ABOUT PERIODIC HETEROGENETICALTY IN CONSTUCTION OF OZONIZERS

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ABSTRACT

In this paper justifying of the expediency of from smooth surfaces of internal electrodes of ozonizers to constructions with the internal electrodes representing periodic variable structure, formed with artificial the created relief of a surface. The offered constructions promote amplification of a field due of heterogeneity on the ledges of relief's with coefficient of amplification of a field 4,25 and 7 for various variants of internal electrodes, that provides growth of energy of electrons up to 20 eV.

Keywords: ozonizers, electrodes, expediency, heterogeneity, structure.

I. INTRODUCTION

Present time for electrosynthesis of ozone are using by the various kinds of electric discharges. In each concrete case apply such version of the discharge where are required the certain elementary processes which are responsible for conditions of passage of a current through gases. The main requirement for all ozonizers is reduction of losses in an active zone, i.e. power efficiency of productivity. For the electric materials applied in reactors of synthesis, it is expedient to use activation by the lowtemperature nonequilibrium electric discharges: corona, decaying, barrier, combustion, which general similarity is the small expense of putting energy to the heating of a material [1].

Nonequilibrium discharges are characterized by the strong tear of electronic temperature from temperature of ions and neutral atoms, i.e. T_e>>T_i>T_n. In these kinds of the discharge the energy received by the "hot" electrons from an electric field, is expense to the processes of ionization, excitation and dissociation of molecules of gas, and at presence of in a discharge gap of small-dispersion dielectric filler also to the atoms of a superficial layer. All these processes lead to creation in volume of favorable conditions for increasing of speed of formation of ozone in ozonizers. The above nonequilibrium, the less energy it is expense for heating of gas. For example, the arc discharge for synthesis of ozone is unsuitable because of a small degree of nonequilibrium as the basic part of the energy putting in the discharge, going to the heating of gas or limiting of reactor surfaces. From literary data follows, that by the degree of nonequilibrium it is possible to arrange discharges in a following line [2]: Cover of corona discharge, barrier, combustion, decaying, spark, arc. Electric discharges at ultrahigh frequencies, depending on speed of input of energy and its "channels" of dissipation, can have a various degree of nonequilibrium.

II. MAIN PART

All nonequilibrium forms of the discharge develop in discrete intervals in the fields of a high intensity: nonequilibrium and strong fields - these two conditions are indissolubly connected with each other. Physically reduction of a degree of nonequilibrium, i.e. reduction of difference T_e - T_i, can occur only at decreasing in intensity of a field in an active zone of the discharge.

Last years at creation of ozonizers, basically, using of barrier discharges. Depending on values of multiplying of pressure *p* and extents of a gas gap *d (pd)* the barrier discharge can exist in two forms [3]. At atmospheric pressure of gas value *(pd)* practically for all real gaps always more than some critical value $(pd)_{кг}$, i.e. separate sites of a surface of a reactor "are charged" through multiavalanche formations independently from each other. The size of microflashes and distances between them the same order, as thickness of a gas gap *d.* In microdischarges localized charged particles having high energies therefore separately taken microdischarge possesses destructive action are localized, destroying molecules up to free atoms and radicals. The primary active particles which have formed here (basically электроны) quickly get in lowtemperature environment where accelerate processes of ozonization.

Dielectrics, putted by a uniform layer on a surface of electrodes in the barrier discharge, except for an intensification of the discharge, play a role of stabilizing resistance. At greater voltage between the electrodes covered with dielectric, charges are not allocated (as at metal electrodes), and some equipotentiality is achieved them «spreading» on a surface and that microdischarges arise chaotically, in casual places [4], on natural микроheterogeneityях, the roughnesses which are available even on smooth surfaces of internal electrodes of ozonizers. For avoidance of localizations of discharges it was offered to apply various periodic variable structures to internal electrodes [5].

In this paper justifying of the expediency of from smooth surfaces of internal electrodes of ozonizers to constructions with the internal electrodes representing periodic variable structure, formed with artificial the created relief of a surface.

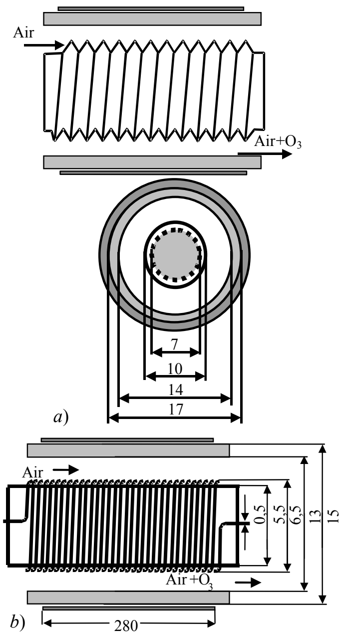
In figure brings two variants of realization of such periodic heterogeneity: on an internal electrode is putted carving so, that each of its each element represents a triangle with height of 0,15cm and on an internal dielectric electrode by the spiral the metal wire with radius 0,025 cm is densely reeled.

