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Recycling Wasted Steel Scrap for Removing Contaminants in Leachate from Landfillsoils

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ABSTRACT

Municipal solid waste landfills contain mainly a mixture of various organic compounds and heavy metals. The decomposition of waste in the landfill may result in producing environmentally harmful substances. Landfill leachate treatment has received significant attention in recent years since landfill leachate is a frequent source of groundwater contamination. It has been emphasized by the identification of chlorinated solvents in leachate-contaminated groundwater. Encouraging results in laboratory experiments have stimulated a rapid increase in the use of zero-valent iron (Fe^0) as a reactive material to remove redox-sensitive compounds from groundwater. With a standard reduction potential (Eh) of 409 mV, Fe^0 primarily acts as a strong reducing agent ($Fe^0 \rightarrow Fe^{2+} + 2e^-$). Industrial wastes such as fly ash, bottom ash, and granulated slag of steel plans have been studied as cost-effective and convenient adsorbents for the treatment of wastewater containing heavy metals. The main objective of this study was to evaluate the reuse of wasted steel scrap to treat contaminants in leachate from landfill. Emphasis was placed on determining whether wasted steel scrap is used as both reducing agent and heavy metal adsorber after pretreatments.

Wasted steel scrap was obtained from an industrial complex and washed with solvent in order to remove oil on the surface (ID). Wasted steel scraps, acid-washed with a hydrochloric acid solution for 2, 5, 10, and 20 hours, were prepared through pretreatment (AD). Batch studies were subsequently run to test the reactivity of the wasted steel scrap towards NO_3^- (at 10 mg/L) and heavy metals (As and Cd, at 10 mg/L each), which are commonly present in

leachate from landfill. Reactors were shaken on a reciprocating shaker (150 rpm, 25℃) and periodically analyzed for NO_3^- and heavy metals using IC and ICP, respectively.

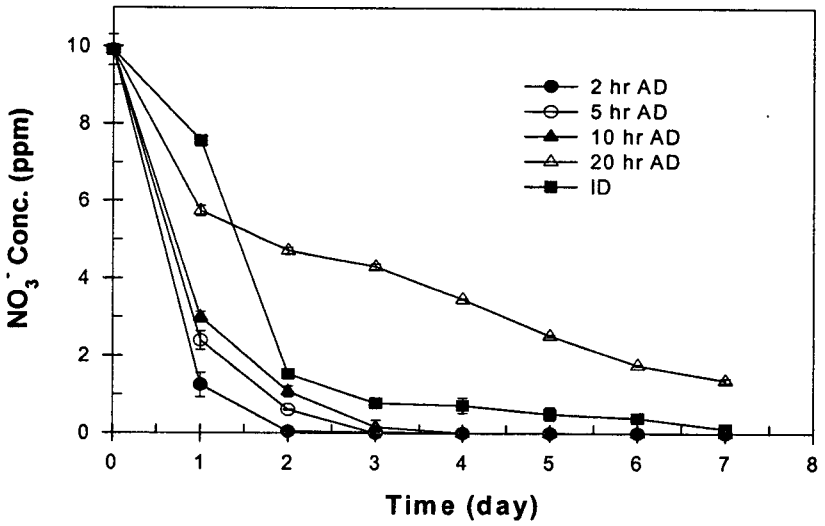

Fig. 1. Nitrate removal by acid-washed AD for various pretreatment time.

Wasted steel scrap through pretreatment showed a high reactivity to remove nitrate (Fig. 1). According to the results, AD should be pretreated for shorter to be a better reducing agent. Batch experiments suggest that wasted steel scrap can effectively remove nitrate. In preliminary experiments, wasted steel scrap with N_2 gas before the pretreatment step did not show any reactivity to nitrate. Note that the wasted steel scrap was reactive through pretreatments such as acid-washed steps.

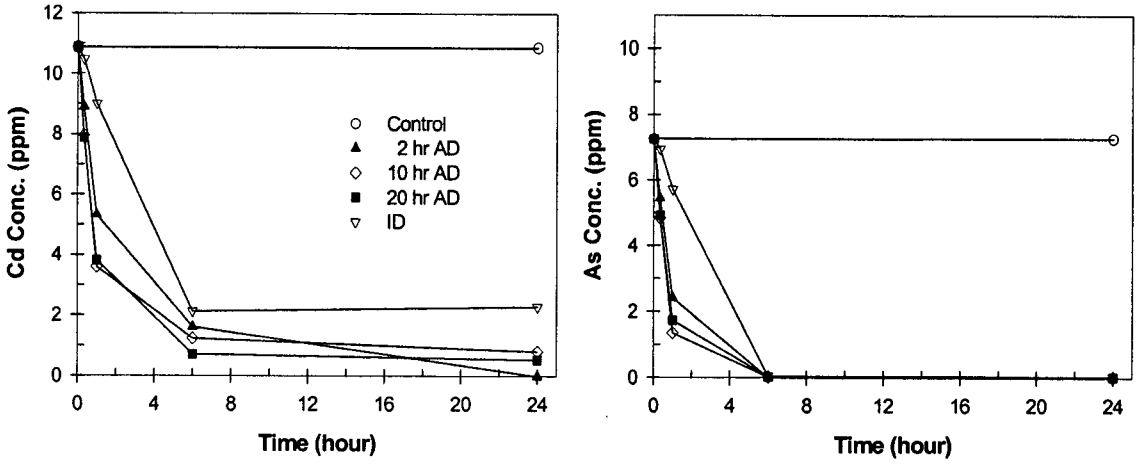

Fig. 2. Cd and As removal by acid-washed AD for various pretreatment time.

The removal assays of heavy metals were also conducted in additional batch reactors to investigate the ability of AD to remove heavy metals. Based on adsorption results, significant heavy metals removal (As and Cd) was observed by AD (Fig. 2). According to the results, AD should be pretreated for longer to be a better heavy metal adsorber. This removal may be due to adsorption by iron oxide on the AD surface that was formed through pretreatment.

Laboratory experiments suggest that wasted steel scrap can be recycled as reactive materials in a permeable reactive barrier (PRB) system to remove contaminants in leachate from landfill. This approach may also be practical and effective to treat other redox-sensitive groundwater pollutants, such as nitroaromatic compounds, chlorinated solvents, hexavalent uranium, and some pesticides.