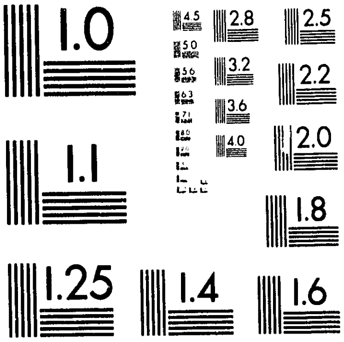
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THE ADVANTAGES OF A SALT/BENTONITE BACKFILL FOR WASTE ISOLATION PILOT PLANT DISPOSAL ROOMS, B. M. Butcher, Sandia National Laboratories, PO Box 5800, Albuquerque, NM 87185.

This paper concludes that a 70/30 wt% salt/bentonite mixture is preferable to pure crushed salt as backfill for disposal rooms in the Waste Isolation Pilot Plant. The Waste Isolation Pilot Plant, near Carlsbad, NM, is designed to be the first mined geologic repository for the safe disposal of transuranic (TRU) radioactive waste generated by DOE defense programs since 1970. The repository is located about 655 m below the land surface in an extensive bedded salt formation. This report examines the performance of two backfill materials with regard to various selection criteria, such as the need for low permeability after closure, chemical stability, strength, ease of emplacement, and sorption potential for brine and radionuclides. Both salt and salt/bentonite are expected to consolidate to a state of permeability $\leq 10^{-18}$ m^2 that is adequate for satisfying regulations for nuclear repositories. The results of finite-element calculations that were used to arrive at this conclusion will be described. The real advantage of the salt/bentonite backfill depends, therefore, on bentonite's potential for sorbing brine and radionuclides. Estimates of the impact of these properties on backfill performance are presented.

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THE ADVANTAGES OF A SALT/BENTONITE BACKFILL FOR WASTE ISOLATION PILOT PLANT DISPOSAL ROOMS

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SUMMARY

Two materials, pure crushed salt and 70% by weight salt/30% by weight bentonite were compared with regard to their potential for backfilling WIPP disposal rooms. A synopsis of this analysis is given in Table 1. Both materials were predicted to consolidate to states with permeabilities of less than 10^{-18} m^2 within times of the order of 50 years. The time to consolidate to a permeability of 10^{-19} m^2 was only slightly greater, with an estimated closure time for salt/bentonite, the slowest consolidating material, of 64 years. Swelling pressure exerted by the bentonite during the later stages of consolidation is small enough to neglect in the closure calculations.

The estimated largest void fractions (porosities) that can exist in the backfill after long periods of time are between 0.09 and 0.05 for crushed salt and about 0.14 for salt/bentonite. Assuming the early estimations of brine inflow rate of 43 m^3 in 100 years, determined from shingle-phase flow calculations, there is insufficient brine flow into the rooms during consolidation to saturate either backfill. Furthermore, even if the materials were saturated, their shear strength in the consolidated state is sufficient to prevent extensive borehole enlargement during human intrusion.

Since both materials are considered acceptable with regard to their ability to achieve a sufficiently impermeable state in a reasonable time, the major difference is their potential for sorbing either brine or radionuclides. Salt has no demonstrated potential for sorption, but the bentonite in the salt/bentonite materials was chosen specifically for this purpose.

Estimates of sorption of brine during backfill consolidation remain inconclusive because the effect of the exceptionally high impurity content of WIPP brine on bentonite sorption remains uncertain. Therefore, while no credit is taken, at present, for brine sorption in salt/bentonite backfill, the possibility that some amount of inflowing brine would be chemically bound is considered likely.

Predicted sorption of radionuclides by bentonite under the condition of uniform distribution of brine throughout the backfill, and no brine flow through a disposal room, could be as much as 50% of the inventory. However, sorption is limited to plutonium, americium, neptunium, with practically no sorption of uranium. When brine transport by flow through porous media is considered, the amount of sorbed material may be greatly reduced because flow localization or channeling will limit the amount of sorbent in direct contact with the bentonite.

TABLE 1. BACKFILL CHARACTERISTICS AT 10^{-18} M^2 PERMEABILITY

	Pure-Salt Backfill	Salt/ Bentonite Backfill	Salt Backfill and Waste	Salt/Bentonite Backfill and Waste
Closure time corresponding to a permeability of 10^{-18} m^2	19-26 years	23 years	18-29 years	44 years
Void fraction corresponding to a permeability of 10^{-18} m^2	0.093-0.058	0.140	0.093-0.058	0.140
Related Parameters				
Backfill void volume*	245-147 m^3	364 m^3	85-51 m^3	127 m^3
Saturation (43 m^3 brine in 100 years)	3%, 8%	3%	9%, 24%	15%
Saturation (43 m^3 brine in 100 years +) 10% water in as-received bentonite		45%	9%, 24%	57%
Bentonite-saturated density**	-	2112 kg/m^3	-	2112 kg/m^3
Bentonite swell pressure	-	1.9-3.0 MPa	-	1.9-3.0 MPa
Lower bound volume of chemically bound water	0	32 m^3	0	11 m^3
Upper bound volume of chemically bound water	0	149 m^3	0	51 m^3
Shear Strength	>1.9 MPa	0.9 MPa	>1.9 MPa	0.9 MPa

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* The total room volume is assumed to be 3646 m^3; backfill volume in a room filled with waste and backfill is 1268 m^3; the volume of the waste is 1817 m^3; and the emplacement density of the backfill is 1400 kg/m^3 for both types of backfill.

** The saturated density of bentonite, ρ_{sat}, for dry density ρ, is: $\rho_{sat} = 1200 + (1 - 1200/2700)\rho$, assuming 1200 kg/m^3 density for WIPP brine and 2700 kg/m^3 for the theoretical solid density of bentonite.

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