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Processes taking place in the water under the action of low temperature plasma

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Abstract

This paper presents presents the equations for the calculation of some characteristics of the plasma at a known distribution function of electron energy, the dependence of the constants different excitation degrees of freedom in water steam from the E/N.
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1. Introduction

Processing techniques to control the structure and properties of the composite materials are different. Activation of the source components, including water, affect the chemical and physico-chemical processes which cause the matrix structure. Modification of the water is carried in different ways: physical, chemical, combined. Plasma treatment is one way of physical activation.

Plasma methods are effective and useful for oxidation of water and organic substances. They are distinguished by the ability to initiate oxidative processes with the highest oxidative chemical potential (atoms and molecules of oxygen in the electronically excited state). These methods also have low inertia in the restructuring of the operating

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modes. The latter fact is crucial for cases which are characterized by significant variations in time chemical composition, concentrations and ratios of the various components.

The general scheme of action "Non-thermal plasma methods" is as follows [1]. The gas stream to be treated, are passed through the low-region nonequilibrium temperature plasma (discharge region). In the low-temperature nonequilibrium plasma are energetic electrons with the average kinetic energy of 2 -5 eV (this energy corresponds to a temperature 20000-50000K) at concentrations 10^{10} - 10^{13} cm^{-3}. Electrons efficiently transfer their kinetic energy to the internal degrees of freedom of the molecules, without causing significant heating of the processed gas. Selective excitation of internal degrees of freedom leads to dissociation of the numerous highly chemically and environmentally harmless particles, ions, atoms and radicals such N^{2+}, O^{2-}, O^{-}, O, O_3, H, OH, HO_2, metastable molecules N_2*, O_2*, N*, and others nonequilibrium processes is expressed in the fact that in the cold gas creates a very high concentration of active particles, which in equilibrium is achieved only by heating the gas to several thousand degrees.

Formed under the action of plasma active species react with molecules of the components treated medium.

2. Results and discussion

To solve these problems requires knowledge of the mechanisms of physical and chemical processes in plasma - ionization, excitation, dissociation, and chemical transformations. In particular, a major issue is the relation between the contribution of the processes under the influence of electron collisions, the charged particles and radicals, accompanied by various nonequilibrium processes: the excitation of rotational, vibrational and electronic levels of molecules, their dissociation and ionization. The rates of initiation is largely dependent on the function of the electron energy distribution, which is a sufficiently low degree of ionization is nonequilibrium. Distribution function of the electron energy determines such important plasma parameters like the electron drift velocity and coefficient of diffusion. The distribution function of the electron energy is determined by solving the kinetic equations.

The only reliable criterion for evaluating the reliability of a set of cross sections is the agreement of the calculated kinetic coefficients, drift velocity and diffusion coefficients of electrons with the data obtained in the measurements on the drift tubes [2]. This criterion is used traditionally for the correction of cross sections measured in beam experiments as was suggested earlier by Phelps [3]. In finding the scattering cross sections on the basis of the experimental data on the drift tube, special attention should be given to the correctness of the numerical model used for the experimental conditions. In particular, it is necessary to take into account that the value of the same kinetic coefficient is different for different productions of the experiment. This effect becomes significant when motion of electrons in high fields, or in the presence of strong electron sticking [4]. A set of sections satisfying the procedure, called the self-consistent. Currently, such self-consistent set of sections are known for many atoms and molecules [5].

With the known distribution function of the electron energy can be defined such characteristics of the plasma, such as: drift velocity of electrons in an electric field

$$v_{avg} = -\frac{1}{3}\left(\frac{2e}{m}\right)^{1/2}\left(\frac{E}{N}\right)\int_0^\infty 4\frac{df}{du}\left[\sum_j I_j Q_{MJ}\right]^{-1} du \quad (1)$$

the average electron energy

$$u_{avg} = \int_0^\infty u^{3/2} f(u)du \quad (2)$$

electron diffusion coefficient

$$D = \frac{1}{3N}\left(\frac{2e}{m}\right)^{1/2}\int_0^\infty u\left[\sum_j y_j Q_{mj}\right]^{-1} f(u)du \quad (3)$$

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