

Reductive Debromination of 1,2-dibromoethane and tribromoethylene by a Shrimp-Shell Biochar and Green Rust Composite

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Abstract

Simple brominated ethanes and ethylenes like 1,2-dibromoethane (DBA) and tribromoethylene (TrBE) are widespread, toxic contaminants and able to persist in soil and groundwater. Some of these compounds are used as intermediates in the production of resins and as wood preservatives. Previous uses include additives for leaded fuel and fumigants for agricultural use (Falta et al., 2005). For the corresponding chlorinated ethylenes, a combination of layered iron(II)-iron(III) hydroxides (green rust) and biochar has been reported to efficiently dechlorinate and thereby detoxify the compounds within a short time span (Ai et al., 2019). For the brominated equivalents, there is only little research on their corresponding debromination reactions, although the contaminants are often present in anoxic sediments and groundwaters (Patterson et al., 2007). In this study, it is demonstrated that various shrimp shell biochars can catalyze the abiotic debromination of tribromoethylene, 1,2-dibromoethane, cis/trans-dibromoethylene, vinyl bromide and bromoethane by green rust sulfate in aqueous solution and in groundwater samples. 1,2-dibromoethane and tribromoethylene were reduced to ethylene and acetylene respectively, within 24 hours, using a shrimp shell biochar, pyrolyzed at 900°C for 2 hours, followed by acid treatment. All reactions followed pseudo first-order kinetics. Further work is being performed on post pyrolysis treatments. Three treatments have been tested: no treatment (NT), acid treatment (AT) and acid treatment + CO₂ activation (CO₂). The SS900CO₂ was the most reactive. The SS900NT was the least reactive. Full reduction of DBA and TrBE was observed by total molar recovery of ethylene and acetylene.

Results

Reactivities of the SS900NT, SS900AT and SS900CO₂ biochars (0.12 g l⁻¹) with 20 μM DBA

and TrBE were tested with an ≈22 mM green rust (GR) suspension in oxygen-free TI-water. Also included were control samples without all three reaction components. Results for SS900AT+DBA and SS900AT+TrBE are shown in **Error! Reference source not found.**

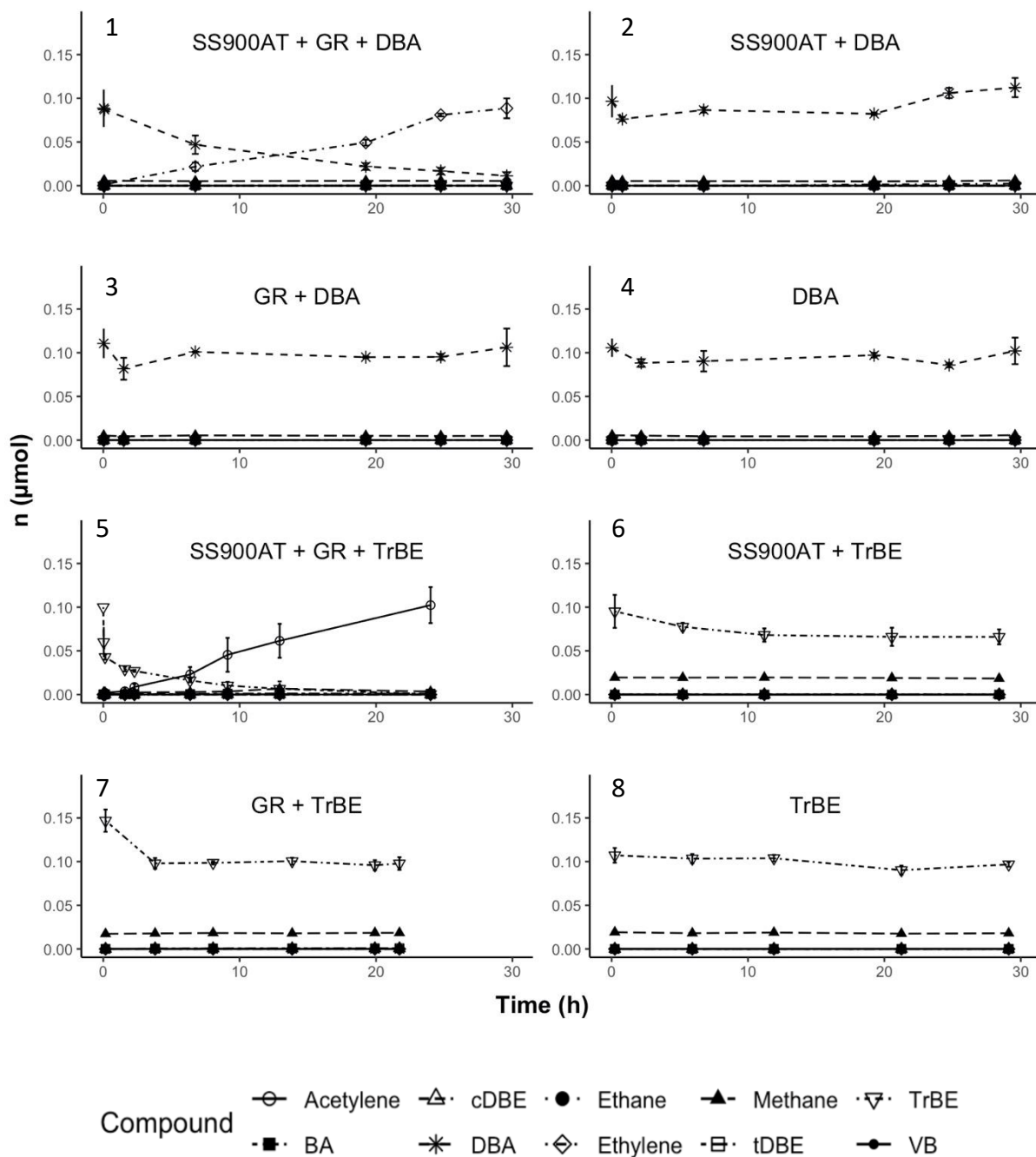
Reduction of DBA and TrBE


Figure 1 Panels 1-4: Reduction of DBA. Main results in panel 1, controls in 3-4. Panels 5-8: Reduction of TrBE. Main results in panel 5, controls in 6-8.

References

Ai, J., Yin, W., & B. Hansen, H. C. (2019).
Fast Dechlorination of Chlorinated