

Engineering and Testing of a Novel Composite for the Remediation of Hydrocarbons and Heavy Metals

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Project Statement

- The objective of this experiment is to visualize the remediation capabilities of Concretion Spheres when exposed to different forms of pollution, represented by heavy metal contamination and hydrocarbon contamination. Ideally the Spheres will be effective at remediating both forms of pollution.
- The Concretion Spheres are hypothesized to remove around 70% of the present metal content (70% in conductivity reduction) and around 30% of the present oil content (30% weight reduction).

Background

- "When bentonite or other clays and zeolites are modified with quaternary amines, they become organophilic. Such modified bentonites are used to remove mechanically emulsified oil and grease, and other sparingly soluble organics... it is placed into a liquid phase carbon filter vessel to remove FOGs (Free Oil and Grease) and chlorinated hydrocarbons." (Alther, George).
- Water is currently purified via evaporation and recondensation, much like desalination processes. Metal is also removed via filtration and chemical precipitation. "Chemical precipitation is the most common technology used in removing dissolved (ionic) metals from solutions... The ionic metals are converted to an insoluble form (particle) by the chemical reaction... The particles formed by this reaction are removed from solution by settling and/or filtration." (Dahman, Yaser).

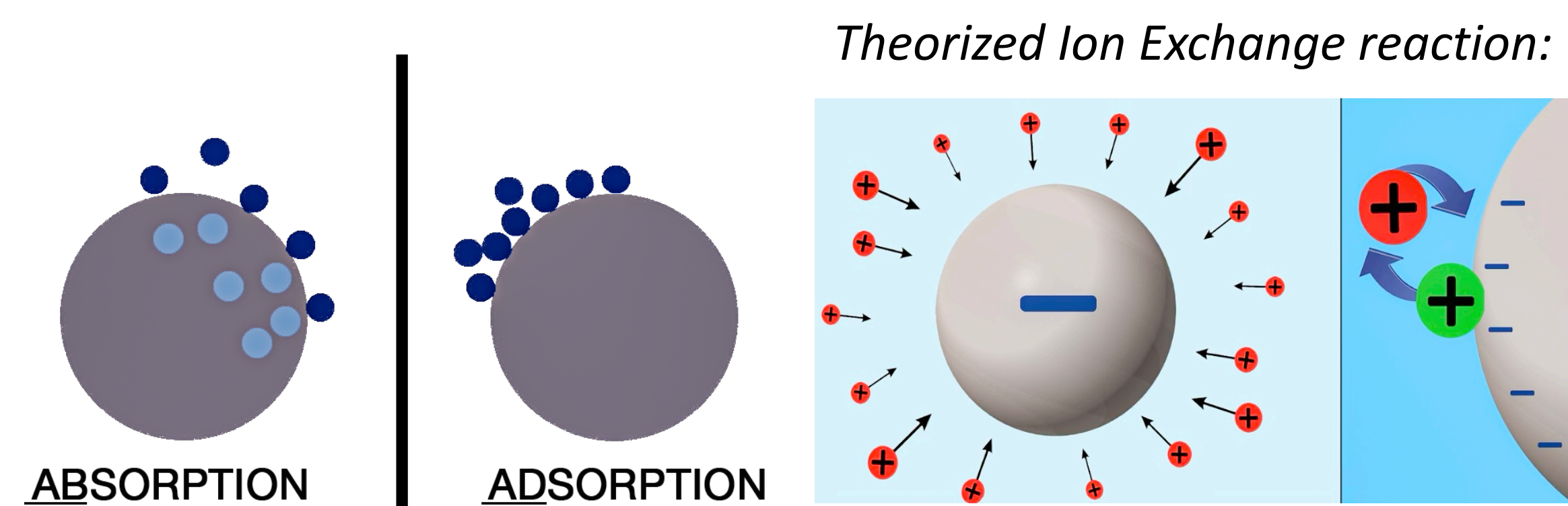
Methodology



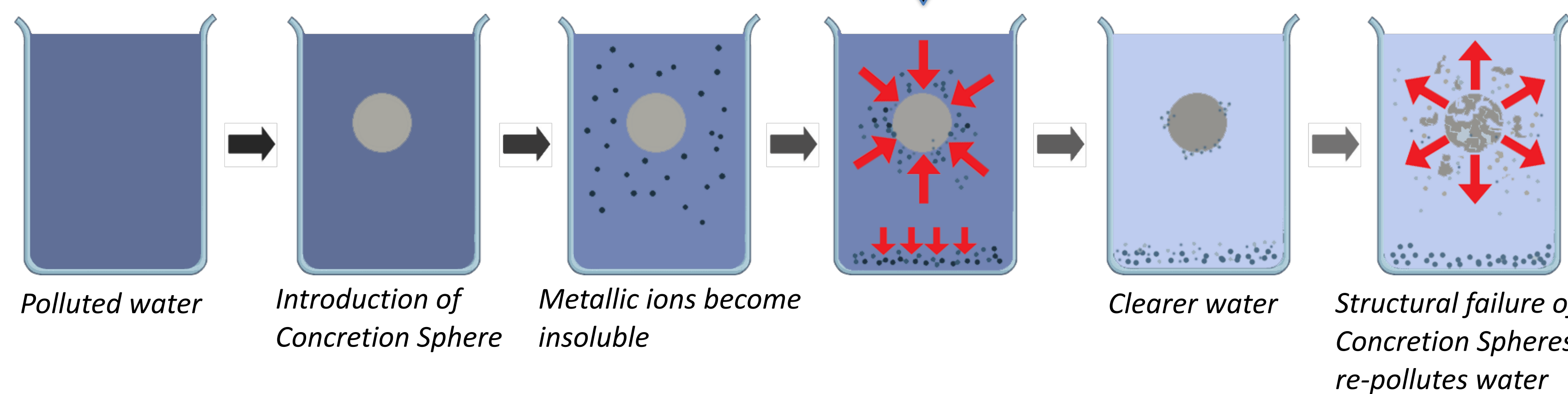
Heating of Calcium carbonate to form Calcium Hydroxide (Lime)

Mixing of total recipe prior to the introduction of water

Concretion Sphere



Ion exchange and chemical precipitation capture metallic particles and limit their spread



Sources:

