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Quasiparallel flow of a binary gas mixture: the Stefan tube revisited S.J.S. MORRIS, Mechanical Engineering, University of California, Berkeley — Placed in the bottom of a vertical tube open at the top, volatile liquid (species 1) evaporates at a rate set by diffusion of vapour through the carrier gas (species 2). In the textbook solution, due to J. Stefan, species 2 is assumed to be stationary, but numerical solutions of the governing equations show that species 2, in fact, recirculates (Mills and Chang 2013; and references therein). But although Stefan's solution is based on an incorrect assumption, the same numerical solutions show that it predicts the evaporation rate to within a few percent (Mills and Chang, below eq.12). Assuming the ratio L/a of tube length to radius to be large, we use lubrication theory to give an elementary solution determining the velocity profiles for each species, including the effect of slip. It is shown that, in the limit as $L/a \to \infty$, the Stefan solution correctly determines the total evaporation rate; this conclusion is independent of the precise form of the boundary condition placed on the species velocities at the tube wall.

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