JOHNS HOPKINS

Center for Environmental & Applied Fluid Mechanics

Weekly CEAFM Seminar: Fall 2011

Friday, November 18, 2011

11:30 a.m. – 12:00 p.m.

Gilman 50 (Marjorie M. Fisher Hall)

"An Effect of a First-Order Chemical Reaction on Turbulent Scalar Transfer into a Turbulent Liquid across a Gas-Liquid Interface"

Presented by

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Abstract: An effect of a first-order chemical reaction on turbulent scalar transport across a gas-liquid interface has been investigated. A presence of turbulent boundary layer above the interface in gas side is ignored, and turbulent transport of substance A into a turbulent liquid across the interface, and chemical degradation of A are considered. The chemical reaction this study assumes is an aquarium, and first-order, i.e., $A + H_2O \rightarrow B + H^+$. Turbulence statistics of concentrations of substances A and B in turbulent water are computed based on a direct numerical simulation (DNS) technique. The Schmidt numbers of substances A and B are assumed the same, and Sc=1 and 2 are used for this study. Rate of the chemical reaction, K, is varied from 10^{-3} to 10^{1} to observe the effect of chemical reaction on turbulent scalar transport of A and B in water. The results of this study show that presence of the chemical reaction changes drastically scalar transport of A and B in water. Roles of turbulent and viscous transport near the interface are important equally when the chemical reaction rate is small, e.g., $K=10^{-3}$, 10^{-2}, and 10^{-1}. A role of molecular diffusion of the substance A near the interface, however, dominates physics of turbulent scalar transport in cases of $K=10^{0}$, and 10^{1}. In particular, concentration of A at K=10 is almost zero outside the turbulent boundary layer below the interface. This trend can be observed in both the Schmidt number cases of Sc=1 and 2. It is concluded that the chemical reaction is completed during the substance A diffuses across the turbulent boundary layer below the interface, in the cases of $K=10^{0}$, and 10^{1}. On the other hand, the substance A can survive during its molecular diffusion across the turbulent boundary layer below the interface when the chemical reaction is not fast, $K \leq 10^{-1}$.