SPECTROSCOPIC INVESTIGATION OF MULTIPLE BOLTZMANN DISTRIBUTIONS OF ARGON ATOMIC AND IONIC EXCITED STATES IN AN EXPANDING H_2O-AR DC-ARC JET

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It has been shown for several years that even in non-LTE hot plasmas, the atomic processes tend to establish the Boltzmann distribution of level populations within each electronic configuration. In this contribution we study population distributions of argon atomic and ionic excited states in the supersonic part of an expanding H_2O-Ar dc-arc plasma jet by optical emission spectroscopy. The excitation temperatures are obtained from ArI (13.1-15.3 eV) and ArII Boltzmann (19.2-22.5 eV) diagrams. The ionization temperature is obtained from the intensity ratio of argon ionic and atomic lines, using electron number density calculated from the Stark broadening of hydrogen H_β line and Saha equation.

A systematic difference in the total excitation temperature between both argon systems is found, with the ionic excitation temperature being significantly higher and close to the ionization temperature. The Boltzmann plots also reveal that the population distribution within a given electronic configuration can be characterized by an effective temperature which is usually much lower than the total excitation temperature. Furthermore, the configuration temperature of ArI 4p (13.1-13.3 eV) is lower than the configuration temperature of ArII (^{3}P) 4p (19.2-19.9 eV) and this difference increases with increasing distance from the torch exit. Moreover, population distribution of higher argon atomic states belonging to the configurations 5p, 4d, 6s, 5d, 7s, 8s (14.53-15.36 eV) can also be approximated by the Boltzmann distribution with the temperature close to the temperature of ArI 4p.

Collisional and radiative processes responsible for multiple Boltzmann distribution as well as their relation with the kinetic temperatures of electrons and heavy species are discussed.

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