Paschen curves and analytical expressions for the electron collision rate coefficients in CH_4/CO_2 and CH_4/O_2 mixtures

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In recent years important progress was obtained in the simulation of plasmas with complex chemistry, as those found in the field of environmental plasma. Most of these simulation programs use table lookup to obtain the electron collision rate coefficients as function of the reduced electric field, E/N, or mean energy. This requires a fraction of time, which although small, represents a time penalty comparing with the evaluation through analytical expressions.

In this work we have fitted empirical formula for electron rate coefficients for excitation, dissociation and ionization in CH_4/CO_2 and CH_4/O_2 mixtures to numerical data. The results were obtained solving the electron Boltzmann equation for a swarm in the hydrodynamic regime using an expansion of the electron velocity distribution function (*evdf*) in density gradients, for a E/N range of (0.2 – 50) x 10^{-15} V cm^2, $T_v = T_g$ and concentration ratios of 1:1 and 2:1, respectively for CH_4/CO_2 and CH_4/O_2.

For the lowest E/N values the data was fitted to the equation $\alpha = a_0 \cdot p \cdot \exp\left(-a_1 \cdot \frac{p}{E}\right)$,

where p is the gas pressure and a_i fitting parameters, corresponding to a Maxwellian tail of the *evdf*, while for the remaining range of E/N values good fittings were obtained for the equation $\propto = a_0 \cdot p \cdot \exp\left(-a_1 \left(\frac{p}{E}\right)^{a_2}\right)$, with three independent parameters. The accuracy of the fitting for the obtained formulas is better than 90%.

Based on these results the Paschen curves for these mixtures were obtained using the law: $V_B = \frac{D \cdot p \cdot d}{\ln\left(C \cdot p \cdot d / \ln\left(1/\gamma\right)\right)}$, where d is the gap distance.

The results are compared with those obtained in pure gases.

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