Reduction of Hexavalent Chromium By Agave Biochar and Modified Biochar

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Introduction

Soil pollution can severely affect ecosystems involving groundwater and rivers by industrial wastes containing heavy metals. Hexavalent chromium (Cr(VI)) is a very toxic element for living organism, and has been discharged to ecosystem from industrial plants. In Guanajuato, Mexico, soil pollution caused by Cr(VI) has been a serious problem due to increasing industrial production. Lignocellulose materials contained in timber and fiber are known to have capability to reduce Cr(VI). Bagasse of agave plant (*Agave tequilana*) from which tequila is produced is one of the examples of lignocellulose materials. In addition, reduction potential by lignocellulose materials can be improved as biochar when pyrolysed at low to medium (200-500^{o}C) temperatures.

Objectives

The objective of this study was to understand the mechanism of reduction potentials of Cr(VI) by agave bagasse and its biochar.

Materials and Methods

➢ Biochars (<160 μm)
- Feedstock: agave bagasse (AB)
- Fresh biochar (**FB**)
- H_2O_2-treated biochar (15% H_2O_2, **HB**)
- Pyrolysis conditions
  1. Highest treatment temperature: 400^{o}C
  2. Heating rate: 10^{o}C min^{-1}
  3. Retention time: 2 hr

Tab.1 Selected properties of biochars

Biochar	Total C mg g^{-1}	Total N mg g^{-1}
FB	405	9.41
HB	355	4.94

➢ Batch experiments (800 mL glass container)
- Biochars mixed: 5 g L^{-1}
- Cr(VI) solution: 100 mg Cr(VI) L^{-1} ($K_2Cr_2O_7$) and pH 2.0
- Measurement: pH and oxidation reduction potential (ORP) with 1 min interval between 1 and 90 min
- Sampling: 1, 5, 10, 15, 20, 30, 40, 50, 60, and 90 min

