Surface Water Quality: Contaminants and Treatment

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Motivations

To identify the contamination levels present in surface water in Israel.

To analyze the effectiveness of different coagulants at different doses in the treatment of surface water.

Introduction

There are three main sources of water that undergo treatment: groundwater, surface water, and wastewater. There are also three main categories of contamination: physical, biological, and chemical. Surface water includes bodies of water that have open access to the environment. Therefore, the expectation for most contaminants in surface water will be moderate to high.

Physical contamination includes contamination that can be measured with pH, color (UV absorption), total suspended solids (TSS), and turbidity.

Biological contaminants present in surface water may include decomposing plants and other organisms, pathogens, and bacteria. Due to the diversity of biological contaminants, E. Coli is often used as an indicator bacteria due to its ubiquitous and unharmful (at right concentrations) presence in water.

Chemical contaminants include inorganics like salts, metals, alkalines, and fertilizers (namely ammonia and phosphates). Carbon containing contaminants are also common, but were outside the scope of the investigation (limited resources and specialized equipment needed).

	Contamination	Explanation
Groundwater	Low	Water permeates through ground layer that acts as a natural filter.
Surface water	Moderate	Open exposure to environment increases contamination.
Wastewater	High	Industrial, agricultural, and residential use increases contamination.

Coagulation: Due to the natural ionic negativity of most contaminants, positively charged chemicals are distributed during treatment in a process known as coagulation. When right concentrations of coagulants are added, particles become attracted to one another rather than repelled. The formation of larger particles is called flocculation. These flocculated particles can then be extracted from the water through sedimentation and filtration, treating the water's contamination levels and decreasing its turbidity.

Methods

Physical Parameters

- pH & Turbidity
- Absorptivity: Spectrometer
- TSS: concentration of the particles in the sample were measured by filtrating and dehydrating the sample.

Treatment

- 6x of 500 mL sample
- PAC and $FeCl_3$ added
- Jar Testing: rapid mixing (20 secs. at 120 rpm), slow mixing (20 mins at 15 rpm), and sedimentation (20mins at 0 rpm)
- Tested TSS, turbidity and pH

Chemical and Biological Parameters

- total organic carbon (TOC): light absorbance of organic compounds through UV light
- Alkalinity: titration
- Salt conductivity: conduction
- Ammonia: nitroprusside through indophenol blue to analyze on a spectrophotometer
- Phosphates/Nitrates: ion chromatography.
- E. coli: indicator organism was measured through filtration and petri dish incubation.

Results

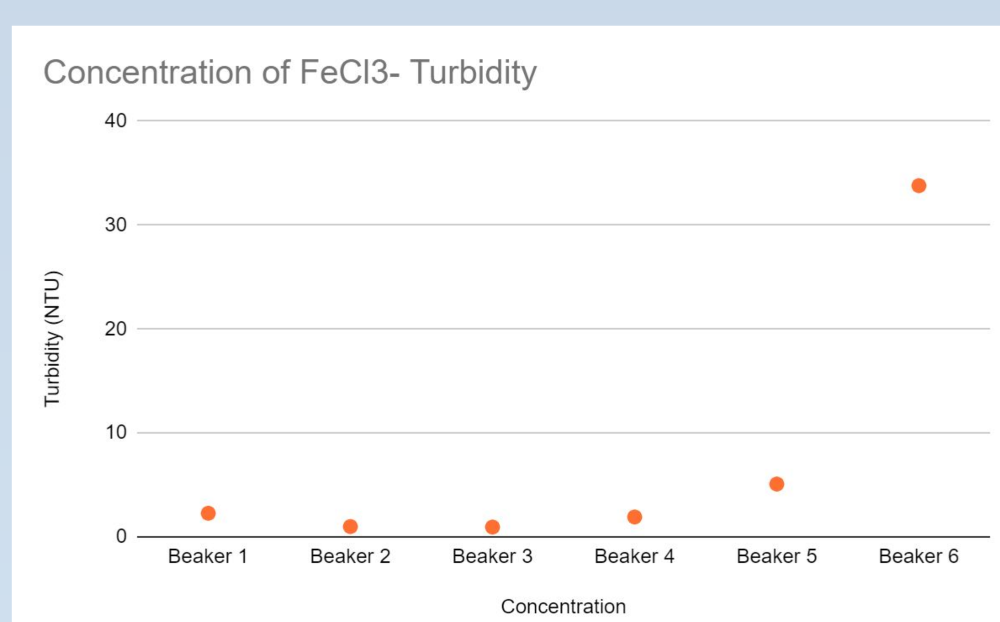
Physical Parameters

pH	Color	Turbidity (NTU)	Absorptivity (λ)	TSS (mg/L)
7.38	light yellow	9.51	0.343	113.3

