POTENTIAL VARIATION OF DISCHARGE PULSES IN AIR AT LOW PRESSURES

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(*Received* 1 *May* 1971 ; *revised* 9 *October* 1971)

A decrease and/or increase of the discharge current ratio $(5i/50i)$, the ratio of the discharge current for 5 volts discriminator bias to that for 50 volts discriminator bias, under irradiation is studied in air filled ozonizers excited by a.c. potentials kV of 50 cycles. sec.$^{-1}$ frequency. Results are in accord with Joshi's theory which consider that external light emits photo-electrons from an adsorption like electrode layer formed with ions and molecules of the gas on the glass wall of the discharge tube. These photo-electrons are captured by excited atoms to form also moving negative ions and bearing about the decrease in $5i_L/50i_L$ as a space charge effect. The positive effect, $+\triangle(5i/50i)$, is also explained by the electronic work function at the boundary layer.

Earlier work[1-7] on photo-variation of discharge current showed that the occurrence of $-\triangle i$ and $+\triangle i$, i.e. negative and positive Joshi effect, is based on the surface origin of the phenomenon. In the present investigations, the production of $\triangle(5i/50i)$, the net ratio of the discharge current for 5 volts discriminator bias to that for 50 volts discriminator bias, is studied. The explanation of this negative and positive effect [$\mp\triangle(5i/50i)$] can be explained on Joshi's theory.

Two Siemen-type-ozonizers of different electrodes spacing and various volumes of space compartments were selected for this investigation. The output of the constant voltage transformer was connected to the input of the variac and the primary of high tension transformer. The inner high tension (H. T.), electrode was formed by using salt solution ($NaCl$) and was connected to the secondary of high tension transformer and was earthed. The outer, low tension (L. T.), electrode was also formed by the same electrolyte and was grounded through an electronic scaler (SS361A, Atomic Energy Establishment, Trombay, Bombay). The first ozonizer, in which the pressure of dry air was 4 mm, was irradiated with a 250 W; 30 cm distant and the second discharge tube, in which the pressure of the same gas was 10 mm, was irradiated by a 15 W; 30 cm distant incandescent lamp. The counts were measured in dark and light for both the values of bias such as 5 and 50 volts. From the measured values of the current, $\triangle(5C/50C)$ or $\triangle(5i/50i)$ was obtained by using the relation

$$\frac{5C_L}{50C_L} - \frac{5C_D}{50C_D} = +\triangle\frac{5C}{50C},$$

where $5C_D/50C_D$ and $5C_L/50C_L$ is the ratio of the discharge counts measured with an electronic scaler at a given time for 5 V discriminator bias to that for 50 V discriminator bias in dark and under visible light respectively.

The results in Table 1 show that $5C_D/50C_D$ increased initially with the applied kV, reached a maximum and then decreased gradually. A marked positive effect, $+\triangle(5C/50C)$, occurred in the voltage range 0·56—1·40 kV. A large applied kV than 1·40 kV revealed the more familiar negative effect $-\triangle(5C/50C)$ and this effect decreased numerically to a negative minimum as the applied voltage was increased progressively. According to Joshi[1], external light releases photo-electrons from a boundary layer of ions and excited molecules assumed to exist on the electrode surface; these photo-electrons are captured in secondary processes by excited particles, atoms or/and radicals with large electron affinity to form slow moving negative ions which reduce the ratio of the discharge count rate $5C_L/50C_L$ as a space charge effect. The above results are significant and suggestive as regards the occurrence of $+\triangle(5C/50C)$ with $-\triangle(5C/50C)$ at $V > V_m$ (threshold potential), observed with a scaler, may be due to primary action of light on the electrode surface[8] causing $+\triangle(5C/50C)$ and secondary processes leading to $-\triangle(5C/50C)$. Joshi's hypothesis[1] seems, therefore, to be their co-occurrence as well as mutual inversion, i.e., sign reversal[9], by only a change in applied voltage[10] and nature of irradiation[11-15].

It is seen from the results of Table 1 that the influence of potential on $\triangle(5C/50C)$ recorded using a counter to the system under a.c. discharge indicated that $5C_L/50C_L$ was practically giving more positive effect [$(+\triangle 5C/50C)$] over the potential range of 0·42—2·73 kV. This effect increased from 0 to $+3{\cdot}79$

TABLE 1

INFLUENCE OF POTENTIAL ON $5C/50C$

Pressure of air : 4 mm Hg.
Source of irradiation :—250 W, 30 cm distant incandescent glass bulb.

V(kV)	$\frac{5C_D}{50C_D}$	$\frac{5C_L}{50C_L}$	$\Delta\left(\frac{5C}{50C}\right)$
	(in arbitrary units)		
0·56	28·19	∞	+ ∞
0·84	108·50	∞	+ ∞
1·12	251·76	∞	+ ∞
1·40	82·86	∞	+ ∞
1·96	70·62	38·80	—31·82
2·52	56·20	43·04	—13·16
3·36	41·42	40·53	— 0·89

Pressure of air : 10 mm Hg
Source of irradiation :—15 W, 30 cm distant incandescent glass bulb.

V(kV)	$\frac{5C_D}{50C_D}$	$\frac{5C}{50C}$	$\Delta\left(-\frac{5C}{50C}\right)$
	(in arbitrary units)		
0·42	∞	∞	0
0·84	0·51	0·52	+0·01
1·26	2·78	3·01	+0·23
1·68	10·91	14·70	+3·79
2·10	40·93	43·95	+3·02
2·52	7·98	11·88	+3·90
2·73	4·52	4·72	+0·20

Frequency of a.c. supply : 50 cycles/sec ; System temperature : 27°C ; counting time : 5 minutes.

in the voltage range 0·42—1·68 kV at room temperature (27°C) and then varied irregularly between +3·02 to 0·20. In dry air at 4 mm pressure under 250 W; 30 cm distant electric (glass) bulb a very prominent positive effect, $+\Delta(5C/50C)$, was observed over a large kV-range and a less negative effect, $-\Delta(5C/50C)$ was observed at very high kV. Compare with air at a pressure of 10 mm, $5C_L/50C_L$ was much smaller under 18 W and positive effect was weaker. A positive effect can be explained by considering adsorption as a function of potential. Since the adsorption increases with kV, it may be assumed that the primary adsorption layer is built up slowly as kV is increased progressively from a low initial value. The electronic work function at the electrode layer may decrease with and reach a minimum when the formation of the monolayer is complete. The $+\Delta(5C/50C)$ with kV may be attributed to the decreased electronic work function associated with the further reduction of the secondary layer(s).

The $-\Delta(5C/50C)$ and $+\Delta(5C/50C)$ effect can possibly explain the decrease and increase in $5C/50C$ under irradiation due to photoemission from the wall of the electrode surface. This photoemission itself depends upon intensity and the frequency of irradiation, and $5C/50C$ also depends on these two factors.

ACKNOWLEDGEMENTS

The author wishes to express his grateful thanks to Prof. S. S. Joshi and **Prof. H. J. Arnikar for giving him encouragement and facilities for carrying out the present work. He wishes to express his** gratitude to Mr. S. S. Sardesai for his assistance in the experimental work.

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