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Basic model for calculating the macroscopic temperature of plasma plume and comparison with electron excitation temperature by optical spectroscopy method for non-transferred DC plasma torch

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Abstract
Optical emission spectroscopy is known as a prevalent technique for plasma diagnostic which was applied in many experiments. The present research is important and considerable from two points of view. First, with accurate details, the spectroscopy of the plasma plume has been analyzed and it was significant since internationally the plume temperature has been less investigated in comparison with the excited electrons temperature, and also is remarkable as regards the national reports may be even not found such study. In the second view, considering in the non-transfer plasma torch design, the plasma plume temperature estimation and its characterization were substantial and necessary. These results are obtained using the Boltzmann method and exact analysis of the Fortrat curve and the selection of the P branch of the curve known as the first negative system N2+(B-X), based on the dominant Nitrogen molecules in the air. By exact selection of rotational quantum numbers, regarding maximum spectrum intensities, the macroscopic plasma plume temperature, and excited electrons temperature were estimated 2000 (0.17 eV) and 6400 (0.5 eV) Kelvin respectively. The temperature results of this thermal torch sample are compared with international authoritative reports and also with the thermodynamic approach in a similar condition and is in the minimum spectrum of temperature which was excepted. It means that, the macroscopic plume temperature is still far away from related thermal plasma near the excited electron temperature (more than 4000 K). Therefore, to design a desirable plasma torch with suitable electrodes and other parameters, and achieve the 4000 K macroscopic temperature, it is in the minimum spectrum of temperature or efficiency and these obtained results are important and necessary for the precise design of a waste-incinerator torch pursuing with this purpose in the future.

Keywords: macroscopic temperature of plasma plume, non-transfer DC plasma torch, electron excited temperature, optical spectroscopy

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