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Modeling the Movement of Solutes Through the Subsurface: Application to Groundwater Remediation with Oxidant Candles

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Modeling the Movement of Solutes Through the Subsurface: Application to Groundwater Remediation with Oxidant Candles

Presented by Colin Chatterton
Advised by Dr. Steve Comfort

1. The Problem
There are many sites across the United States where groundwater has become contaminated. In 2012, the National Research Council estimated that there were 126,000 sites in the U.S. in need of remediation (NRC, 2012). Slow-release permanganate candles are a relatively new technique for remediating groundwater contaminated with chlorinated solvents (Christenson, 2011). One practical question limiting candle use is determining how close the oxidant candles should be spaced to effectively treat a contaminant plume. Our research is addressing this by using 3D modeling techniques to determine the zone influence of the slow-release candles via the dispersion of permanganate.

2. Methods
A custom-built wide flow tank (12 x 14 x 8 in) was filled with sand and a constant gradient was established using with a peristaltic pump. We then pumped red food coloring into a screened well at a rate of 0.5 mL/min. We also pumped in tritiated water as a tracer ($^3$H$_2$O) at 10 mL/min and noted the start time. Samples at the outlet were taken every 1 to 4 h by collecting 2 mL of effluent and mixing it with 18 mL of Ultima Gold LSC-cocktail. Samples were then placed into a liquid scintillation counter (LSC) to find the dpm (disintegrations per minute) of each sample. Once all the data was collected, it was graphed to find the dispersivity of the sand in the tank, which was used in model development.

3. Results

4. Discussion and Conclusion
Groundwater remediation is a process that is heavily dependent upon the properties of the subsurface. Dispersion is a huge factor that controls the spread of a chemical’s mass from its center, which directly controls the volume of subsurface material affected (Pepper, Gerba, & Brusseau, 2006). Quantifying the dispersivity of the medium in the flow tank will help immensely in trying to accurately predict the zone of influence of the slow-release oxidant candles.

Sources

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**Image Descriptions:**
- **Oxidant Candle with aeration:** Illustrates a candle with aeration, labeled as a zone of influence.
- **Peristaltic Pump:** Shows a peristaltic pump setup.
- **3D Flow Tank:** Demonstrates a 3D flow tank model.
- **$^3$H + Red Dye:** Represents a combination of tritiated water and red dye in the flow tank experiment.