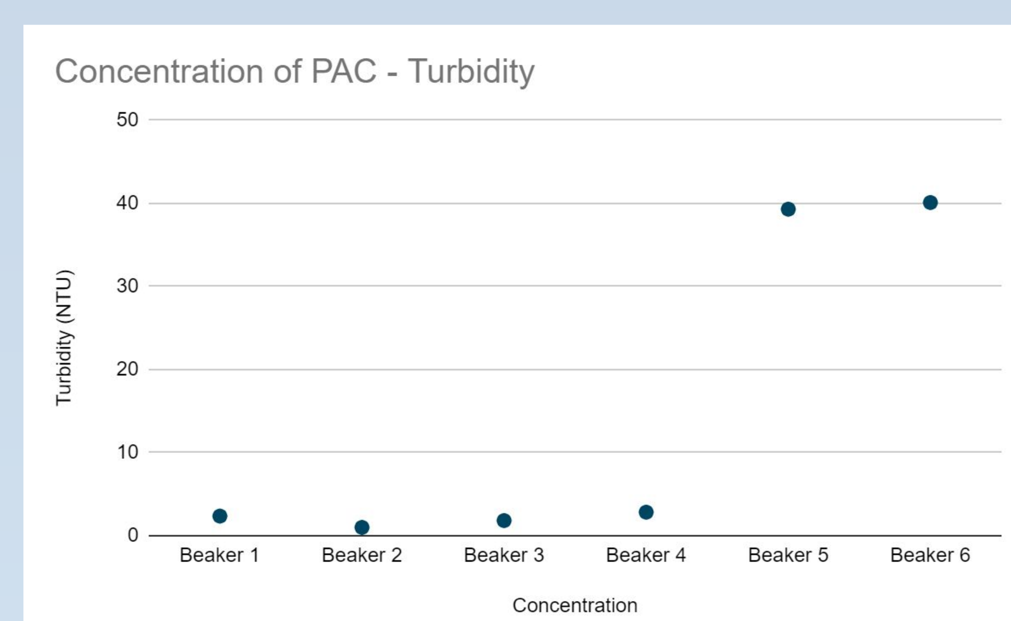
Chemical and Biological Parameters

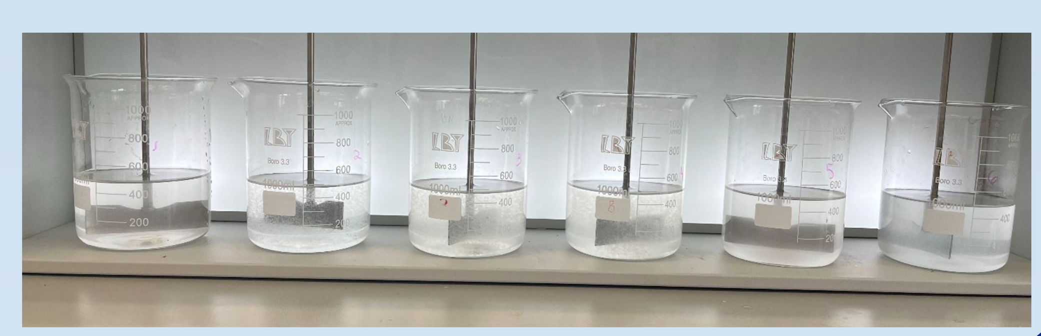
TOC (mg/L)	Alkalinity (m_{eq}/L)	Nutrients		Salt Conductivity (µS/cm)	E. Coli (CFU / 100ml)
102	275 5.5 mL (pH – 7.3 to 4.34,)	NH_4^+ 0.923 nm diluted to 10 mL	NO_3^- 22 mg/L Phosphates 7 mg/L	1123 (indirect at .64) product: 718.72 mg/L	$1x10^5$

