

Modelling Heat Transfer, Diffusion, Water Adsorption and Radiolysis in PuO₂ Powder under Repacking and Storage Conditions

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During retreatment and repacking of PuO₂, glovebox atmospheres are inerted to prevent moisture adsorption; however, under fault conditions, this may not be achievable. Radiolysis of the water results in the generation of hydrogen, with the potential for the formation of a flammable atmosphere and/or pressurisation of a sealed container. The ability to model the rate of water adsorption, as well as predicting the consequences of long-term storage, plays an important part in establishing process design and safety.

A 2D model of PuO₂ powder in a cylindrical container was developed to simulate heat transfer, diffusion, adsorption and radiolysis. This model has been applied to open containers to determine the rate of moisture ingress and adsorption, and to sealed containers to predict pressure, atmospheric composition and humidity changes within a container during storage. During validation, the model was found to predict temperatures accurately to within 4% of experimental values. Mass gain due to adsorbed water was overpredicted by between 32-38% for Magnox inner cans by the end of each experiment, which makes for a reasonable and conservative estimate.

Further development is planned to include containers in alternative configurations, as well as convection, radiative heat transfer, liquid water accumulation and additional species and reactions. Expansion of the physical property data used by the model is also planned.