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Turbulent Scalar Flux Modeling for Inclined Jets in Crossflow: an Optimization Approach[1] PEDRO MILANI, KEVIN RYAN, JOHN EATON, Department of Mechanical Engineering, Stanford University — Turbulent mixing for jets in crossflow is important in numerous applications. Reynolds-averaged models for turbulent scalar transport are usually based on the gradient diffusion hypothesis (GDH), with a scalar eddy diffusivity calculated from the model eddy viscosity. Such models are not accurate in the near jet region causing poor prediction of the scalar concentration distribution. We use 3D mean velocity and concentration data acquired using magnetic resonance imaging to infer improved diffusivity models. The transport equation is solved using the experimental velocity data and a prescribed functional form for the scalar diffusivity. An evolutionary algorithm then optimizes the model constants to minimize the difference between the calculated and measured scalar concentration fields. Tests of multiple model forms for seven different jet in crossflow configurations provide insight into the required characteristics of advanced models. The GDH with a weakly anisotropic diffusivity is very accurate beyond 4 hole diameters downstream of the injection point. However, standard turbulent diffusivity models overestimate turbulent mixing in the separation region; in most cases, the optimization procedure inferred counter-gradient diffusion in this region. New models that adjust automatically depending on the characteristics of the mean velocity and concentration fields are under development.

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Pedro Milani
Stanford University

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