TerraShield™
Aluminum Nitrile Vapor Barrier

ANALYSIS OF BARRIER MATERIAL PERFORMANCE

TerraShield Barrier Components

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BRIEF OVERVIEW:

In the development of a new vapor mitigation barrier system, TerraShield™, extensive studies were performed to understand the relative chemical resistance of the TerraShield barrier components as compared to components of other barrier systems. This test evaluated the dual-metallized base layer of TerraShield (TerraBase) as compared to a 10 mil HDPE barrier. In addition, the nitrile-modified spray-applied asphalt core (Nitra-Core) versus a typical styrene-butadiene-modified asphalt material used in other barrier systems. Using a custom-made testing apparatus consisting of a top and bottom chamber separated by the material to be tested, the relative chemical resistances of these barrier components to the contaminant trichloroethylene (TCE) were determined. To accomplish this, the individual barrier components were evaluated under identical test conditions where the contaminated vapor concentration was held constant in the bottom chamber, and the amount of contamination that diffused through the barrier was measured in the top chamber. The testing results showed that the dual-metallized film of TerraBase decreased the TCE diffusion by over two-orders of magnitude (>100X more resistant) compared to an HDPE barrier. A comparison of the spray-applied asphalt layers showed slower diffusion of TCE and an order of magnitude lower TCE flux (10X more resistant) with the nitrile-modified asphalt when compared to the styrene-butadiene-modified asphalt layer of the same thickness.

Based on the results of this study that compared the individual components of TerraShield to known components of existing barrier systems, we can also use this data to estimate the PCE diffusion coefficient for TerraShield to be at least 1 x 10-19 m^2/sec.

EXPERIMENTAL METHOD:

Vapor Barrier Testing Apparatus:

The vapor-diffusion testing apparatus is shown in **Figure 1**. To create the challenge vapor, the bottom chamber was filled with a TCE in water solution and allowed to naturally equilibrate between the liquid and vapor phases. The challenge concentration was held constant throughout the test using either 10 mg/L or 100 mg/L of TCE, which correlated to ~700 ppmV or 7,000 ppmV TCE in the vapor phase of the bottom chamber. While these high concentrations of TCE are an exaggeration of what would be encountered below an inhabited building, the elevated concentration allowed experiments to be completed in a short period of time and offered an understanding of the relative TCE chemical resistance of the materials tested. The material to be tested was secured between the bottom and top chambers, which effectively separated the chambers such that the only path from the lower chamber to the top chamber was to diffuse through the barrier. Continuous airflow (2.5 mL/min), mimicking an HVAC unit within an inhabited building, was maintained in the top chamber throughout the lifetime of the experiment.

PREPARATION OF THE BARRIER COMPONENT SAMPLES:

No modifications were made to the base layers tested in this study: TerraBase and a 10 mil HDPE. To prepare the asphalt barriers for this test, the asphalt emulsion source and the weight ratio of asphalt to polymer were held constant, and the type of polymer modifier was varied: One sample used a styrene-butadiene (SBR) polymer, and the second used an acrylonitrile butadiene (nitrile) polymer (Nitra-Core). Both asphalt layers were sprayed to 20 mil thickness on an identical geotextile fabric (the geotextile fabric should have no effect on the contaminant diffusion) using calcium chloride to break the emulsion. The layers were cured for over two weeks before testing.

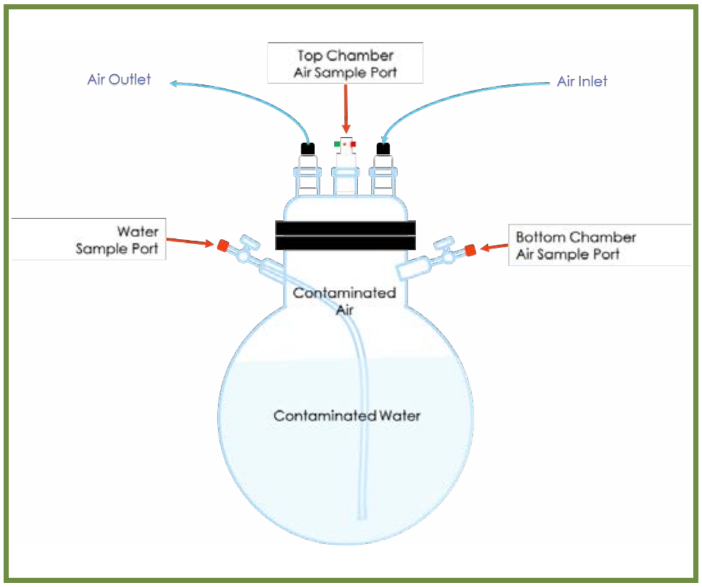

Figure 1. *Vapor-Barrier Testing Apparatus*

SAMPLING PROCEDURE

Triplicate vapor samples were taken from the top and bottom chambers at each timepoint throughout the experiment using an air-tight sample-lock syringe and the TCE concentrations were analyzed on an Agilent GC-ECD. The results from the concentrations measured in the top chamber were used to compare the performance of the barriers. The samples of the contaminated air in the bottom chamber were analyzed to ensure the concentration remained constant throughout the lifetime of the experiment and to confirm the challenge concentration was identical between experiments. If a decrease in the target concentration was observed, additional TCE was added to the bottom to chamber to re-establish the target concentration.

RESULTS AND DISCUSSION:

Vapor Barrier Base Results:

The relative performance of the vapor barrier base-components tested, TerraBase and 10 mil HDPE, is shown in **Figure 2**. These results were obtained by comparing the relative TCE flux through the two barriers, as measured in the top chamber of the testing apparatus once equilibrium was established. The results of this study indicate that that over 100 times less TCE diffused through the TerraBase layer as compared to the HDPE layer within the conditions of this test.

