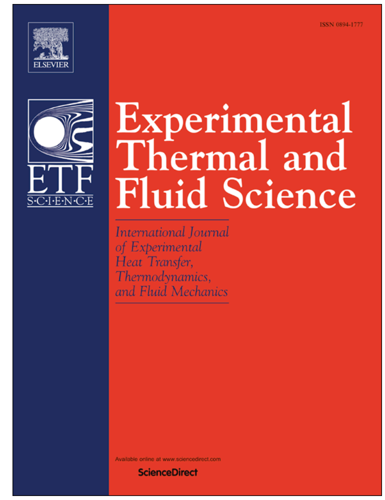

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A Study of the Electrical Characteristics of an Oxy-Fuel Flame

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Abstract

Electrical phenomena useful for oxy-fuel process sensing are demonstrated at signal level voltages applied to an oxy-fuel cutting torch. The current-voltage characteristic of the flame between the torch and work is recorded while varying torch-to-plate standoff, fuel-oxygen ratio, total flow rate, and plate temperature. At ±10V, typical currents are on the order -100μA to 25μA, and the I-V characteristic exhibits three regimes. At low currents, the relationship between voltage and current is linear. At positive currents, transition to saturation is heavily curved around 10μA to 20μA. Negative currents do not totally saturate in this voltage range, but there is an abrupt transition to a new slope, which we describe as "partial" saturation. The properties of these regimes demonstrate strong repeatable links to standoff and fuel-oxygen ratio. Flow rate and plate temperature also demonstrate correlation to these electrical properties despite substantial scatter.

1. Introduction

In the present study, we investigate ion currents in the preheat flame of an oxy-fuel cutting torch as a potential means for sensing system parameters. While applying signal level voltages (-10V to 10V) between the torch and a metal work surface, measured currents were on the order -100μA to 25μA, and demonstrate nonlinear behaviors with sufficient complexity to potentially allow the inference of multiple important system parameters from a single electrical waveform.

1.1. Motivation

Oxy-fuel cutting is a century-old process for cutting steel uses a jet of pure oxygen located concentrically in a semi-annular preheat flame to burn away hot iron. Figure 1 shows the geometry of the Oxweld $\frac{1}{2}$-inch tip used in this investigation. The preheat flame is fed by the channels formed at the interface between a brass insert and sleeve.

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