Effects of Potassium Permanganate and Hydrogen Peroxide on the Biodegradation of Weathered Crude Oil in Sediments from Indiana Harbor Canal

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The Indiana Harbor Canal shoreline is heavily contaminated with highly weathered crude oil, and traditional bioremediation processes are not expected to be effective due to the low concentrations of readily biodegradable compounds and high concentrations of poorly degradable and potentially toxic compounds. A feasibility study was conducted to investigate the ability of chemical oxidation to increase the biodegradability of this oil. The effectiveness of the combined treatment was determined by measuring the oil mineralization rate from sediment slurries in sealed microcosms. Carbon dioxide produced by oil mineralization was trapped in a potassium hydroxide solution suspended in the headspace of the sealed reactors, and oxygen was added as necessary to maintain constant pressure. Microcosms were treated with potassium permanganate (9.0g/L), hydrogen peroxide (2.9g/L), or no oxidant. Half of the oxidant-treated microcosms were sterilized by autoclaving to distinguish between biological and chemical oxidation processes. The extent of oil mineralization was highest in the biologically active permanganate-amended microcosms. The biologically active hydrogen-peroxide-amended microcosms produced carbon dioxide at a slightly greater rate than the unamended microcosms. Significant chemical oxidation was observed in the sterile permanganate- and peroxide-amended microcosms. The rate of oil mineralization was faster in the sterile hydrogen-peroxide-amended microcosms than in the biologically active peroxide-amended microcosms. This apparent anomaly was probably due to the presence of catalase, an enzyme that decomposes hydrogen peroxide to oxygen and water through a non-radical mechanism, in the biologically active microcosms.