Tech Expo, Fall 2025 – Team 16

Photocatalytic PVA Scrubber

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Problem Statement

The use of common washing machine detergent pods deposits over **8,000 tons** of PVA plastic into the water supply each year. This contamination goes unseen, and up until now, there haven't been any options for the average washing machine user to limit their contribution to this issue. Our focus is on providing an easy-to-use product attachment that filters out these contaminants.

Client Background

Purdue Northwest has recently been experimenting with ways to stifle the flow of contaminants into major water sources and reduce the amount of contaminants. These contaminants, specifically microplastics and PFAS, are destructible when introduced to a UV light source and a photocatalyst. Our team was tasked with developing a functional testing apparatus to achieve this goal.

Requirements

Req #	DESIGN REQUIREMENTS	DESIGN TARGETS	VALIDATION
	RATIONALE		
1	UVC Light	UVC 380 - 395 nm.	
	Essential for activiating the photocatalyst (TiO2)		
2	Titanium Dioxide (TiO2)	TiO2 responds to UV radiation & decomposes PVA into CO2 and H2O.	Responds to UVC light radiation.
	The photocatalyst is used to complete the reaction to degrade PVA. Used to coat beads, then placed in water.		
3	Oxygenate Water	Provide oxygen for chemical reaction.	Water remains in active flow state.
	Oxidize water to perform chemical reaction between PVA, UVC light & TiO2.		
4	Water pump	Water is actively moving through system for duration of experiment	Water flows in and out of gallon canister.
	Activate water flow movement keeping water bubbling to flow through system		

Experimentation and Concepts

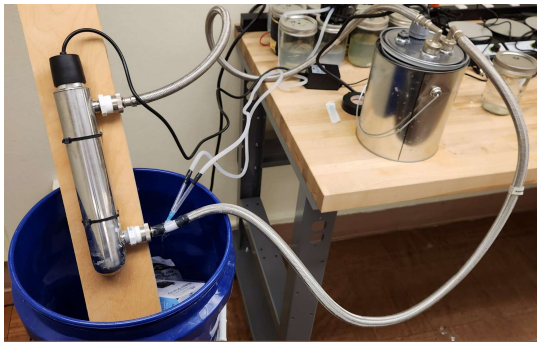
The reaction that facilitates the destruction of PVA requires four main things: (1) UV light, (2) a photocatalyst, (3) oxygenation, and (4) active water flow at the site of the reaction. The idea is that the photocatalyst, when excited by UV light and oxygen, forms a superoxide that destroys particulates in the water. A recirculating basin was designed to feed PVA-contaminated water through a reaction chamber to study the destruction of PVA and the accompanied variables.

To determine the amount of PVA in the water, a spectrophotometer was used to measure the absorbance of light through the samples before and after running them through the apparatus. To analyze the degradation of the PVA, spectrophotometer readings were taken to see if the absorbance was lower on the sample after having been run through the machine. Tests used one liter at a time, running each test for an hour and sampling every 30 minutes.

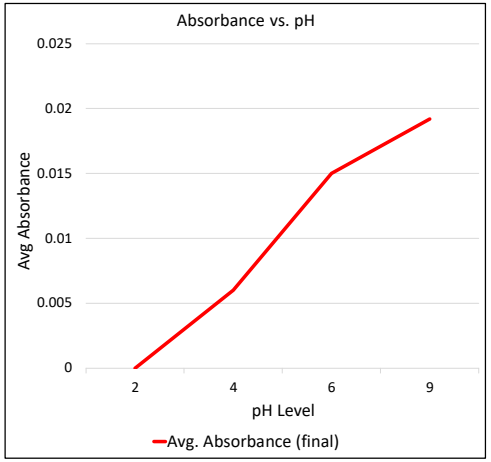
Final Design

The final design for the testing unit consisted of two main parts: (1) a gallon paint jug as a basin and (2) a UV aquarium sanitization tube that acted as a reaction chamber. In this unit, an aquarium pump cycles water from the basin through the reaction chamber, where the UVC light is enclosed alongside Titanium Dioxide pellets.

The reaction required oxygenation, so a hypodermic needle with an air supply was inserted into the reaction chamber's intake hose. The reaction takes time, so water is recirculated through the system continuously.



Testing and Results



In the initial tests before implementing the photocatalyst, the total observed degradation of the PVA was 99%, after running the system for 8 hours. This was an inefficient timeframe, but it proved that the system would work. After implementing the photocatalyst, system run times reduced to one hour, but a major complication of contaminated, cloudy water arose due to excess coating dust on TiO2 pellets. To solve this issue, clear water samples were run to calculate the absorbance that the TiO2 dust imposed on future samples. This unintended absorption was treated as noise and subtracted from subsequent PVA samples' absorption.

The final method of testing PVA degradation was light absorbance using a spectrophotometer to measure the light absorbance of the samples before and after running them. The idea was that when the PVA was destroyed, the water would be less absorbent of light. With the provided equipment and materials, using the spectrophotometer was the best possible solution to measure the degradation of PVA after running through the photocatalytic reaction. Absorption values post-system were calculated by recording the difference of the initial mixed water absorbance and the post-run samples' absorbance.