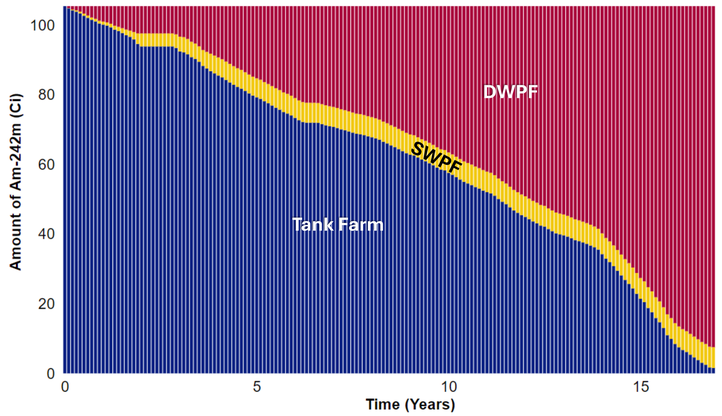
$$r_i = k_i \times [i]^n (1 - \xi_i)^m$$

$$[\bar{i}]_{max} = Y_{max} \times e^{-\left(\frac{RT}{E} \times ln\frac{S}{[\bar{i}]}\right)^p}$$

The TOM simulates material movement and chemical reactions at the Tank Farm (TF), Salt Waste Processing Facility (SWPF) and Defense Waste Processing Facility (DWPF).

Material Balance & Tracking

The TOM performs material accountancy and tracks the movement of chemical species between facilities.



The figure above shows the movement of Am-242m between 3 key facilities across a 17-year simulation run. The above visual enables identification of material gain or loss in a simulation lifecycle.

Modelling the dynamics of settling solids

Convective-Diffusive Equation

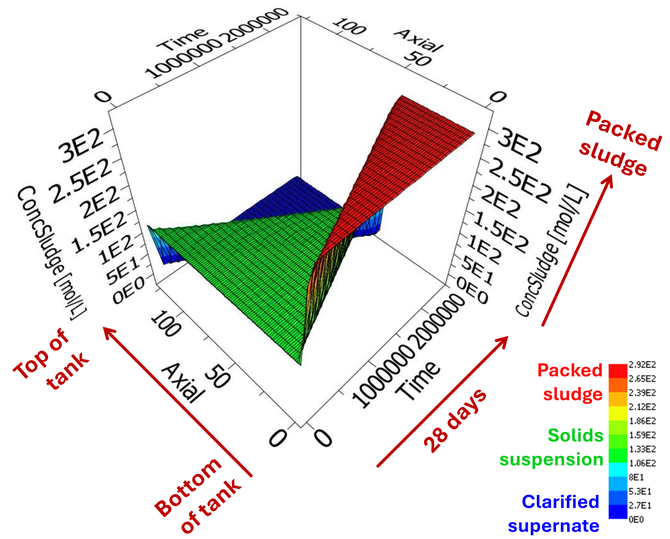
$$\frac{\partial \phi}{\partial t} = D\frac{\partial^2 \phi}{\partial z^2} - \frac{\partial (v_h \phi)}{\partial z}$$

Richardson & Zaki Hindered Velocity Model

$$\nu_h = \nu(1 - \phi_z)^n$$

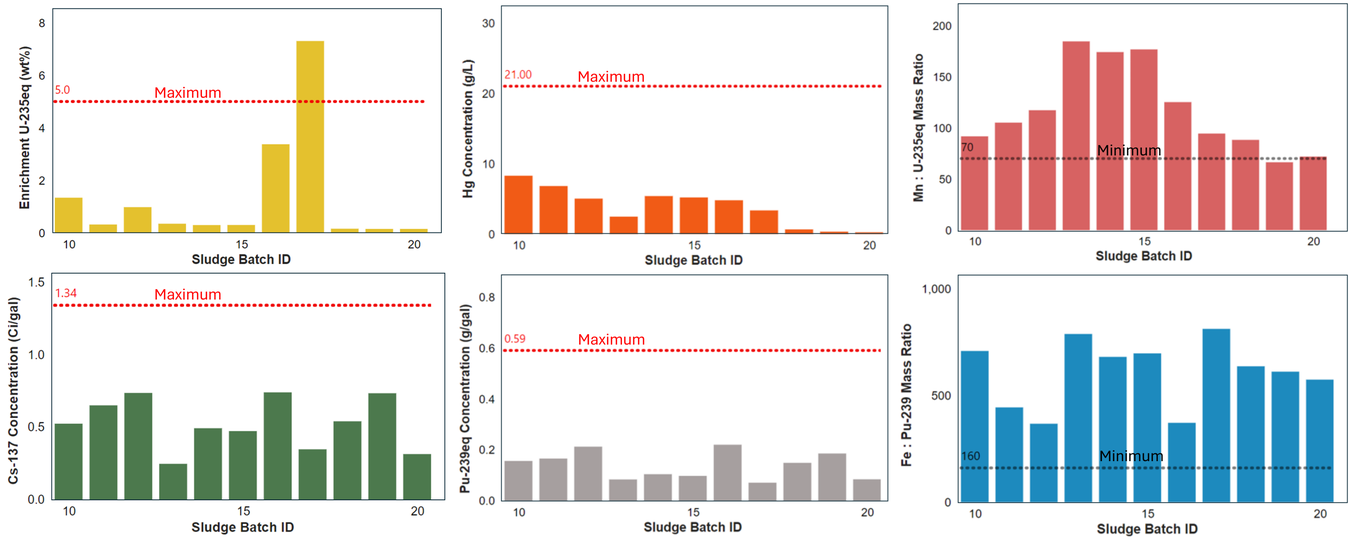
$$\nu = \frac{g(\frac{\rho_p}{\rho_l} - 1)d_p^2}{18\mu_0} \qquad Re = \frac{\nu \times d_p \times \rho_l}{\mu_0}$$

This solids settling model was applied to simulate sludge washing operations.



Sludge Batch Waste Acceptance Analysis

The TOM calculates key metrics for sludge batching and compares them to their respective waste acceptance criteria values.



Canister Fissile Loading & Heat Generation

Species Heat Generation

$$Q_i = A_i \times q_{decay,i}$$

The heat generated by chemical species i is a product of its activity and decay heat generation.

The TOM tracks the amount of fissile loaded into a canister and calculates the heat generated by chemical species inside it.

This enables us to spot canisters that exceed their fissile loading or heat generation limits.