Necessity of creation periodic relief heterogeneity was caused by that on the one hand, there was an opportunity of creation on them adjustable localization of microdischarges which are a source high-energy electron, participating in formation of ozone. On the other hand, the increasing of the area of a surface of an internal electrode leads to reduction of density of a current that promotes to the reduction of heating and destruction of an electrode and consequently increases service life of ozonizers. Simultaneously, such structure provides multiple interaction of atoms and molecules of made up gas with periodic intensive zones of a discharge gap, and turbulence of current of air promotes more effective cooling of an active zone.

Let's estimate a degree of heterogeneity of an electric field of both kinds of the above-stated constructions of the central electrodes. Usually, as is known from the literature [6], the degree of heterogeneity of a field f is defined by the formula $f = E_{\max}/E_{AV}$. Here for E_{AV} accept average intensity of a field between electrodes $E_{AV} = U/(R-r)$, where U - the enclosed voltage, R-r - distance between external and internal cylindrical coaxial electrodes with radiuses R and r, accordingly, E_{max} - a field defined by the formula, on a surface of an internal electrode. Such approach to definition f does not consider heterogeneity of the field created by a roughness of a surface of an internal electrode. In case of which takes place in a construction considered by us, for calculation of heterogeneity of a field it is necessary to take advantage of concept of increase of a field near of the sharp ledge which is characterized by the aspect relation [7]. At distance between electrodes L amplification of intensity of a field $f_{A.F.}$ on a ledge with small radius of curvature a is defined by expression:

$$f = A\frac{L}{a} \tag{1}$$

where A - the numerical coefficient close to 0,2.



Periodical heterogenic of relief of active elements of ozonizer (sizes given in mm).
a) Internal electrode with putted carving.
b) Internal electrode from metal spiral, densely reeled on dialectical core.

Thus, an electric field near to a ledge, which is characterized by the aspect relation L/a, (where L - in our case distance between the cylindrical coaxial electrodes, equal R-r) approximately to 0,2× (L/a) time exceeds an average by volume value. It is necessary to note, that the coefficient of amplification is rather sensitive to the geometrical form of a ledge. Such ledges in our case are the measured radius of curvature of top of carving cutting of an internal electrode (a = 0,01 cm) and the heterogeneity, created the thin metal wire densely reeled on a cylindrical glass tube of small radius. This wire creates on a surface of dielectric ledges with radius of curvature a = 0,025 cm Hence, for an estimation of a degree of the heterogeneity of an electric field created by us it is necessary to use of the formula (1). Estimations of heterogeneity for a case *(a)* give size of the order 7, and for a case *(b)* - 4,25. It is accepted, that [6, p. 8-9] sharply heterogenic fields are considered for which coefficient of heterogeneity $f \geq 4$, but in poorly heterogenic fields $f \leq 1{,}6\text{-}2$. Thus, it is possible to tell, that in considered by us both of the types of constructions it is possible to consider strongly of a field heterogenic. For heterogenic field average energy of electrons, participating in elementary acts of interaction in volume of a discharge gap, it is possible approximately to calculate by the formula [8]:

$$W_{E,AV} = 8{,}63 \cdot 10^{-4} \cdot T\left[21 + 33\lg\left(\frac{0{,}5}{d} + 44\right)\right], \qquad (2)$$

where d-length of a discharge gap, in centimeters, T-absolute temperature of gas, $W_{E,AV}$ -energy of electrons in electronvolts. Should to note, that in ozonizers the working range on temperature of a discharge gap considers an interval from 15 up to 32 ^{0}C. At high temperatures its begins oxidation of nitrogen and formation of ozone stops [9].

The calculations lead by the formula (2) show, that for both considered constructions average energy of electrons hesitate from 18,83 eV at T=288 K up to 19,95 eV at temperature T=308 K. This energy of electrons is quite enough for activation of processes of formatting.

III. CONCLUSION

Measurements of productivity of ozonizers have indeed shown, that with other conditions, an output of ozone in case of with is artificial the created periodic relief of a surface essentially above, than in smooth structures.

Thus, it is possible to conclude, that transition in constructions of ozonizers to periodic variable structures increases efficiency of formatting.

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