THE COURSE OF OZONE PRODUCTION IN ALL-METAL DEVICE

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ABSTRACT

A metal ozonizer with a polyester dielectrical barrier has been studied and compared a commercial laboratory device, containing a glass electrode. A significant decrease of energy consumption at the same range of ozone concentration has been observed.

1. INTRODUCTION

Almost all ozonizers exploited, as laboratory devices, as technical plants, contain a glass dielectrical barrier. It is necessary for the stabilization of silent discharges because every development of a spark /spark discharges/ causes decrease of ozone concentration and apperarance of a significaut amount of nitrogen oxides in the discharge gap.
Ozone finds the largest application in the technology of water supply. For that purpose the concentration of ozone, in the range of 20 g/m^3, easy obtained in ozonizers with glass barrier, is sufficiently high. /1,2/.
The increase of ozone concentration is possible, but it causes increase of energy consumption and decrease of productivity of a plant.
The part of electrical energy, used for the ozone synthesis is always relatively small. Most of it is lost for heating substrate gas and the dielectric layer. The energy loss in glass depends on its conductivy /or on the capacitance/ and consequently on its thickness. On the other hand the thickness of on cannot be less, than it is necessary for the mechanical strength of the electrode. In many papers the possibility of replacing glass by other dielectric hard stiff material has been studied /2/. In the present paper a laboratory set-up in which a thin layer of condensor-material has been used as a dielectrical is described. The results of experiments, including the determination of final ozone concentrations, and of energy consumption and productivity of the device, have been compared to the data concerning a commercial ozonizer /with glass barrier/.

2. EXPERIMENTAL

A developed type of an ozonizer with a polyester layer /fig.1/ is equipped with two metal electrodes. The inner aluminium electrode is covered with dielectric and the outer one is made of stainless steel. Both electrodes are cooled. The thickness of the layer is of the range 0,15 mm. For the comparison a commercial ozonizer with a metalic inside electrode and metalized outside glass electrode has been tested. As substrate gas in

both cases purified and carefully dried air has been used. The range of variability of applied parameters was the following: the air flow 5...200 dm^3/h, the discharge power 15...40 W, the voltage on the electrodes is 3,75 - 4,35 kV.

3. RESULTS

On the basis of experiments it has been proved, that an all-metal device with polyester layer is better, than a traditional glass ozonizer /fig.2...5/. The ozone concentrations are higher and energy consumption lower. Also the productivity of the new type of an ozonizer is better as far as the range of product concentrations useful for industrial production is concerned. The obtained results have given the basis for the calculation of the constants to the equation, describing ozone concentration obtained in silent discharges with simultaneous chemical reaction /5,6/:

$$y_{O_3} = y_{lim}\left[1 - \exp\left(-k \cdot P/\dot{V}\right)\right]$$

where:

y_{O_3} - ozone concentration
P - discharge power
$\dot{V}$ - the rate of air flow
y_{lim} - the limit values of the ozone-concentration

This equation is related to the kinetic description of the processes by the assumption, that the rate of the reaction is proportional to the discharge power. In this formula diffusion is not taken into the account.
If the equation describing the rate of reaction can be presented in the following form:

$$r_{O_3} = \frac{d\,y_{/O_3/}}{d\,t} = k_o \cdot P/\dot{V} - k_1 \cdot y_{O_3} \cdot P/\dot{V}$$

it is possible to calculate the constants on the basis of the results obtained in the paper. Calculated values are presented in the table 1.

Table 1 - Rate-coefficients calculated for the eguation describing the process of ozone synthesis.

	k_o $kgO_3/J \cdot x10^{-8}$	k_1 $m^3/J x10^{-5}$	y_{lim} $kgO_3/m^3 x10^{-3}$
glass ozonizer 4,35 kV	1,2663	0,02477	51,12
polyester ozonizer 3,75 kV	1,6918	0,02507	67,48

In both types of ozonizers the rate of ozone destruction is of the same range, but the rate of production is higher in the

ozonizer with a polyester layer. Consequently the limit concentrations of ozone, obtained in the device with the polyester layer increase in comparison with the glass ozonizer. Of course the energy concumption decreases.

CONCLUSIONS

An ozonizer with a polyester layer less sensitive to shocksand mechanical damages than ozonizers containing glass dielectric. It has been also experimentally proved that it is characterized by stable work, the ability of producing high /40-50 g/m^3/ concentrations of O_3 from air, comparatively low energy consumption. The productivity of one-element small set up is comparable and even superior to some laboratory commercial ozonizers.

REFERENCES

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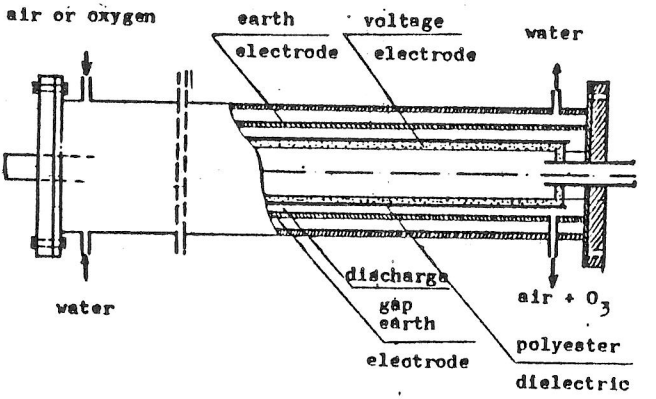

