Leadership in Sustainable Infrastructure
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Case Study

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EFFECT OF A NOVEL BIOCHAR SUPPORTED NANOSCALE IRON SULFIDE COMPOSITE ON *CORYNEBACTERIUM VARIABILE HRJ4* AND A CHEM-BIO HYBRID PROCESS FOR TRICHLOROETHYLENE DEGRADATION

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1 Project Overview

Trichloroethylene (TCE) is one of the most common organic pollutants detected in both soil and groundwater (Bacik et al. 2012). Since TCE poses a number of risks, there has been an increasing concern over TCE usage, and growing attention on monitoring its environmental levels, fate, and remediation.

Several studies have been reported for degradation or transformation of TCE, including physico-chemical oxidation, UV/TiO_2 photocatalysis, and microbial degradation (Murugesan et al. 2011). However, microbial degradation of TCE is mainly hindered by the halogen substituents and their hyper-toxicity. Therefore, preceding dechlorination is essential for efficient microbial degradation to occur.

Traditional catalysts, such as nFe and nFe–Pd, were found to be toxic to microorganisms and the bactericidal activity (Lee et al. 2008), which is another important concern as they might affect the biodegradation process in the hybrid treatment. Therefore, an efficient, economic, and environmentally friendly multifunctional catalyst should be developed.

2 Innovation

In this project, a sequential chem-bio hybrid process with a novel biochar (BC) supported nanoscale iron sulfide (FeS) (CMC-FeS@BC) as chemical remover and *Corynebacterium variabile HRJ4* as biocatalyst for TCE degradation and the impacts of CMC-FeS@BC on TCE biodegradation by *HRJ4* were investigated.

3 Lessons Learned

Strain *HRJ4* grew well in the presence of CMC-FeS@BC up to 0.25 g/L in medium with TCE as carbon source, which is higher than the CMC-FeS@BC dosage for TCE chemical removal (0.18 g/L). The CMC-FeS@BC composite displayed an enhanced TCE removal capacity of 77.8 mg/g compared to 59.7 mg/g for CMC-FeS, 26.8 mg/g for bare FeS, and 56.5 mg/g for BC. At the equilibrium TCE concentration of 3.4 mg/L, 40.4% of TCE removal was due to reduction, and 59.6% was ascribed to sorption. The dechlorination pathway was proposed based on the results of GC-MS and XPS. 10 mg/L of TCE was dechlorinated to *cis*-1,2-dichloroethene (*cis*-DCE), vinyl chloride (VC), and acetylene within 12 h by 0.18 g/L CMC-FeS@BC. Addition of *HRJ4* strain into the reactor effectively degraded the *cis*-DCE and VC to ethylene and acetylene. XPS analysis suggested that sorption, reduction and biodegradation were dominant mechanisms for TCE removal. Results from this study forecast the potential of CMC-FeS@BC/*HRJ4* chem-bio hybrid treatment in TCE degradation

Figures

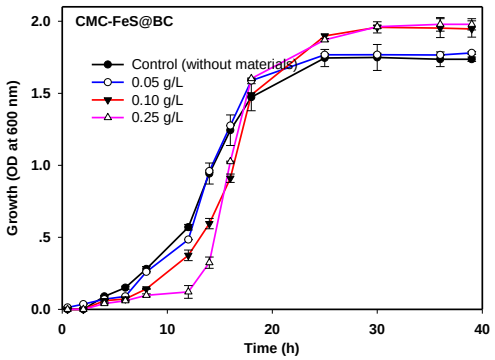

Figure 1: Example figure caption Effect of CMC-FeS@BC on the growth of *Corynebacterium variabile HRJ4* in MSM medium with DE as a sole carbon source.

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