Effect of Ionic Strength on the Transport of Fe/Ni Particles through Clayey Soil

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Abstract: Transport of Fe/Ni fine particles through a clayey soil column with 17.5% kaolinite clay and 10^{-4} cm/s^2 permeability was investigated. Based on the column study, the distribution of 100 g/L bimetallic particles (Fe/Ni) in the size range of 100 nm to 3 µm along the soil column with different ionic strength was determined. Also the diffusion and retardation transportation parameters increased with the ionic strength and represented by a nonlinear relationship.

1. Introduction:

A fundamental understanding of the effect of ionic strength of transport of Fe-Ni particle is important in clayey soil. Transport of colloidal particles is greatly affected by ionic strength, pH and some other soil related properties. Ionic strength affects transport parameters such as diffusion coefficient and retardation factor of colloid particles significantly. Solution ionic strength influences the dynamics of colloidal deposition and transport in heterogeneous porous media by controlling the range and magnitude of interparticle forces. Low to moderate concentrations of indifferent electrolytes containing monovalent counterions promote interparticle repulsion and declining deposition rates as accumulated particles block collector surfaces from subsequent deposition [Daylin et al., 1995].

The injection of colloid particles to treat contaminants in the ground is a novel technology carried out mainly in US contaminated sites. Recently, reactive slurries of nanoscale colloidal Fe-Ni particles were fed into an injection well to study the transport and reactivity of the particles in an aquifer [Liuzong et al., 2001].The study showed that number of factor affected the transport of the particle. Hence there is a need to further investigate the transport of Fe/Ni bimetallic particle in the soil

2. Objective:

The overall objective of this study was to determine the effect of solution ionic strength on the Fe/Ni particles transport parameters and distribution through a clayey soil.

3. Materials and methods:

In this study, Fe/Ni bimetallic particles were produced from solution method and the particle size varied from 100 nm to 3 µm (Fig 1). Soil was packed in 5.1 cm diameter column to a height of 6 cm and the breakthrough curves for bimetallic particles was determined by measuring the effluent concentrations with time.. The permeability of the soil was 10^{-4}cm/s. The bimetallic particles were produced by mixing 6.15 g of $FeSO_4.7H_20$ and 1.5 g of $NiCl_2.6H_2O$ in 50 ml water and stirring in 200 mL bottles for 30 minutes and finally adding 1.3 g $NaBH_4$ into the solution for preparation of Fe-Ni bimetallic particles. The entire system was kept under nitrogen atmosphere in order to prevent the oxidation of Fe-Ni bimetallic particles. The transport parameters such as retardation factor (R), diffusion coefficient (D) of Fe/Ni particles were determined with different ionic strength of solutions.

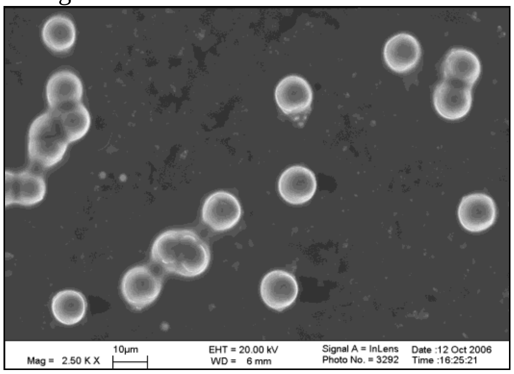

Fig 1: SEM image of Fe/Ni bimetallic particles

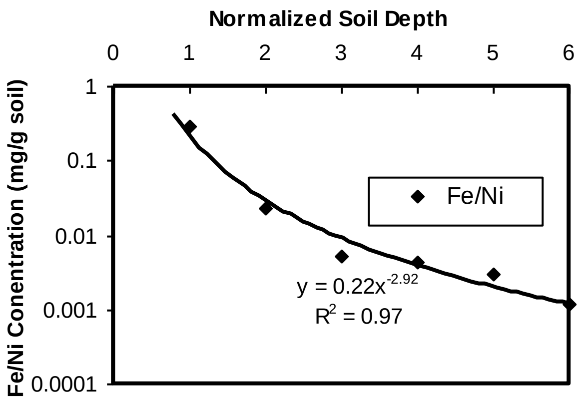

Fig 3: Variation of Fe/Ni Concentration along the soil column

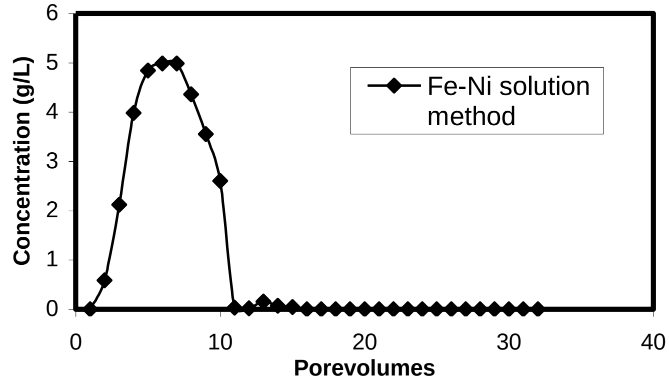

Fig 2: Breakthrough curve of Fe/Ni bimetallic particles

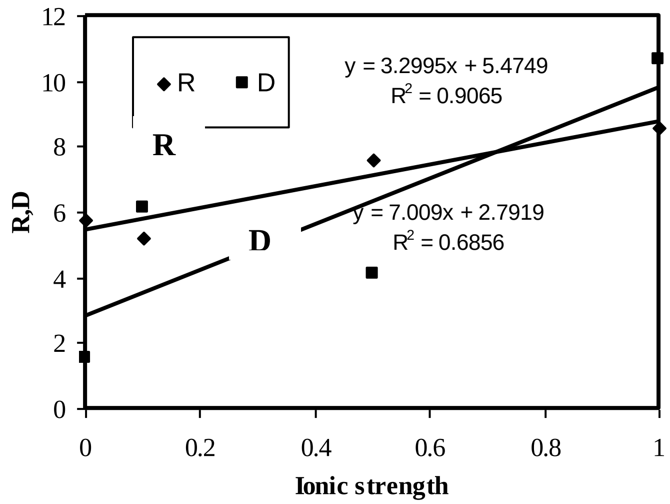

Fig 4: The effect of Ionic strength on Fe/Ni transport parameters

4. Discussion:

The SEM micrograph of the Fe/Ni particles are shown in Fig (1).Particles were < 10 µm and were spherical in shape .Most of the bimetallic particles were filtered out in top 2 cm (1/3 of column) of the column.

5. Conclusions:

Transportation of 100 g/L of Fe/Ni particle with sizes in the range of 100 nm to 3 µm were filtered out of the solution in the top 33% of the soil column. The diffusion coefficient (D) and retardation factor (R) increased with increase in ionic strength.

6. Acknowledgement:

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7. References:

1) Daylin liu et al, Colloid deposition dynamics in flow through porous media: Role of electrolye solution" *Environmental Science and Technology (1995)*, Vol 29, pp 2963-2973

2) Liuzong Z. and Selim H.M "Solute transport in layered soils: Nonlinear and kinetic reactivity" *Journal of Soil Sci.Soc.Am* (2001)", Vol 65, pp 1056-1064