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Student Excellence Award Finalist: Comparison between Non-Equilibrium and Equilibrium Modeling Results of an Arc Plasma Torch JUAN TRELLES, JOACHIM HEBERLEIN, EMIL PFENDER, University of Minnesota — The strong plasma – cold-flow interaction, added to the intense cooling of the electrodes, suggests that thermal non-equilibrium effects could be important inside arc plasma torches. These effects can modify significantly the energy balance within the torch and subsequently affect the arc dynamics. In this research, a two-temperature non-equilibrium and a local thermodynamic equilibrium model are developed and applied to the three-dimensional and time-dependent simulation of the flow inside a plasma torch. The equations in both models are approximated numerically by a multi-scale finite element method. The results show large non-equilibrium regions near the plasma – cold-flow interaction region and close to the anode surface. Furthermore, marked differences between the non-equilibrium and equilibrium results in the arc dynamics, and in the magnitudes of the voltage drop, and outlet temperatures and velocities are observed. The non-equilibrium results show improved agreement with experimental observations, and clearly indicate the necessity for considering non-equilibrium effects in the description of plasma processing systems were strong plasma – cold-flow interactions are present.

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