VIDEO ARTICLE

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Cost-effective, Green and Sustainable Filtration Media for Multi-pollutant Removal: An Inter-disciplinary Sustainability Solution

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Abstract

Nutrient and heavy metal pollution due to agricultural discharge, stormwater runoff, wastewater effluent, tailing water release from mining sites, and improper waste disposal has augmented the impact of economic development on ecosystem integrity in receiving waterbodies, causing harmful algal bloom, hypoxia, eutrophication etc. Besides, nonpoint sources pollution from agricultural crop fields and dairy farms oftentimes have elevated concentrations of dissolved organic nitrogen (DON) in stormwater runoff, which are difficult for microbial communities to decompose. A series of cost-effective, sustainable, and green sorption media were developed for removal of these existing and emerging pollutants of importance. Mixed recycled and natural materials with synergized recipes were developed for three types of green sorption media for nutrient removal and possible recovery in high nutrient-laden agricultural discharge and stormwater runoff as well as removal of other existing and emerging pollutants of concern. The three generations of "green sorption media" in sequence include: 1) bio-sorption activated media (BAM), 2) iron-filings based green environmental media (IFGEM), and 3) aluminum-based green environmental media (AGEM). Liquid Chromatography with tandem mass spectrometry (LC-MS-MS), quantitative Polymerase Chain Reaction (qPCR) and Fourier transform ion cyclotron resonance mass spectrometer (FT-ICR-MS) were used for functional analysis. These green sorption media have been proven effective at both laboratory- and field-scale and widely applied to almost 300 sites in the United States. The most recent pilot-scale project is related to the use BAM and IFGEM to simultaneously remove nitrogen species, phosphorus species, algal toxins, algal mass, E Coli, and Per/polyfluoroalkyl Substances (PFAS) from canal water upstream of the St. Lucie River and Estuary, Florida. PFAS are deemed as emerging pollutants of concern worldwide. Preliminary design of the filter with 3-million-gallon capacity per day along the C-23 canal feeding the St. Lucie River and Estuary has been completed to document cost-effectiveness and operational efficiencies. Most recent advancements have been directed to test IFGEM/AGEM for color (humic acids) removal in river water of Black Creek, north Florida before delivering 10 million gallon per day to a lake for drinking water treatment and the use of BAM for DON removal for large-scale C-43 off-reservoir treatment in south Florida with 189-million-gallon capacity per day.

Biography of Presenting Author

Ni-Bin Chang is Professor of Environmental Engineering. He received his B.S. degree in Civil Engineering from the National Chiao-Tung University in Taiwan in 1983, and M.S. and PhD degrees in Environmental Systems Engineering from Cornell University in the United States in 1989 and 1991, respectively. He is Director of the Stormwater Management Academy and Professor with the Department of Civil, Environmental, and Construction Engineering at the University of Central Florida in the United States. His research lies at the intersection between "Environmental Sustainability", "Green and Sustainable Materials", and "Resilient Infrastructure Systems". Beginning with the research in the early 1990s through today these investigations have provided the research focus for a large and diverse scientific community. Up to 2020, he has published over 275 peer reviewed journal articles and received 12 US patents in which 11 of them are related to "Green and Sustainable Materials" and have been fully commercialized. He has received 40 awards/honors since 1987 nationally and internationally, including the Outstanding Achievement Award from the American Society of Civil Engineers in 2010, the Fulbright Specialists Award from the Department of State and German-American Fulbright Council in 2012, the Bridging the Gaps Award from the Engineering and Physical Sciences Research Council in the United Kingdom in 2012, the Distinguished Visiting Fellowship from the Royal Academy of Engineering in the United Kingdom in 2014, and the Blaise Pascal Medal from the European Academy of Sciences in 2016 and the Fulbright Canada Research Chair of Interdisciplinary Sustainability Solutions from the Department of State and Canada-American Fulbright Council in 2020. The citation of his Blaise Pascal Medal is "for his outstanding contribution in Environmental Sustainability, Green Engineering, and Systems Analysis". He is inducted Fellow of the following 7 professional organizations, including the National Academy of Inventors (NAI), the American Society of Civil Engineers (ASCE), the Institute of Electrical and Electronics Engineers (IEEE), the International Society of Optics and Photonics (SPIE), the American Association for the Advancement of Science (AAAS), the Royal Society of Chemistry in the United Kingdom (RSC), and the European Academy of Sciences (EurAsc) in European Union. From August 2012 to August 2014, Professor Chang served as Program Director of the Hydrologic Sciences Program and Cyber-Innovated Sustainability Science and Engineering Program at the National Science Foundation in the United States.

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