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Impact of nitrogen source on vanadium removal during anaerobic digestion process : *Investigating the feasibility of anaerobically treating V(V) and nitrate rich wastewaters*

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Anthropogenic activities like smelting and fossil fuels combustion can induce metal contamination of waterbodies. Microorganisms in environments with high vanadium concentrations have been shown to precipitate vanadium(V) using nitrate and nitrite reductases to convert it to its less soluble form V(IV).[1] Recent research efforts have focused on combining anaerobic digestion with metal removal as a cost effective, sustainable strategy towards wastewater decontamination and valorisation.[2]

Competition between vanadium removal and denitrification can occur in wastewater containing nitrate (e.g. due to pesticides and fertilizers use), perhaps jeopardising the feasibility of combining anaerobic digestion for methane production and vanadium removal in co-contaminated systems. Furthermore, the impact of the composition of anaerobic sludge inoculum on this combined process has not yet been investigated. Here, we assessed how 200 mg/L V(V) impacted methane production with ammonium or nitrate as nitrogen source by incubating anaerobic granular sludge, with glucose as carbon source, at 37°C for 10 days.

Biogas production and methane content were measured by pressure monitoring and gas chromatography, respectively. Vanadium was quantified in the solid and soluble fraction (0,45 µm filtration) over time. Additional measurements on soluble nitrogen speciation and dinitrogen proportion in the gaseous phase were carried out and sludge aliquots were sampled for 16S rRNA profiling from DNA and cDNA.

Vanadium supplementation did not impact methane production with ammonium as the nitrogen source provided, while it significantly decreased in the presence of nitrate. Both conditions reached 98% decrease in soluble vanadium concentrations but removal was slower in the presence of nitrate. Indeed, substrate competition for nitrate/nitrite reductases might have prolonged the exposure to soluble vanadium which in turn might have inhibited methanogenesis.[2]

A comparative assay evaluating the tolerance to V(V) of three different sludges is currently underway.

Taken together, these results including microbial community analysis linking phenotypic observations to microbial composition will deepen the theoretical understanding of vanadium interaction with microbial metabolism as well as inform the development of potential remediation technology.

[1] Yan, G. et al. (2022), Water research 226, 119247
[2] Zhang, J. et al. (2014), Chemical Geology 370, 29-39