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The transient start of supersonic jets[1] MATEI I. RADULESCU, CHUNG K. LAW, Princeton University — The present study investigates the initial transient hydrodynamic evolution of highly under-expanded jets. Two-dimensional numerical simulations for slit and axisymmetric jets were performed to investigate the flow field during the initial stages over distances of approximately 1000 orifice radii. The parameters used in the simulations correspond to the release of pressurized hydrogen gas into ambient air, with pressure ratios varying approximately between 100 and 1000. The simulations indicate that the head of the jet is laminar at early stages, while a highly complex turbulent flowfield is established at the sides of the jet, involving shock interactions within the vortex rings. A closed form analytic similarity solution is derived for the pressure, density, and temperature temporal evolution at the jet head for vanishing diffusive fluxes generalizing a previous model of Chekmarev using Chernyi's boundary-layer method for hypersonic flows. Very good agreement is found between the present model, the numerical simulations and previous experimental results. The results are used to derive the criteria for Rayleigh-Taylor instability of the decelerating density gradients at the jet heads. The analytical results for the jet evolution could be used in the future to address the ignitability of unsteady expanding diffusive layers formed during the sudden release of pressurized fuel into an oxidizing atmosphere.

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