Ozone Mass Transfer Analysis in an Opposing-Jet Reactor

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Abstract

A standard product opposing-jet pipeline flash reactor was used as a secondary mixing and contact device to enhance the mass transfer of ozone gas into tap water. In this system, a venturi injector was used for initial introduction and partial dissolution of ozone upstream of the flash mix reactor. The ozone mass transfer performance of each system was measured by determining the overall volumetric liquid mass transfer coefficient ($k_L a_{Inj}$) of the injector and the ozone transfer efficiencies of the injector and the opposing-jet pipeline flash reactor on a gas-phase basis ($O_3TE_{Inj,Gas}$), and the ozone transfer efficiency of the entire system on a liquid-phase basis ($O_3TE_{Sys,Liquid}$) under a wide range of operating conditions. Tracer studies revealed that the injector could be modeled as a plug flow reactor and that a continuous flow stirred tank reactor model could represent the opposing-jet pipeline flash reactor. Mechanistic models were developed and tested for predicting the performance of the ozone mass transfer process in the injector and the opposing-jet pipeline flash reactor. Over the tested range of operating conditions, $O_3TE_{Inj,Gas}$ ranged from 42.3 to 92.3%. Meanwhile, the estimated gas-phase-basis ozone transfer efficiency of the opposing-jet pipeline flash reactor ($O_3TE_{OJ,Gas}$) ranged from 6.1 to 78%. The estimated liquid-phase-basis ozone transfer efficiency of the system composed of an injector followed by an opposing-jet pipeline flash reactor ($O_3TE_{OJ\ Sys,Liquid}$) ranged from 64.5 to 100%. A comparison between the performance of this ozone dissolving system and other previously investigated ozone contacting systems is presented.