

Effects of surface Fe(III) oxides in a steel slag on the formation of humic-like dark-colored polymers by the polycondensation of humic precursors

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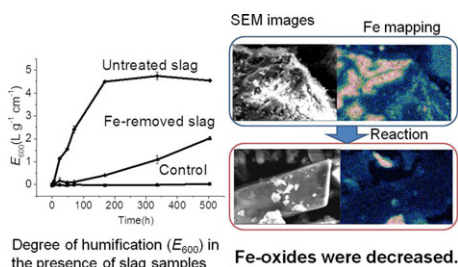
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HIGHLIGHTS

- ▶ A steel slag can be used to enhance polycondensation reactions of humic precursors.
- ▶ To elucidate this, slag surfaces were altered by treating with HNO₃, HF and NH₂OH.
- ▶ Catalytic activities of the HNO₃ and HF treated slags were decreased significantly.
- ▶ XRD peaks corresponding to Fe(III)-oxides in the treated slags were decreased.
- ▶ Fe(III)-oxides can serve as catalytic sites that enhance polycondensation reactions.

GRAPHICAL ABSTRACT



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ABSTRACT

Carbonated furnace steel slag is effective in enhancing polycondensation reactions of humic precursors such as quinones, amino acids and saccharides. To obtain more detailed information concerning the nature of the catalytic sites on the surface of slag, a pristine slag sample was treated with HNO₃, HF and NH₂OH to alter the surface states. The catalytic activities for the formation of humic-like dark-colored polymers were significantly decreased for the samples treated with HNO₃ or HF compared to untreated slag. Because substantial amounts of iron were eluted as the result of the HNO₃ and HF treatments, the minerals remaining on the surface of steel slag were characterized by XRD and SEM, and the results were compared with untreated slag. XRD patterns indicated the significant decrease in Fe(III) oxide content, including magnetite and hematite, as the result of the HNO₃ and HF treatment. In addition, when untreated slag was reacted with humic precursors, the hematite and magnetite were largely eluted as a result of the reaction. These results support the conclusion that Fe(III)-oxides on the surface of steel slag, such as hematite and magnetite, serve as catalytic sites for enhancing catalytic activity for the formation of humic-like dark colored-polymers from humic precursors.

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1. Introduction

It is generally accepted that humic substances (HSs) comprise one of the fractions of soil organic matter and serve as a pool

of carbon in the geosphere. In HS formation, biomacromolecules such as proteins, polysaccharides, lignins and polyphenols are hydrolyzed to low-molecular-weight compounds such as amino acids, sugars and quinones, which are referred to as humic precursors. These precursors are subsequently recombined via polycondensation reactions to form humic-like dark-colored polymers [1–3]. It has been reported that minerals in soil can influence the formation of dark-colored polymers that are formed by the

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