Evaluation of Presence of Nylon 6 and Polystyrene Micro- and Nanoplastics on Degradation of Chlorinated Solvents and Energetics

Fadime Kara Murdoch (karamurdoch@battelle.org), Jacob Lilly, and Katarzyna H. Kucharzyk
(Battelle Memorial Institute, Columbus, OH, USA)
Yanchen Sun, Frank E. Loeffler (University of Tennessee, Knoxville, TN, USA)
Mark Fuller (APTIM, Baton Rouge, LA, USA)

Background/Objectives. Bioremediation plays a major role in the transformation and detoxification of chlorinated solvents and only some strains of *Dehalococcoides mccartyi* (*Dhc*) can detoxify chlorinated ethenes to environmentally benign ethene. *Pseudomonas fluorescens* I-C and *Gordonia sp*. KTR9 strains have been reported for their capability with RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine) degradation. Plastics, as synthetic chemicals, are extensively used in daily life and form smaller particles that accumulate in soils and sediments. The persistence of microplastics (MPs) and nanoplastics (NPs) in environmental systems has started to raise concerns. Inhibitory effects of nano/microplastics on biological processes such as sludge digestion, nitrification/denitrification, hydrogen generation and methanogenesis have been recently documented, yet little is known on the impacts of MPs and NPs on bioremediation processes. Our study has focused on the potential inhibitory effects of Nylon 6 and polystyrene (PS) of nano/microplastics on reductive dechlorination of chlorinated solvents and microbial degradation of RDX.

Approach/Activities. The reductive dechlorination activity of mixed dechlorinating-culture SDC-9 and degradation of RDX by strain I-C and KTR9 in the presence of PS (10 µm and 10 nm) and nylon 6 (15-20 µm and 360 nm) microplastics and nanoplastics have been evaluated. The dechlorination of trichloroethene (TCE) has been monitored using gas chromatography with flame ionization detector (GC/FID). *Dehalococcoides spp.* cell abundance has been determined by quantitative PCR. Targeted proteomics was used to quantify process-specific reductive dehalogenases (RDases). For RDX experiments, RDX was determined using HPLC and cell abundance was monitored via OD_{600}.

Results/Lessons Learned. The presence of PS and nylon 6 nanoplastics did not cause any detrimental effect on dechlorination activity of the SDC-9 or degradation activity of strain KTR-9 and IC for RDX. On the other hand, the presence of nylon 6 microplastics negatively affected the reductive dechlorination activity of the SDC-9 culture. A cis-DCE stall has been observed for sets with nylon 6 and no further dechlorination to VC and ethene has been observed. Also, the effects of nylon 6 and PS microplastics on production and availability of biomarker RDase proteins were evaluated. The presence of nylon 6 MPs at abundance of 5.0E+05 particles/mL caused nearly 1,000-fold decrease in the TceA and VcrA reductive dehalogenase proteins/mL in the SDC-9 culture with time, which indicates potential negative effect on reductive dechlorination activity. On the other hand, nylon 6 and PS MPs did not show any detrimental effect on RDX degradation of strain I-C and strain KTR9. Depending on the results of this study, the type and abundance of MPs should be considered for a decision support system for RPMs and site managers.