Introduction

Tile drains as shown in Fig. 1 are basically designed to facilitate removal of excess water to reduce erosion and runoff off soil while irrigation distributes water deposits evenly across land [1]. These two methods of agricultural infrastructure ensure that the soil receives the proper amount of water. This runoff typically feeds into a larger water flow. Nutrients, particularly phosphorous, seep into soil and bodies of water through tile drains and can lead to algae blooms when left untreated in natural waters, creating an environment that is not healthy for a present ecosystem.

A team at UWM WaTA Technology Accelerator has developed a novel approach to reducing the effects fertilizers have on freshwater bodies. The method uses an adsorbent material, functionalized by a metal oxide that is used for selective removal of Phosphorus from farm water runoff [2,3]. Compared to existing materials available in the market, UWM’s material is more accessible, cheaper to produce, and has a higher adsorption efficiency. Additionally, it has a promising capability to recover Phosphorus adsorbed and allow for remanufacture and reuse the media in the field.

Objective

- Manufacture functionalized media for selective removal of phosphorous.
- Protect water resources from highly concentrated nutrients in farm runoff, which causes algae production and eutrophication.
- Recover nutrients adsorbed by the media.
- Restore adsorption capacity of the media for reuse.
- Reduce monetary waste by returning recovered nutrients to the farmer.
- Spread social awareness of phosphorous pollution from farms, and encourage implementation of regulatory standards to control its effects.

Materials & Methods

To facilitate selective removal of phosphorous by the material, a novel approach was developed to functionalize the adsorbent using a metal oxide. Then column experiment as demonstrated in Fig. 3 was performed to analyze adsorption behavior of the material in different condition. To optimize the model material, several variables have been tested and controlled, including the flow rate and phosphorus concentration of the subjected fluid and different techniques used for fabrication of the materials to find out the best condition for having the highest adsorption. Moreover, submersion test was performed to study effect of contact time on adsorption. And finally, since this material will be utilized inside a filter box on the outlet of a storm water drainage system, a laboratory scale filter box as shown in Fig. 4 was designed to simulate and study the performance of the material in a full-scale application.

Results

The results of the column experiments show that all versions of UWM’s functionalized adsorbent have higher removal efficiencies compared to the competitor’s adsorbent in the market (Fig. 5). Submersion test results as shown in Fig. 6 determine the optimal contact time necessary for maximum phosphorous removal from the solution. Finally, filter box results shown in Fig. 7 indicate the necessary number of adsorbent cartridges for highest adsorption rates in the field.

Conclusion

- A novel approach was developed to reduce the effects fertilizers have on freshwater bodies by installing a filter box with functionalized, adsorbent materials to an outlet of a farm tile drainage system.
- Compared to standard materials available in the market, UWM’s material is more accessible, cheaper to produce, and has a higher adsorption efficiency.
- Captured phosphorus can be desorbed from the filtration material, so that the nutrient can be collected and returned to the farmers. The filter’s adsorption capacity will be restored after desorption so that it can be reinstalled at the site of runoff. This creates a sustainable method of phosphorous removal and recovery, allowing farmers to effectively reduce water pollution without experiencing considerable loss of profit.
- The result of the column experiments prove that by decreasing flow rate in a dynamic system and increasing contact time in static system, adsorption increases.
- Future tasks include the fabrication of a full-scale apparatus and the coordination with local farmers to test the system in the field, while addressing farmers’ concerns.
- This new technology has shown to be an effective method of Phosphors removal and is well on the way to becoming a revolutionary approach to pollution control as it relates to agriculture.

References


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