

## Reaction front dynamics under shear flow for arbitrary Damköhler numbers

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Reaction fronts where two reactive fluids displace one another play an important role in a range of applications, including contaminant plume transport and reaction, soil and aquifer remediation, CO<sub>2</sub> sequestration, geothermal dipoles and the development of hotspots of reaction in mixing zones. The background flow induces enhanced mixing, and therefore reaction, through interfacial shear. Hence the coupling of fluid flow with chemical reactions is pivotal in understanding and quantifying effective reaction kinetics in reaction fronts. While this problem has been addressed in the limit of fast reactions (e.g. de Simoni 2005, Le Borgne 2014), in natural systems reactions can span a large range of Damköhler numbers since their characteristic reaction times vary over a large range of typical values. Here the coupling of shear flow and reversible chemical reactions is studied for a reaction front with initially separated reactants at arbitrary Damköhler numbers. Approximate analytical expressions for the global production rate are derived based on a reactive lamella approach. We observe three distinct regimes, each of them characterized by different scalings of the global production rate and width of the reactive zone. We describe the dependency of these scalings and the associated characteristic transition times as a function of Damköhler and Pécellet numbers. These results are validated against 2D numerical simulations. The study is expected to shed light on the inherently complex cases of reactive mixing with varying reaction rates under the influence of an imposed flow.

de Simoni et al. (2005) Water Resour. Res., 41, W11410

Le Borgne et al. (2014) GRL, 41(22), 7898