A Ph.D. Student Tackles Stormwater Management

Now more than ever, the world needs innovators, scholars and outside-the-box thinkers to help find creative solutions for pressing global challenges. Annesh Borthakur, a Ph.D. student in the Civil & Environmental Engineering department at the University of California, Los Angeles (UCLA), is one such trailblazer.

Borthakur's groundbreaking findings on the use of expanded shale, clay and slate (ESCS) in biofilters were published in the May 2022 volume of the Journal of Hazardous Materials. He attributes much of the success of his research and scholarly article to the path he embarked on when dubbed the first recipient of the Expanded Shale, Clay and Slate Institute's (ESCSI) John Ries scholarship, 2019-2020.

Recognizing the looming impact of climate change and urbanization on the quality and availability of water, Borthakur has dedicated the last several years to extensive research on sustainable stormwater management. Through his experiments, Borthakur findings supported his claim that stormwater biofilters amended with ESCS can effectively remove toxic pathogens. Doing so both improves the quality of the water and extends the service life of the biofilter. Borthakur believes that utilizing a reimagined biofilter will be necessary in the future as effective stormwater management becomes an increasingly important tool to conserve and reuse the world's diminishing water supply.

Here is a brief Q&A with Borthakur:

Annesh, your scholarly article was just published in the May 2022 volume of Journal of Hazardous Materials: "Natural Aging of ESCS Amendment with Heavy Metals in Stormwater Increases its Antibacterial Properties: Implications on Biofilter Design." Can you please provide a high-level summary of the article?

Borthakur: Let's start with the concept of stormwater biofilters. Ideally, they are supposed to capture stormwater and then remove pollutants from the water over a 20-year service life. However, today's biofilters still use a very primitive design and are a breeding ground for harmful pathogens and bacteria. If the water is recycled and consumed (even inadvertently by eating produce grown in the soil), you will get sick.

Through my research, I found that stormwater contains heavy metals. While harmful to ingest, heavy metals do still offer benefits when applied correctly. Most pertinent to this research, heavy metals can have a positive impact on pathogen removal. I wanted to illustrate that if we could leverage heavy metals as a solution rather than a problem, we could see a reduction in the growth of pathogens in biofilters.

Where does ESCS enter the equation?

ESCS media can quickly absorb and retain large amounts of heavy metals, which means it's an effective – if not surprising – means of killing off pathogens. To examine its effectiveness, we exposed biofilter media amended with ESCS to metals by intermittently injecting natural stormwater spiked with copper, lead and zinc. Metal adsorption on ESCS media decreased their net negative surface charge and altered the surface properties as confirmed by zeta potential measurement and Fourier-Transform Infrared Spectroscopy (FTIR) analysis.

Seeing the lightweight aggregate material adsorb the metals in front of me was amazing. I had never seen anything perform like this before. A live-dead analysis confirmed that the adsorbed metals inactivated attached pathogens (E. coli), thereby replenishing the adsorption capacity.

Overall, the results confirmed that natural aging of biofilter media with adsorbed metals could indeed have a net positive effect on E. coli removal in biofilters and therefore should be included in the conceptual model predicting long-term removal of pathogens from stormwater containing mixed pollutants.

What is your vision for the future of stormwater treatment management?

Borthakur: Capturing and recycling stormwater by amending the design of filter media with ESCS is going to be incredibly important in the years to come because of the global water crisis. For example, urban areas, where 70% of the world's population is projected to live by 2050, are already water stressed. I have experienced this firsthand living in southern California.

The industry will collectively need to transform the way stormwater treatment systems are designed to ensure a sustainable future. My hope is that I can be a part of the solution through continuing my research on stormwater and wastewater treatment.

Source: Expanded Shale, Clay and Slate Institute (ESCSI)