SYNTHESIS OF PURE OZONE BY NANOSECOND DISCHARGE AT CRYOGENIC TEMPERATURES

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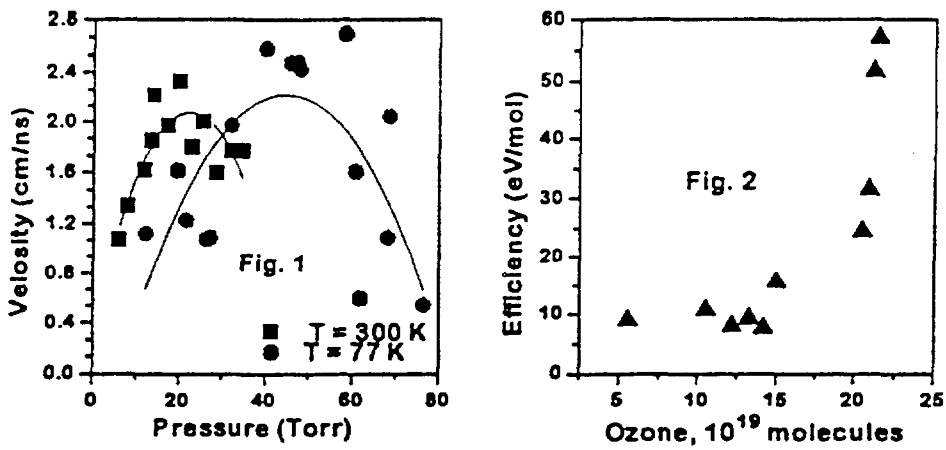
It was recognized that the energy yield of ozone generation was greatly increased at very low temperatures [1]. Basic benefit of ozone is that ozone is an ice or liquid at a near liquid nitrogen temperature. Ozone production at medium pressure DC glow discharge positive column was proposed. 40-45 % of the conversion of oxygen was obtained used liquid nitrogen cooling. The energy yield as high as 600 [g/kWh] was observed from experiments [1]. The maximum ozone energy yield in DC glow discharge is obtained at gas pressure in the 0,5-2 Torr. At such pressures the productivity is limited because a main reaction of ozone productions is quadratic in pressure.

To overcome these difficulties the discharge in the form of breakdown waves has been proposed. This wave occurs at sufficiently high initial electron concentration and fast increasing of the potential of the electrode in the vicinity of which a wave of the space charge is formed..

The similarity of electric breakdown waves [2] propagating in shielded discharge tubes, the heat regime and the estimation of ozone concentration necessary to condensation were taken into account to determine the geometry of the discharge tube. This was made of quartz and was 48 cm long and of 8 mm internal diameter. The electromagnetic screen had a diameter of 10 mm. The reduced oxygen pressure in the tube was within the range 1-100 torr.

To determine the discharge parameters (current, power, energy per pulse, voltage) the pulse reflector method was used. Incident and reflected nanosecond pulses were measured in the long line. The measurements were made using the broad-band capacitive divider and the oscillograph having a pass band of 300 MHz. An incident pulse voltage with a peak value range +20 to +25 kV, 20-ns pulse width and with repetition frequency from 10 to 100 Hz was used. The breakdown wave velocity was measured by the appearance of a phase shift between pulsed received from the photomultiplier when the latter was displaced along the tube. The ozone concentration was determined from UV radiation absorption at wavelength $\lambda = 254$ nm.

The wave breakdown in oxygen at room and liquid nitrogen temperatures has been studied in the pressure range from 3 to 70 torr. The velocity of breakdown wave was measured by the method of x-t diagram. It is found that at decreased temperature the position of maximum of the dependence of wave velocity is shifted to the area of higher values of density (Fig. 1). The maximum value of velocity does not depend from temperature and equals to 2 cm/ns. A good matching between the line and the wave breakdown was realized. A high energy transfer efficiency (~ 50%) from line to wave breakdown was measured.



The concentration of ozone in discharge was measured at room and liquid nitrogen temperatures. The quasi stationary concentration at 300 K is in good agreement with known data [3]. It is found that at the pulse frequency regime the ozone concentration produced after each pulse is higher than value of density of saturated vapor at walls temperature that is equaled to liquid nitrogen temperature. Typical time dependence of ozone concentration has a maximum between high voltage pulses at cryogenic temperatures. Such a dependence could be explained by diffusion of ozone to the walls at which a condensation was developed. The average ozone concentration in the volume of the discharge tube was less at cryogenic temperatures than at room temperatures.

The production of condensed ozone have been determined by measuring the ozone concentration when the walls was heated and ozone evaporated. The density of evaporated ozone was in many values higher than density of oxygen in the discharge reactor at which the accumulation of condensed ozone was produced. The maximum of achieved gas ozone pressure was 0.5 atm with life time of ten hours when the discharge tube had a diameter 8 mm, that was much more than known quenching diameter.

The energy yield of ozone generation at cryogenic temperatures has been calculated. The maximum value was 200 g/kWh. The investigation of the accumulation and destruction of condensed ozone showed that the accumulation of ozone in the discharge tube decreased the energetic efficiency of synthesis. Fig. 2 is a plot of the energetic efficiency against the amount of condensed ozone.

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