The Quality of Runoff Water: The Impact of Organic Compounds

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Introduction

More than 80% of the world's wastewater flows back into the environment without being treated. The success of water treatment is very important to human health as harmful contaminants can cause damage and have long lasting effects. The quartz crystal microbalance was proposed as a method to determine contaminants in runoff water from parking lots. Parking lot contaminants include those found in concrete, asphalt, and automobile fluids. The composition of automobile fluids in parking lot runoff can result in contamination containing hazardous compounds. The quantity of these compounds in runoff water was evaluated for detection using silicone polymers. The polymer was used to add the affinity of the contaminant molecules to the quartz crystal microbalance surface, adding selectivity and sensitivity. By observing the frequency changes, we will be able to pinpoint volatile organic compounds that stay within runoff water and offer further insight into the treatment and analysis of our water supply.

Methods & Materials

Two crystals were coated with one of the following silicone polymers; OV-25 & OV-73. The polymer was added with the expectation of an increase in frequency with respect to change in concentrations. Analyte solutions were created consisting of hexane, toluene, and o-diethylbenzene, mixed with water, respectively. Each trial was run in triplicate format with 5-minute intervals between injections at different concentrations. Concentrations for each compound were dependent on its solubility in water.

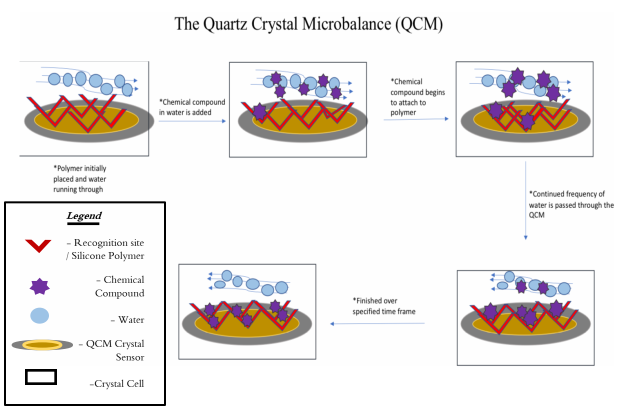

Figure 1.) Depicts a schematic of the performance of the Quartz Crystal Microbalance for the detection of organic contaminants in runoff water. The silicone polymers, Silicone OV-25 & Silicone OV-73, act as the recognition apparatus to detect the compounds (hexane, toluene, o-diethylbenzene).

Data & Results

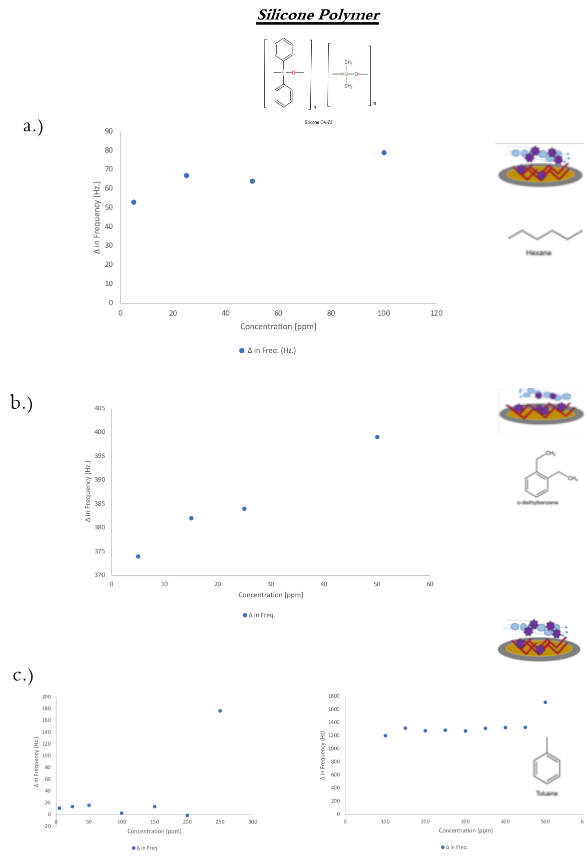

Figure 2.) Depicts QCM trials of varying analyte solutions. Each trial was run in triplicate format on a crystal containing Silicone OV-73. a.) hexane analyte solution; b.) o-diethylbenzene analyte solution; C_1.) (left graph) toluene analyte solution at lower concentrations; C_2.) (right graph) toluene analyte solution at higher concentrations.

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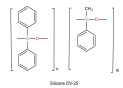
Discussion

Two silicone polymers were used to assess the binding affinity of these compounds within solution. OV-25 was unable to demonstrate any reproducible findings or selectivity for the analytes within this study.



Primary findings shown were produced from the use of OV-73. O-diethylbenzene offered the best graph, conveying that it was the most sensitive analyte to OV-73.

Figure 2C depicts different concentrations for toluene. After the first initial trials of the solution received intelligible results, introduction of higher concentrations were required. The second test, indicated by Graph C_2, revealed similar results. Therefore, leading us to believe a need for an alteration in testing procedure could be advantageous for this compound.

The inability of OV-25 to produce better results could be attributed to the physical attributes of the polymer. Each polymer was introduced to tetrahydrofuran (THF). THF is known to be excellent in chemical solvency & widely-used for the dissolution of various substances. After solvency, OV-25 was found to have a continued liquid/fluid consistency in comparison to OV-73 which had a more solid consistency. This information advises us that OV-25 might not be adhesive. However, a more in-depth study would be needed to support this assumption.

Conclusions & Future Work

Based on data several conclusions were made. Linear molecules displayed a low binding affinity to both silicone polymers. This would be attributed to the polymers selectivity and sensitivity to linear compounds. However, aromatic compounds were seen to offer better results. Graphs for the aromatic compounds tested, depicted a much more positive and linear progression on Silicone OV-73 showing that aromatic compound held a better binding affinity or selectivity to the polymer. Further analysis could be directed toward more aromatic compounds found in automobile fluids.

The aromatics in this study were relatively smaller aromatics. If positive results continue to follow, larger aromatics could be tested to discern if they provide similar or more beneficial results. Likewise, trial length could be extended in the hope to identify beneficial results, as seen in graph C for toluene. Though increasing concentrations served favorable, extended time lengths could provide distinction and linearity. Last, the period between solution creation time and trial run of the analyte solutions could be shortened to ensure the degradation of solutions doesn't occur.