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Permeability and porosity of loose mixtures of salt

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Permeability and porosity measurements were made on loose granular salt from the Waste Isolation Pilot Plant (WIPP) to aid in understanding the potential post-closure room condition following roof falls. Run-of-mine (ROM) produced from excavation (typically <1 cm) and larger pieces (referred to as rubble, with sizes up to 25 cm) formed from breakage of large diameter cores were combined to produce multiple sample configurations with a wide range of particle size distributions. The permeability and porosity measurements were made with air under vacuum conditions in a sealed bag contained in a 1 m by 25 cm by 25 cm box. The permeability measurement was made by applying vacuum to one end and drawing atmospheric air through the sample while monitoring the flowrate with a flow meter and the pressure drop in the sample using a differential pressure gage. With this configuration, permeabilities can be measured in the range of about 10^{-7} to 10^{-12} m^2. A supplemental gas reservoir was introduced into the system to allow for porosity measurements with the gas expansion method. The permeabilities of the samples containing rubble increased with increasing rubble content while the porosity did not substantially vary from a nominal value in the range of 0.4. Measurements were compared with a version of the Kozeny-Carman model that accounts for the particle size-dependent specific surface area as well as the porosity and a shape factor for the material. The model underpredicts the measured permeabilities by about an order of magnitude. This result is believed to be due to the finest ~ 10% of the material: there are not enough of these fines to fully occupy the large pores between the much large particles and thus the fines do not significantly affect the permeability. However, the model includes the contribution of specific surface area of the fines which reduces the predicted permeability. Adjusting the model to account for this effect significantly improves the model predictions. These results suggest that modified models for permeability of granular materials can be applied to salt with a wide range of particle sizes, which could include rubble piles from roof falls.

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