

STEM project series example session, water quality

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1 Overview of session

This session is intended to introduce students to common technologies used in wastewater treatment and outline some best practices for efficient and robust experimental design. The live demonstration will specifically focus on the removal of suspended solids in a synthetic water laden with natural organic matter (e.g., humic acid).

The synthetic water will be treated with a so-called "coagulant" to destabilize the colloidal material in suspension (particles from 1-1000 nm), after which solid-liquid separation will be achieved through filtration. Students will be tasked to dose the coagulant such that the residual turbidity of the water is below a defined discharge limit.

The residual turbidity will be measured with a low-cost turbidity sensor that will be automated with an Arduino and Raspberry Pi setup. This will require configuring the sensor to the Arduino, creating a program for the Arduino to receive the sensor output voltage (using the Arduino programming language), and creating a Python program for the Raspberry Pi to analyze and display the sensor data. Lastly, known turbidity standards will be used to validate that the sensor measures turbidity as expected.

1.1 Notes on background material

The reading "Zeta potential in 5 minutes" provides an excellent introduction to colloid stability, an extremely important concept in water treatment and many other areas in science. For the purposes of this experiment, the coagulant is used to decrease repulsion forces between neighboring particles in suspension and increase their propensity to aggregate (or "coagulate"). The aggregated solids can then be separated from the liquid via sedimentation, flotation or filtration. For configuring the turbidity sensor, sample code and associated connection diagrams can be found in the [product wiki](#).

2 Materials for experiments

Item description (with link)	Approx. cost (USD)	Additional notes
Calcium chloride dihydrate (500 g)	35	Coagulant for treating water
Garden soil (0.75 ft³)	5	Organics for synthetic water
Arduino Uno	30	Reads in voltage from turbidity sensor
Raspberry Pi 3 kit	100	Analyzes and displays raw signal from Arduino
Analog turbidity sensor	10	Measures approximate turbidity of still water sample
Coffee filter	10	Filters treated water to separate aggregated solids
Funnel	5	Used with coffee filter to separate aggregated solids

3 Expected results and discussion

The key graph from this experiment will be a dose-response curve showing the residual turbidity of the treated water versus the amount of coagulant dosed. The practical selection of different coagulants for real-world water treatment applications (e.g., calcium chloride versus polyaluminum chloride) will also be discussed here.