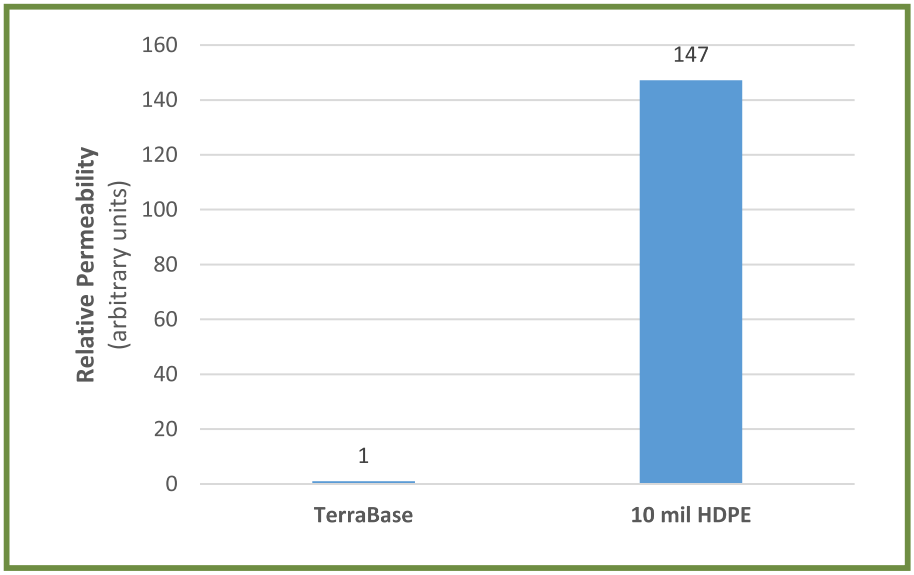

Figure 2. *Accelerated comparison showing the relative TCE flux through the vapor barrier base components : TerraBase, a dual-metallized geomembrane film, versus 10 mil HDPE.*

Spray-Applied Asphalt Coating Results:

This test was conducted to determine if the type of polymer used in a polymer-modified spray-applied asphalt coating would impact the chemical resistance of the asphalt layer. **Figure 3** shows the relative performance of the two asphalt layers over time. The nitrile-modified asphalt coating shows an attenuated rate of TCE diffusion and over 10-fold lower TCE flux as compared to the SBR-modified asphalt coating. It is expected that the trends observed in this study at a high challenge concentration will be further extrapolated under more relevant contaminant concentrations.

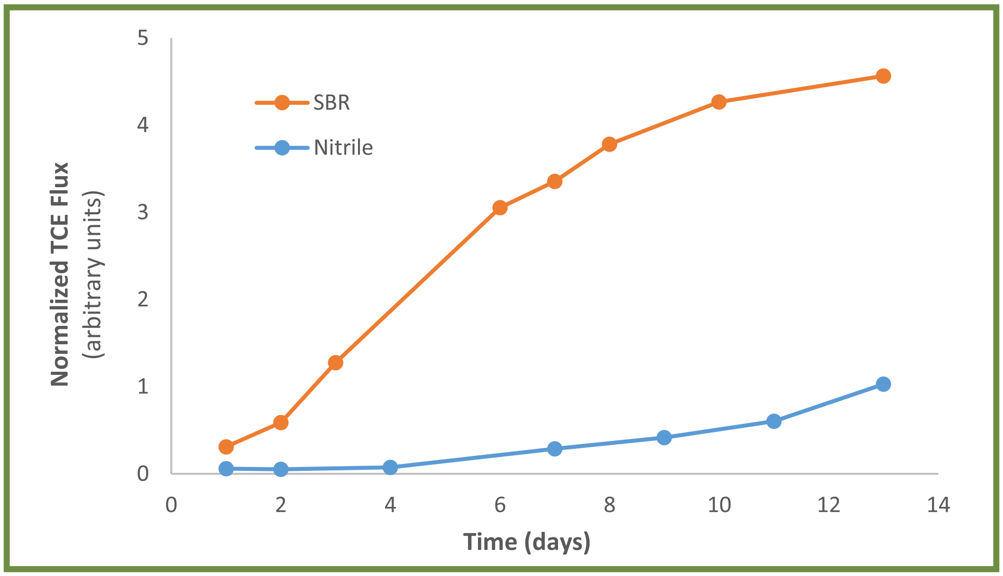

***Figure 3:** Accelerated comparison showing relative TCE flux through the two polymer-modified spray-applied asphalt layers tested over time. SBR = styrene butadiene modified-asphalt, nitrile = acrylonitrile butadiene-modified asphalt. Both asphalt layers were sprayed to an identical thickness (20 mil) for the test.*

CONCLUSION:

The new barrier materials used in TerraShield proved to be very effective at resisting the diffusion of TCE, even at concentrations far above those encountered in buildings, demonstrating its efficacy for blocking the flow of contaminant into a structure's indoor air. The TerraBase material showed over 100-fold lower TCE flux when compared with 10 mil HDPE. Furthermore, the nitrile-modified asphalt used in TerraShield showed slower diffusion and a 10-fold increase in chemical resistance over other commonly used spray-applied asphalts, under identical TCE diffusion testing conditions.

These results, combined with diffusion coefficients available for common vapor systems, provide an estimated PCE diffusion coefficient for TerraShield of at least 1 x 10-19 m^2/sec.

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