DIFFUSION OF VARIOUS ION SPECIES THROUGH GEOSYNTHETIC CLAY LINER UNDER ELEVATED TEMPERATURES

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Geosynthetic clay liners (GCLs) are used as a major component of landfill bottom liner in most of the modern engineered landfills. Their performance as a hydraulic barrier to landfill leachate is well known due to their very low hydraulic conductivity. However, when hydraulic conductivity is too low, the main transport mechanism through the liner is diffusive transport of solute or leachate. The diffusion properties of liner material are expected to be highly dependent on the nature of chemicals present in landfill leachate as well as landfill temperature. Recent studies have shown that temperature inside the landfill increases near the base liner due to weight of overlying waste and chemical processes involved in its biodegradation. Therefore it is necessary to investigate the performance of GCL against diffusion migration under high temperature conditions using different chemical species.

In this study solute diffusion tests were performed on bentonite component of a commercially available typical GCL Bentofix®. This GCL employs Na-bentonite which is mainly responsible for its hydraulic performance. The tests were performed on pre-hydrated samples of bentonite to avoid its further swelling during the test. Salt solutions of four major exchangeable cations (Na^+, K^+, Ca^{2+} and Mg^{2+}) each at a concentration of 0.01M were used as source solutions. Deionized water was used as receptor solution. The tests were carried out at two different temperatures 20 ^oC and 40 ^oC under atmospheric pressure.

The results showed that concentration of anion (Cl^-) in the source solution decreased with the passage of time and equal amount of concentration increased in the receptor solution for all the four types of solutions. However, the cations showed a different behavior depending on the nature of each cation. The concentration of Na^+ in the source solution did not decrease significantly with time which was possibly due to presence of abundant Na^+ cations at the exchange sites of the bentonite sample. These exchanged cations resisted further diffusion of Na^+ cations from the source solution. However, an increase in Na^+ cation was observed in the receptor solution with the passage of time which is mainly due to diffusion process occurring between the sample and the receptor solution. Contrarily, the concentration of cation in source solution decreased with time for all other cation solutions. The increase in concentration of these cations in the receptor solution was found negligible. A further examination of the samples taken from receptor solution showed that a significant amount of Na^+ diffused from the bentonite sample to balance the net negative charge in the sink compartment arising due to diffusion of anions. The results were interpreted as the possible cation exchange process occurring in the bentonite sample due to high affinity of K^+, Ca^{2+} and $Mg^{2+.}$

Temperature was found to have significant effect on solute diffusion coefficient for all the given ion species. The diffusion coefficient was found to increase significantly with increase in temperature. Further investigations are being carried out to study the effect of a further increase in temperature on diffusion coefficient of GCL.

Keywords: Diffusion, Contaminant transport, Elevated Temperature, GCL, Leachate