

ESTIMATION OF THE ROTATIONAL TEMPERATURES IN AN ARGON PLASMA AT ATMOSPHERIC PRESSURE DURING THE DESTRUCTION OF TRICHLOROETHYLENE

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Abstract. The program DMESS has been developed for the determination of rotational temperature of diatomic molecules that is based on the fitting with the least square method of a numerical spectrum to the vibrorotational bands of N_2^+ , CN and C_2 . This method has been applied to the determination of the temperatures in an argon plasma during the destruction of trichloroethylene, generated by a microwave torch at atmospheric pressure. The results were compared with those obtained by the well established spectral simulation program LIFBASE, using in the two methods the N_2^+ rotational band.

1. INTRODUCTION/THEORY

For the last years there is growing environmental awareness which makes it increasingly unacceptable for industrial processes to be sources of pollution. This problem is expressed in a number of ways, such as through public opinion, and results in legislation and changing practices in companies and other organizations. Regulatory requirements mandate a very high destruction and removal efficiency (greater than 99.9%).

Volatile organic compounds (VOCs), such as carbon tetrachloride (CCl_4), toluene ($C_6H_5CH_3$), o-xylene [$C_6H_4(CH_3)_2$], and trichloroethylene (C_2HCl_3), are typical emission gases from the semiconductor and paint industries. Specifically, trichloroethylene (TCE) has shown evidence of being a carcinogen in animals and is suspected of being a human carcinogen and teratogenic agent [1].

Atmospheric pressure non-thermal plasmas have been studied as an optimal method in the area of pollution abatement. These non-thermal plasmas (or more correctly non-equilibrium plasmas) are characterized by the electrons in the plasma having a higher mean energy than the ions or atoms and molecules, and this higher energy of the electrons can produce sufficient active chemical radicals which lead to the destruction of gaseous pollutants. It is necessary to identify and quantify the species produced in the plasma processes as well as to characterize the plasma during the destruction. The characterization consists on the estimation of parameters so important such as rotational temperatures among others (electronic density and temperature, excitation temperature and vibrational temperature). The measurement of the rotational temperatures during the destruction of TCE or another contaminant is representative of the energy of the heavy species in the plasma during this process and is responsible for the atomization of the molecules inside the discharge.

Optical emission spectroscopy (OES) offers a simple, in situ diagnostic of the vibrorotational bands of the heavy species in reactive plasmas, offering information of the species and the excitation states, from which the rotational, vibrational and excitation temperatures can be calculated.

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