Dahman, Yaser. "Precipitation (Chemical)." *Precipitation (Chemical) - an Overview | ScienceDirect Topics*, www.sciencedirect.com/topics/chemistry/precipitation-chemical.

Alther, George R, et al. "Organically Modified Clay Removes Oil from Water." *Waste Management*, Pergamon, 22 Dec. 1999, www.sciencedirect.com/science/article/abs/pii/S0956053X96000232#:~:text=When%20bentonite%20or%20other%20clays,and%20other%20sparingly%20soluble%20organics.

EPA, Environmental Protection Agency, archive.epa.gov/emergencies/content/learning/web/html/sorbents.html#:~:text=Natural%20inorganic%20sorbents%20consist%20of,used%20on%20the%20water's%20surface.

Meneguini, Joziane G, et al. "Preparation and Characterization of Calcium Treated Bentonite Clay and Its Application for the Removal of Lead and Cadmium Ions: Adsorption and Thermodynamic Modeling." *Process Safety and Environmental Protection*, Elsevier, 12 July 2017, www.sciencedirect.com/science/article/abs/pii/S0957582017302197#:~:text=Bentonite%20clay%20is%20an%20effective,2%2B%20ions%20from%20wastewater.

Oil Spills | National Oceanic and Atmospheric Administration, www.noaa.gov/education/resource-collections/ocean-coasts/oil-spills.

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Discussion of Results

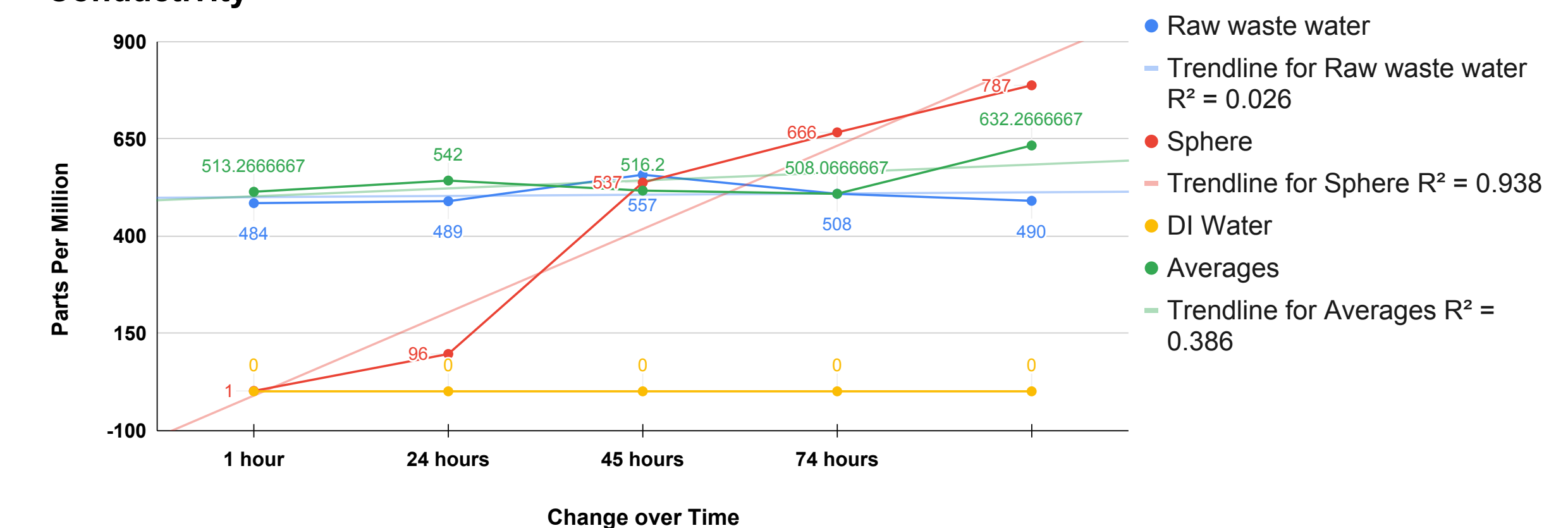
- The deionized water remained stagnant in fluctuation at 0 parts per million. The Sphere control rapidly increased over time. The raw wastewater control maintained a high value for the entirety of the testing period. The average values of the samples showed no significant effect on the conductivity of the water.
- The control value(s) within the oil test both remain stagnant in fluctuation. The spheres gradually increase in weight over time with a net change of around 1.7 grams over the course of the trial period, while the oil decreases in weight over time with a net change of around 4.3 grams.

