MEASURED VAPOR DISTRIBUTION AND THE DIFFUSIVE, CONVECTIVE, AND VELOCITY FIELDS OF AN EVAPORATING SESSILE METHANOL DROP

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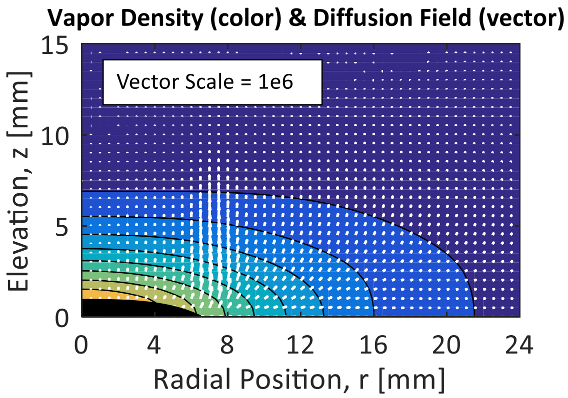
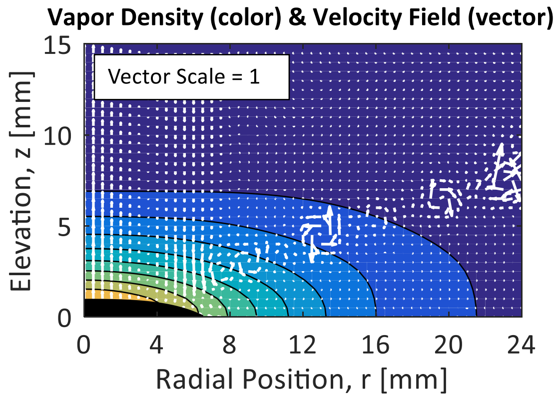
This paper reports on the vapor transport for an evaporating methanol drop. Methanol was chosen for this study because our evaporation rate measurements were significantly higher than values predicted by the diffusion-limited model, a common model for vapor transport, even though solutal convection is expected to be negligible due to the molecular weight of methanol being approximately equal to that of air. The methanol vapor concentration distribution was measured and then used to compute the diffusion, convection, and velocity fields.

The vapor concentration distribution was measured using infrared spectroscopy and computed tomography, generally following the technique reported in [1]. Since convection alters the spatial distribution of the vapor surrounding the drop, measurements of the vapor distribution provides a qualitative indication of the relative influences of diffusion and convection on the evaporation process. Following the computation of the concentration gradient, from which the diffusive flux field was determined, the evaporation rate was computed according to the technique of Dehaek et al [3]. With knowledge of the evaporation rate and the diffusive flux, mole balance equations for vapor and air were solved for a series of control volumes to determine the convective flux and velocity fields, thereby providing quantitative information about the nature of the vapor transport. The figures below show the measured vapor distribution in a vertical plane with the silhouette of the drop shown in black, and the resulting diffusion field (left) and velocity field (right). As in the case of diffusion-limited evaporation, the diffusive flux is high near the perimeter of the drop. The velocity field indicates a downward flow above the drop perimeter and a series of vortices at larger radii.





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