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Experimental and Numerical Studies on the Characteristics of a Dual-Jet, Direct-Current Arc Plasma Generator

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Due to the increasing problems with hazardous waste disposal and the unique features of thermal plasmas with high energy densities and the opportunities to generate valuable co-products, thermal plasma hazardous waste treatment would become a more prominent technology [1]. Among different types of thermal plasma reactors, the dual-jet DC arc plasma generator with one set of cathode and anode directed at an angle to one another, as one type of the non-transferred DC arc plasma torches, can provide large high gas temperature regions with high chemical reactivity for the treatment of the hazardous waste. Previous studies showed that different operation parameters, such as the arc current, the distance and the declination angle between electrodes, the flow rate of the plasma-working gas, etc., could influence the arc voltage and the thermal efficiency of the plasma torch [2].
In this paper, experimental studies on the thermal and electrical features and the two-dimensional modeling on the heat transfer and fluid flow inside a dual-jet, DC arc plasma reactor are conducted with a collinear electrode configuration. Comparisons of the typical discharge image and the corresponding calculated gas temperature distributions inside the plasma reactor using the local thermodynamic equilibrium (LTE) and two-temperature (2T) models show that the gas temperature distribution using the 2T model is closer to the experimental observation than that of the LTE model for the case with arc current of 50 A, electrode distance of 3.0 mm and flow rate on the cathode and anode sides of 10.0 slpm.

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