

Diffusion coefficients in sedimentary rocks

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Abstract

The safety of the use of deep-well injection of hazardous or toxic wastes depends upon the containment of the wastes within the geologic formations into which they are injected. In the United States the strata bounding the injection zone layers are often shale or other sedimentary rock. In the case of shales, the assumption has generally been made that the formations are so tight as to be impermeable and to constitute an absolute barrier to chemical migration. In view of the long time that the chemicals must be contained, consideration must be given to the molecular diffusion of soluble chemicals through the pore water contained in the bounding strata. While the diffusion coefficients for transport of chemicals through shale and other sedimentary rocks are expected to be very low, actual data on diffusion coefficients in these rocks for formations of interest were not previously available.

In previous research, effective diffusion coefficients of aqueous iodide ion in various sedimentary rocks at atmospheric pressure and 25°C were measured in a diaphragm cell. Porosities were measured by water uptake. The effective diffusion coefficients and porosities determined were as follows:

Material	Porosity	Diffusivity (cm ² /s)
Proviso siltstone	0.118	5.8×10^{-8}
Hartselle sandstone	0.137	2.0×10^{-8} 2.7×10^{-8}
Pottsville shale	0.030	4.5×10^{-10} 6.2×10^{-10}
Pottsville sandstone	0.046	9.9×10^{-10}

These values are in contrast to the diffusivity of iodide ion in water of 2.0×10^{-5} cm²/s. The geometric correction factor is the ratio of the effective diffusivity

in the rock to that in water. It was found that the geometric correction factor for diffusion in these rocks in all cases was less than the square of the porosity. Thus, it appears that the square of the porosity can be used as an upper bound on the geometric correction factor.

The research has been extended to sedimentary rocks from Mississippi and Texas which are typical of those formations which bound chemical waste injection zones.

Electrokinetic decontamination of soils

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Abstract

The purpose of electrokinetic treatment of soils is to aid in the recovery of heavy metals and other chemicals from contaminated soils. The process involves placing electrodes into subsurface wells and passing an electric current through the soil between the electrodes. Water and heavy metals will flow toward the negatively charged electrode where the chemicals can be collected and removed. The technology is particularly attractive for silt- and clay-rich soils (which are common along the Gulf coast) because, for such soils, electric currents are far more efficient in driving water and chemical flow than conventional pumping of water from wells.

Several laboratory experiments were performed on samples of kaolinitic soil that were "contaminated" with $\text{Cu}(\text{NO}_3)_2$. Tests were performed over a range in concentration of 0–320 mg/L Cu^{2+} and a voltage of 0–5 V. The amount of copper recovered from the negatively-charged reservoir (cathode) was very low. However, at the completion of the tests, the soil columns were sectioned and a large accumulation of Cu^{2+} was found in the soil adjacent to the cathode reservoir. Copper was transported toward the cathode, but because of the high pH in the soil near the cathode, copper was precipitated and therefore failed to enter the reservoir in significant quantities.

A model is being developed to predict boundary conditions in reservoirs and movement of contaminants in soil during electrokinetic treatment. Dissolution of alumina from the clay particles has been found to be critically impor-