Graph 1 - Iron Chloride



Graph 2 - Poly Aluminum Chloride





Acknowledgements

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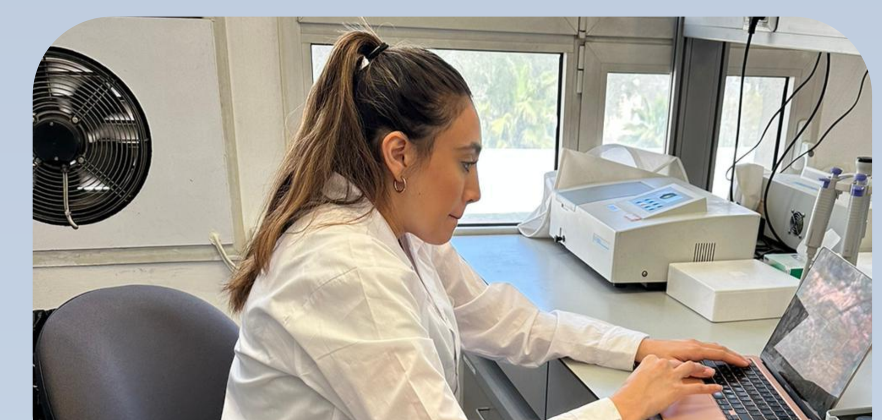
Conclusions

We used coagulants Polyaluminum Chloride (PAC) and Iron Chloride ($FeCl_3$) to determine the concentration that resulted in the lowest TSS and turbidity values for our water sample. Comparing the turbidity values in Graph 2 to Graph 1, The PAC values for each beaker are greater than the respective turbidity values for $FeCl_3$, meaning $FeCl_3$ is a more effective coagulant to form flocculants. Additionally, because of the orange color of $FeCl_3$, it is easier to see in the water, making it easier to remove all of the flocculants from the water. Therefore, for coagulation in water treatment the most effective coagulant to use is $FeCl_3$ with a concentration of 20 mg/L (represented as beaker 3).

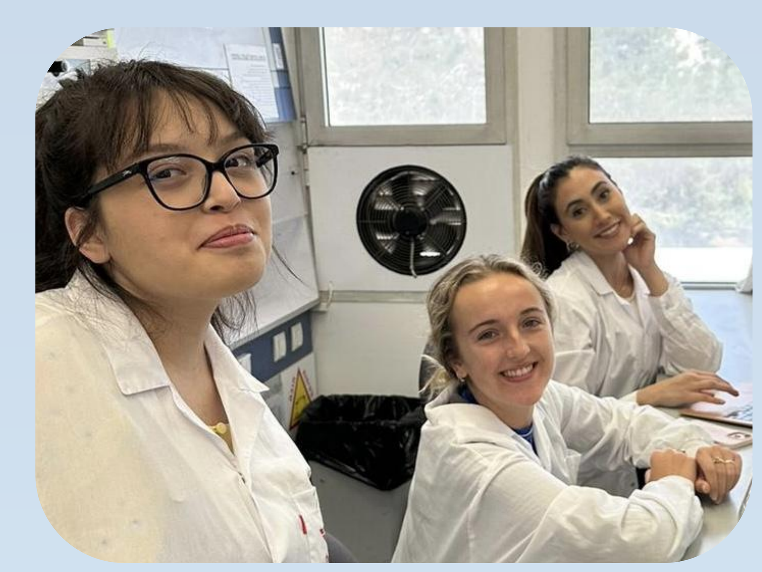


When Coagulant is added, contaminating particles become positively charged and interact with the negative contaminating particles to form larger flocs.

Too Much Coagulant: Too many positive ions are added,resulting in the coagulant and contaminating particles to repel each other. This increases the turbidity.

Too Little Coagulant: Not enough positive ions are added to the water in order to attract all of the negative ions and the turbidity does not reach the desired concentration.

About MENG365



This course is designed for USD students to gain knowledge in the mechanical and environmental engineering aspects of water quality and treatment. For 10 days, students from USD traveled to Arieliz College of Engineering and engaged with Israeli water systems and culture. This project and course is in collaboration with a group of students from Azrieli College of Engineering.