Fig.1 The schema of the ozonizer

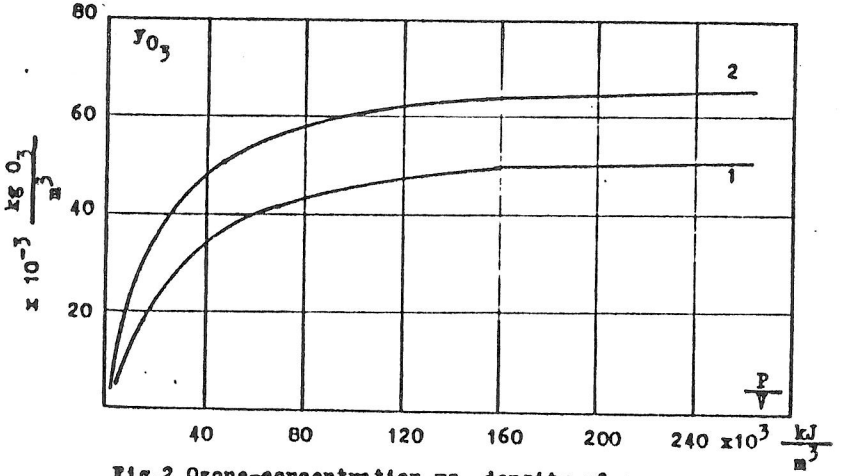

Fig.2 Ozone-concentration vs. density of energy
Curve 1 glass ozonizer U = 4,35 kV
Curve 2 set-up with polyester layer U = 3,75 kV

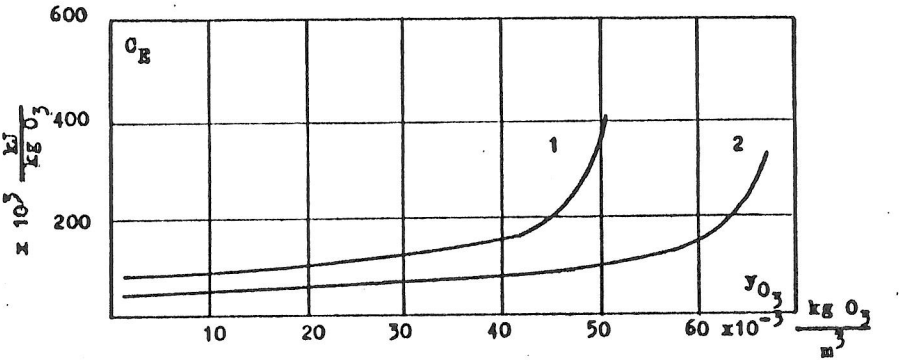

Fig.3 Energy consuption vs. ozone concentration
Curve 1 glass ozonizer U= 4,35 kV
Curve 2 set-up with polyester layer U=3,75 kV

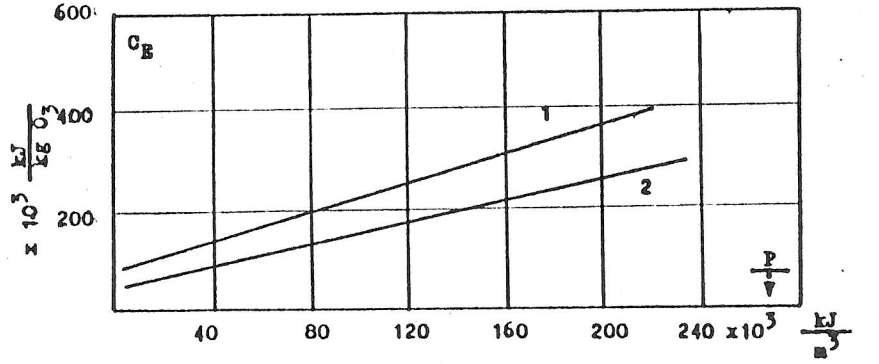

Fig.4 Energy consumption vs. density of energy
Curve 1 glass ozonizer
Curve 2 set-up with polyester layer

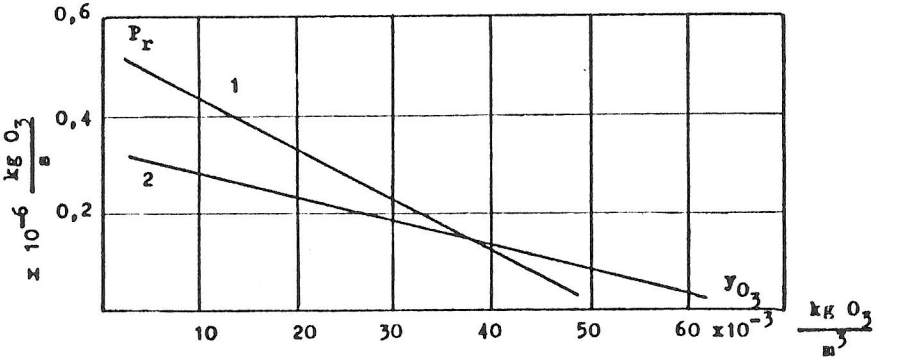

Fig.5 Productivity of the devices vs. ozone concentration
Curve 1 glass ozonizer U = 4,35 kV
Curve 2 set-up with polyester layer U = 3,75 kV