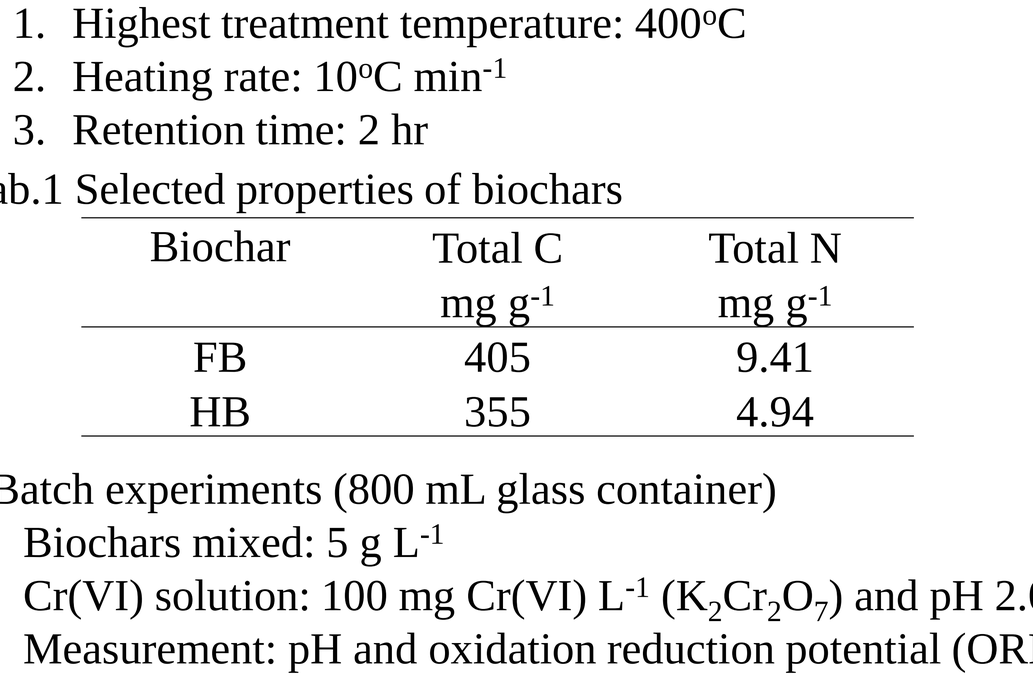

Fig.1 Equipment of batch experiments

Results and Discussion

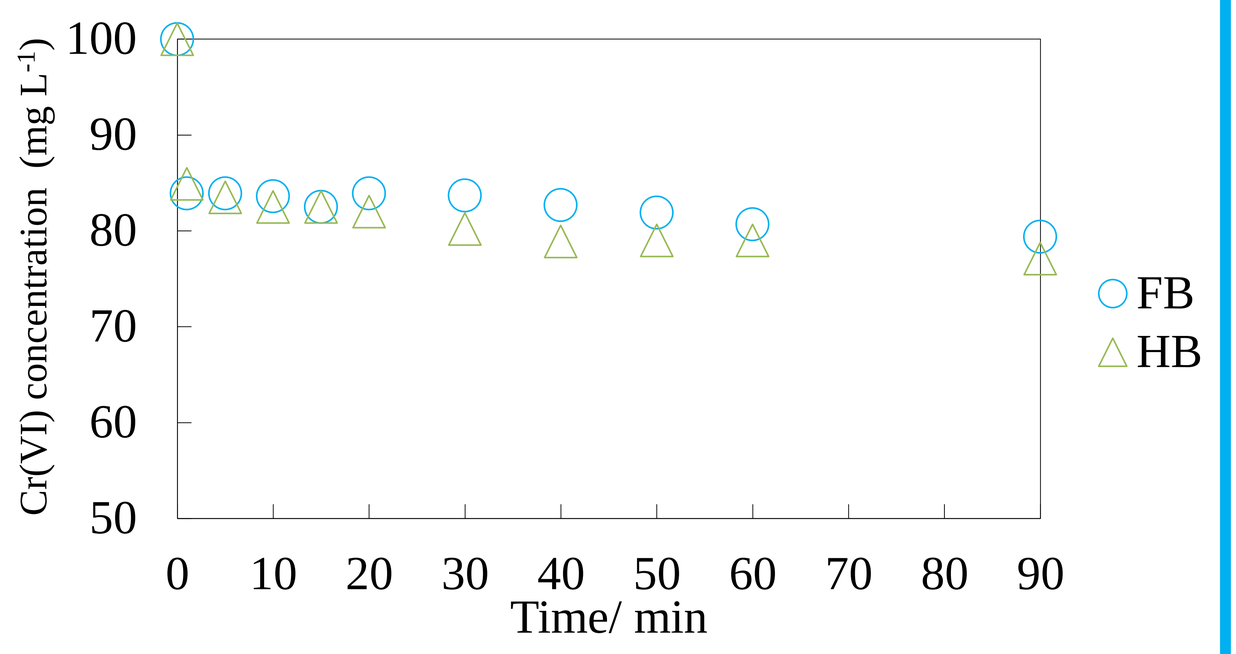

Fig. 2 Removal of Cr(VI) in solution by biochars

➢ **Removal of Cr(VI) with FB and HB were similar.**
→ Cr(VI) reduction may not greatly change by carboxyl groups on biochar surface which HB contained more than FB.

