Influence Of Gas Feeder Design On Arc Stability In A DC Torch For Plasma Gasification

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Abstract

Plasma torches are essential components in high-temperature applications such as plasma gasification, where stable and focused energy delivery is critical for the efficient conversion of waste into syngas. A key challenge in these systems lies in understanding and optimizing the gas feeder design to enhance plasma jet stability—an important factor influencing electrode erosion and overall process efficiency. In this study, we develop a three-dimensional, steady-state model of a plasma torch based on an experimental setup at TU Freiberg, Germany. The model couples laminar flow and heat transfer using a non-isothermal flow approach and captures the impact of gas flow patterns on thermal gradients within the plasma region. The detailed geometry of the gas feeder is shown to play a vital role in plasma stability, with significant implications for reaction uniformity, energy efficiency, and system longevity. Future work will extend this model to incorporate variable gas compositions and electrode geometries, enabling more realistic simulations and closer alignment with industrial plasma gasification torch operations.