Conclusion

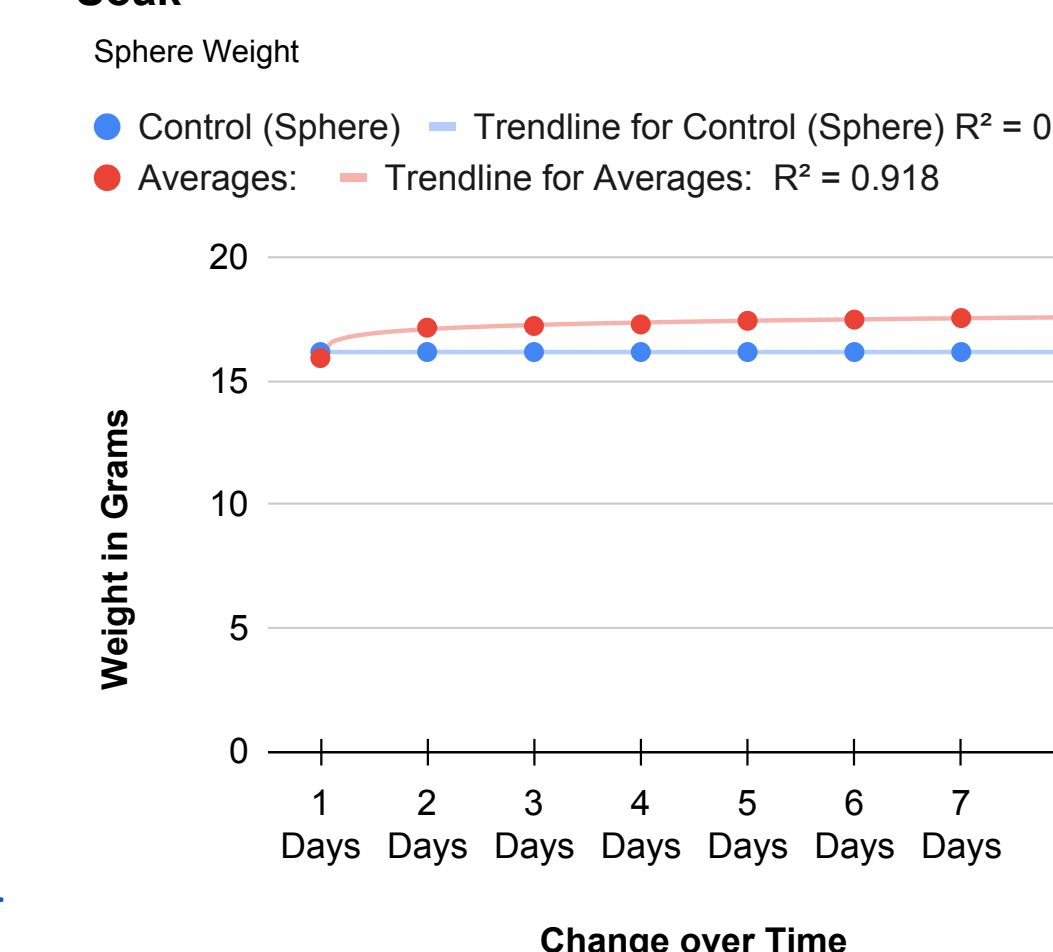
- The spheres did not have a statistically significant effect on the conductivity within the water contaminated by the raw sewage waste. During testing, it was visually observed that the spheres began to dissolve within the water, it is believed this is due to an improper cure which caused the chemical bonds holding the clay materials together to fail.
- Over time the spheres were able to increase in weight, displaying their ability to relocate oil.

Data

Conductivity



Soak



Soak

