Development of a Tubular High-Density Plasma Reactor for Water Treatment

Derek C. Johnson\textsuperscript{1}, David S. Dandy\textsuperscript{1*}, and Vasgen A. Shamamian\textsuperscript{2}

\textsuperscript{1}Colorado State University, Dept. of Chemical & Biological Engineering, Fort Collins, CO 80523 USA

\textsuperscript{2}Dow Corning Corporation, Auburn, MI 48611 USA

*To whom the correspondence should be addressed:
Telephone: (970) 491-7437
Fax: (970) 491-7369
Email: dandy@colostate.edu

Abstract

Experiments have yielded a number of important insights into the energy distribution, sparging and oxidation of methyl \textit{tert}-butyl ether (MTBE), benzene, ethylbenzene, toluene, \textit{m}- and \textit{p}-xylene, and \textit{o}-xylene (BTEX) in a dense medium plasma reactor (DMPR). It has been found that the DMPR transferred a relatively small amount of electrical energy, approximately 4\% in the form of sensible heat, to the surrounding bulk liquid. Rate constants associated with plasma initiated oxidation, interphase mass transfer and photolysis were determined using a combination of nonlinear least squares analysis and \textsc{matlab} \textsuperscript{®} optimization for each species. The rate constants developed for the DMPR, in conjunction with a species mass balance on a prototype tubular high-density plasma reactor, have been applied to determine the removal rates of MTBE and the BTEXs when operating in batch and continuous flow configurations. The dependence of contaminant concentration on parameters such as treatment time, the number of pin electrodes, electrode gap, and volumetric flow rate has been determined. It was found that, under various design specifications and operating conditions, the tubular high-density plasma reactor may be an effective tool for the removal of volatile organic compounds from aqueous solutions.