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Effects of Kinetic and Transport Parameters on Accelerated Migration of Reactive Additive From Plastic Sheet

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The effects of kinetic parameters Hatta number Ha and ϕ, and transport parameters Biot number Bi and ψ on the migration of a reactive additive have been modeled. The convective boundary layer can be considered inert to fully reactive for Ha $\rightarrow$ 0 to 2, respectively. The migration is controlled by diffusion, reaction rate, equilibrium partitioning of the migrant between the plastic film and the solvent, and boundary layer resistance, depending on the time scale and values of the above parameters. For a nonreactive boundary layer, at high Bi, migration is initially diffusion-controlled but becomes reaction-rate controlled at later times. However, under similar conditions, a slight increase in the reactivity of the boundary layer immediately changes the transport process from diffusion-controlled to reaction rate-controlled. With further increase in reactivity, migration spontaneously reaches equilibrium. At low Bi, equilibrium partitioning and reactive depletion of the migrant in the fluid phase change predominantly to boundary layer-controlling mass transport phenomenon. For a given sampling time ($\tau = 1.0$), the migration increases with the increase in Bi only for a reactive boundary layer. At low Bi and ($\tau = 1.0$), migration decreases only up to $\phi \cong 0.3$ for nonreactive to partially reactive boundary layer, but for intermediate and high Bi, ϕ and Ha do not influence migration.