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ROOM CLOSURE RESPONSE TO GAS GENERATION AND MECHANICAL STRENGTH OF DIFFERENT WASTE FORMS IN A BEDDED SALT REPOSITORY, F.T. Mendenhall & C.M. Stone, Sandia National Laboratories, PO Box 5800, Albuquerque, NM 87185.

Finite element calculations of the porosity history of a nuclear waste disposal room in a bedded salt formation have been completed. The analyses include an elastic/secondary creep model for the host halite and a nonlinear consolidation model for the crushed salt backfill. Separate gas generation and constitutive models were used for three distinct waste forms, 1) unaltered defense related CH-TRU waste, 2) shredded and cemented CH-TRU waste, and 3) incinerated and vitrified CH-TRU waste. Solutions were determined for a 2000 year time period starting from the decommissioning of the repository. The resulting room porosities varied from roughly 55% to less than 10%.

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ROOM CLOSURE RESPONSE TO GAS GENERATION AND MECHANICAL STRENGTH OF DIFFERENT WASTE FORMS IN A BEDDED SALT REPOSITORY

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SUMMARY

In a nuclear waste disposal room excavated in a bedded salt formation, room closure and consolidation are driven by the overburden load in the host halite. The overburden induces a stress field around an excavation that drives a slow creeping process in the host salt, which over time would totally close an empty disposal room. The closure process reduces the void space available for fluid storage and also affects the permeability of the room contents, which in turn changes the ability of fluids, usually brines, to flow through the room, mobilize radioactive and hazardous materials, and carry these contaminants to the accessible environment.

Room closure and consolidation can be retarded by the mechanical resistance of the waste as the room boundaries make contact and press in on the waste during closure. Closure can also be countered by the build up of gas pressure from corrosion, degradation, and radiolytic gas generation processes active in the waste materials.

In this study, the response of a disposal room is evaluated where the room contains one of three possible waste forms and a crushed salt backfill. The specific waste forms considered are hypothetical defense related CH-TRU wastes that are : 1) unaltered from their storage condition, 2) shredded and cemented, or 3) incinerated and vitrified. The three waste forms each have a different mechanical response to room closure and a different gas generation behavior.

The unaltered CH-TRU wastes are assumed to be contained in 55 gallon drums or in standard waste boxes, with both containers assumed to be made of low carbon steel. The waste material itself is assumed to be of three major types: 1) sludges, 2) solid organics such as paper, plastics, tissues, plywood, etc., 3) solid inorganic wastes such as metals and glass. The unaltered waste form is expected to have a high initial porosity, 0.74 for the disposal room average, and to deform in a nonlinear fashion. The waste was therefore modeled using a volumetric plasticity constitutive relation. Gas generation in a disposal room was modelled as roughly 11 million moles of gas in 1000 years.

The shredded and cemented waste form assumes the shredding of the solid organic and inorganic materials. These materials are then combined in a homogenous manner with cement based materials and placed in a drum or standard waste box. This process is not expected to impact the gas generation potential of the waste. However, the reduced initial porosity, 0.46 for the disposal room average, and the Ph near the cement is expected to slow the rate of or to delay the onset of some of the gas generating processes by roughly 100 years. This material is much stiffer mechanically than the unaltered waste and it is assumed that the waste itself can never densify to any porosity below its initial value of 0.22.

Incinerated and vitrified waste assumes combustible materials are burnt and vitrified, metals are separated and stored in ingots, and sludges are vitrified. For this waste form, the resulting gas generation potential is controlled only by the anoxic corrosion of the metals. The reduced surface area of the metal ingots may slow down the gas generation rates as compared with the unaltered waste form. Gas generation in a disposal room is expected to be roughly 7.75 million moles of gas in 1500 years. Incineration and vitrification is expected to result in only 442 m³ of waste to be distributed in the 3644 m³ disposal room volume. Because of the small volume of waste, this case

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was modeled as a room containing only crush salt backfill and the appropriate gas generation.

The resulting calculated porosity histories for the disposal room and three waste forms are shown in Figures 1-3 below.

Figure 1. Disposal Room Porosity History for Unaltered Waste. Different Gas Generation Rates Through Multiplier f .

Figure 2. Disposal Room Porosity History for Shredded and Cemented Waste. Different Gas Generation Rates Through Multiplier f .

Figure 3. Disposal Room Porosity History for Incinerated and Vitrified Waste. Different Gas Generation Rates Through Multiplier f .

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