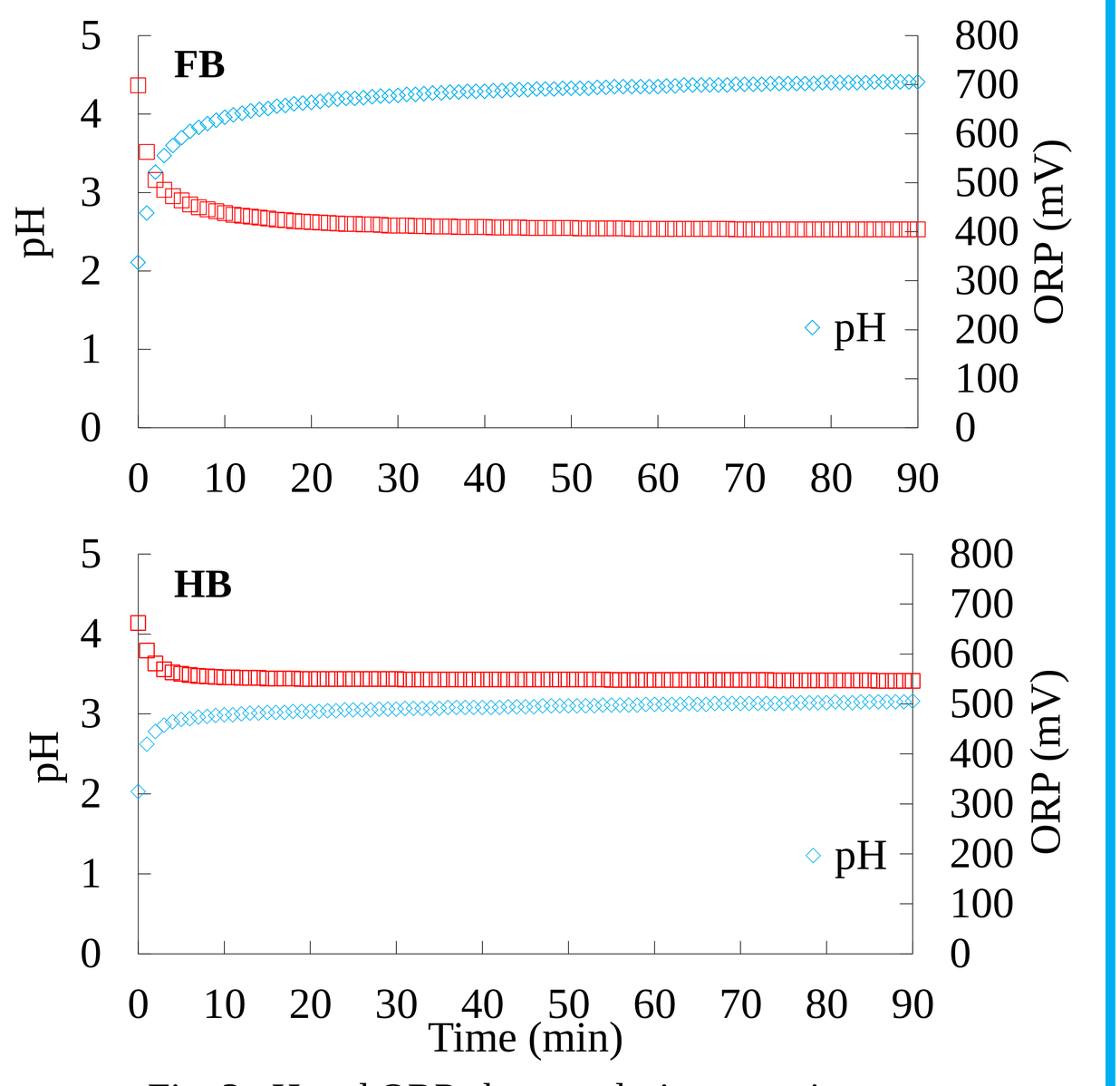

Fig. 3 pH and ORP changes during experiments

➢ **The pH and ORP changes with FB were smaller than HB.**
→ pH increased and ORP decreased along with Cr(VI) reduction with both FB and HB.
→ Acidic functional groups on HB surface may have prevented pH increase compared to FB.

Conclusions

➢ Cr(VI) reduction was about 21-23% by AB biochars, but H_2O_2 treatment of biochar did not improve the reduction.
➢ The pH and ORP changes were consistent with Cr(VI) reduction, but surface functional groups may affect these changes.
➢ Batch experimental setup needs to be improved.