VANDERBILT
School of Engineering

DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING

Seminar

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“THE DIRTY SIDE OF CLEAN ENERGY: LITHIUM ION BATTERIES AS A SOURCE OF PFAS IN THE ENVIRONMENT”

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ABSTRACT

Lithium ion batteries (LiBs) are used globally as a key component of clean and sustainable energy infrastructure. Emerging LiB technologies have incorporated a novel class of per- and polyfluoroalkyl substances (PFAS, i.e., "forever chemicals") known as bis-perfluoroalkyl sulfonimides (bis-FASIs). PFAS are recognized internationally as recalcitrant, mobile, and toxic environmental contaminants. Despite this, virtually nothing is known about environmental impacts of bis-FASIs released during LiB manufacture, use, and disposal. Here we demonstrate that occurrence, ecotoxicity, and treatability of this novel class of PFAS are comparable to PFAS that are now prohibited and highly regulated worldwide and confirm the clean energy sector as an unrecognized and growing source of global PFAS release. In total, 82 water, 1 snow, 15 sediment, and 21 soil samples were collected near Cottage Grove, MN, Paducah and Louisville, KY, Antwerp, Belgium, and Salindres, France. Bis-FMeSI was detected in surface water (1.12-2,437 ng/kg), sediment (14.4-1,626 ng/kg), and soil (12-2,300 ng/kg) in all sampling regions, confirming international environmental release. Toxicity data demonstrated effects on swimming behavior in Daphnia magna at bis-FASI exposures of 10 ppt and swimming behavior and metabolic process changes in Danio rerio resulting from exposures of 25 ppt. Occurrence of up to 881 ng/L of bis-FASIs in landfill leachates highlights current impacts of LiB disposal. Although fully recalcitrant to advanced oxidation processes, select bis-FASIs were removed from water during adsorptive treatment with similar or better efficiency as more hydrophobic PFAS such as perfluorooctane sulfonate (PFOS). LiB use is anticipated to increase globally over the next decade, and 8 million tons of LiB waste are projected by 2040 as a result of low recycling rates. This suggests that environmental exposure to this novel, unregulated class of PFAS will increase with time and will be relevant to the majority of the world's population. Results underscore that environmental impacts of clean energy infrastructure merit scrutiny to ensure that reduced CO2 emissions are not achieved at the expense of increasing global releases of persistent organic pollutants.

BIOGRAPHY

Jennifer Guelfo, Ph.D., is an Assistant Professor and an Edward and Linda Faculty Fellow in Civil, Environmental, and Construction Engineering at Texas Tech University. She joined Texas Tech University in 2018 following a postdoctoral appointment in the Brown University School of Engineering. Dr. Guelfo has a BA in Geology from the College of Charleston, a MS in Environmental Science & Engineering from the Colorado School of Mines (CSM), and a PhD in Hydrologic Science and Engineering, also at CSM. For the past 13 years, her research has focused primarily on occurrence, fate, transport, and remediation of per- and polyfluoroalkyl substances (PFAS). In addition to academia, she also has a combination of consulting and industry experience, and she uses this background to engage in activities that can inform policy and bridge gaps between research and practice.