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Evaporation Modelling of Refrigerant-Solvent Droplets

Harry N. Scott [1], Swetha C. Vutlapalli [1], Damon R. Honnery [1] and Daniel J. Duke [1*]

[1] LTRAC Dept. of Mechanical and Aerospace Engineering, Monash University, Clayton, VIC 3800, Australia

* Email: daniel.duke@monash.edu

Abstract

Refrigerants are volatile at ambient temperatures. Their application as propellants in flash-atomising sprays is common, particularly in medical sprays. Lower volatility solvents are often blended, forming binary component spray droplets. An effective conductivity model was developed to characterise the evaporation of these blended droplets. The effects of propellant type, diffusivity and initial composition are presented here. When rapidly mixing, evaporation is described by 4 stages: (I) droplet heating/cooling, (II) refrigerant vaporisation, (III) secondary droplet heating and (IV) ethanol vaporisation. As mixing reduces, the droplet vaporisation is limited by the rate of propellant transport to the surface. Consequently, the evaporation stages II-IV occur simultaneously. Both liquid species evaporate concurrently, and propellant remains trapped in the droplet core. This occurs at diffusivities with an order of magnitude of 10^{-9} m^2s^{-1}. Larger initial ethanol concentrations increase the duration of concurrent species evaporation. Analysis of propellant type highlights the importance of improving thermodynamic data tables for refrigerant ethanol blends. The thermodynamic properties not only influence the evaporation within stages but also affect which processes dominate. When designing formulations, the entire evaporation process must be examined.