charger with the detonation products is effected. In the experiments at increased pressure, a displacement of the cathode spots to the region of large electrode curvatures was observed.

The lower electrical stability in comparison with air and the increase of this difference with increase of pressure are common for the detonation products of all the explosives investigated. It should be noted that the electrical stability of the detonation products for the first breakdowns after filling the discharger is lower than for subsequent breakdowns. For example, with Trotyl 20-30 min after explosion, it was 25% less than the asymptotic stability for a large number of breakdowns. Over 24 h, this difference amounted to 15%. Similar experiments with ÉVV-8G gave, respectively, 50% lower stability 20-30 min after explosion of the charge and 25% after 24 h. The same tendency for the other explosives investigated is expressed to a considerably lesser degree (order of experimental accuracy 5-7%).

The dependence of the electrical stability of the detonation products on the time between the explosion of the charge and the application of the voltage to the discharger, and also the increase of stability of the gap with increasing number of breakdowns, can be explained by the continuing chemical reactions in the detonation products. The intermediate products, having a lower ionization potential by comparison with the final detonation products, burn up with the passage of time, and in the spark this same process occurs more rapidly. The weaker decrease of stability of the dispersing detonation products [2] after explosion of the charge as compared to the corresponding measurements of their density can also be explained by this.

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PROBLEM OF DETERMINING ION COLLECTION EFFICIENCY IN LIQUID IONIZATION CHAMBERS

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In certain areas of physics, in particular, in ionizing radiation dosimetry employing liquid ionization chambers, the necessity of measuring the ion collection efficiency in liquids is encountered. Measurement of the ionization current is carried out by means of complex measurement devices. The saturation current of a liquid is difficult to obtain even with voltages which are close to breakdown, and therefore its determination is frequently carried out by an extrapolation method.

It is possible to determine the ion collection efficiency in dielectric liquids by a method using the ponderomotive forces (PMF) of an electric field. For this purpose, a pair of electrodes of known width a, height h_e, and fixed interelectrode separation d is partially immersed in the dielectric liquid, poured into a vessel (see Fig. 1). This system, which has a certain capacitance C and high dielectric properties, is charged from an electric voltage source to a certain potential difference U_0. In consequence of the action of the PMF, in the interelectrode gap a rise of the liquid dielectric to a certain height h_0 is observed, determined by the equation [1]

$$h_0 = \frac{\varepsilon_0(\varepsilon_l - \varepsilon_g)U_0^2}{2\rho g d^2 \cos\varphi},$$

where ε_l and ε_g are the relative dielectric constants of the liquid and gaseous dielectrics, respectively; ρ is the density of the liquid dielectric; ε_0 is the electrical constant; g is the acceleration of gravity; and φ is the angle between the longitudinal axis of the electrodes and the direction of the force of gravity.

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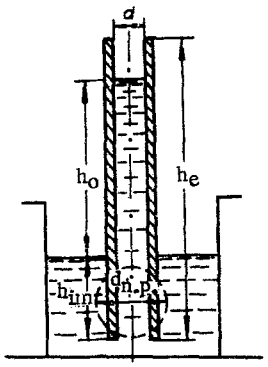

Fig. 1

TABLE 1

Exp. No.	t, sec	Efficiency f		$E_t \cdot 10^6$, V/m	
		P_1=3,04rad/min $\tau(P)_1$ = 192 sec	P_2=3,642 rad/min $\tau(P)_2$ = 162 sec	$\tau(P)_1$= =192 sec	$\tau(P)_2$= =162 sec
1	15	0,17401	0,17194	3,7	3,67
2	25	0,16443	0,16095	3,52	3,43
3	50	0,14204	0,13561	3,08	2,94
4	75	0,12190	0,11334	2,71	2,52
5	100	0,10394	0,09400	2,38	2,16
6	150	0,07406	0,06300	1,83	1,59
7	200	0,05103	0,04028	1,41	1,17
8	300	0,02010	0,01200	0,84	0,63
9	350	—	0,00356	0,64	0,465
10	400	0,00261	—	0,496	0,348

After switching off the power supply, in consequence of self-discharge, the height of the column of liquid dielectric decreases according to the exponential law

$$h = h_{im} + h_0 e^{-2t/\tau_0}, \quad (1)$$

where h_{im} is the depth of immersion of the electrodes in the liquid, h_0 is the charge height of the column of liquid, and τ_0 is the time constant of the capacitor in the absence of radiation.

When the interelectrode gap of the charged system is irradiated by directional radiation over the system (see Fig. 1), the law of change of the height of the liquid column remains as before, but the rate of descent of the liquid increases:

$$h = h_{im} + h_0 e^{-2t/\tau(P)}, \quad (2)$$

where $\tau(P)$ is the time constant of the capacitor for an absorbed dose intensity of ionizing radiation P.

By recording the height of the liquid column at different instants t during self-discharge and irradiation, we can determine τ_0 and $\tau(P)$ by Eqs. (1) and (2).

The experiment shows that the time constants of such a capacitor [τ_0 and $\tau(P)$] are independent of the height of the liquid column between the electrodes [2].

The transition processes in the charged capacitor are described by an equation of the type [2, 3]

$$R(h, P)dq/dt + q/C(h) = 0, \quad \tau(P)dq/dt + q = 0,$$

the solution of which is the function

$$q = q_0 e^{-t/\tau(P)}, \quad (3)$$

where q and q_0 are the electric charges of the capacitor at times t and t = 0, respectively; R(h, P) and C(h) are the electrical resistance and capacitance of the condenser.

It is well known that the change of electrical voltage on the electrodes of a charged capacitor for an irradiation time t is determined by the equation [4].

$$\Delta U = \int_0^t \frac{fNeVdt}{C} = \int_0^t \frac{fPVdt}{C_{un} + \Delta Ce^{-2t/\tau(P)}},$$

where f is the ion collection efficiency in the liquid; N is the number of ion pairs formed in unit time in unit volume of liquid for irradiation with an absorbed dose intensity P; e is the ion charge; $V = add_{n.p.}$ is the irradiated volume of dielectric liquid with small d; C is the electrical capacitance of the condenser; C_{un} is the uncharged condenser capacitance and ΔC is the change of capacitance of the condenser due to the descent of the liquid between the electrodes by a charge height h_0.

In accordance with the solution (3), the change of the electrical potential of the capacitor due to irradiation, taking account of self-discharge, can be expressed in the form

$$\Delta U = \int_0^t \frac{fPVdt}{C_{un} + \Delta Ce^{-2t/\tau(P)}} = \frac{q_0(1 - e^{-t/\tau(P)})}{C_{un} + \Delta Ce^{-2t/\tau(P)}} - \frac{q_0(1 - e^{-t/\tau_0})}{C_{un} + \Delta Ce^{-2t/\tau_0}}. \quad (4)$$

Differentiating Eq. (4) and carrying out transformations, we obtain the expression for the ion collection efficiency:

$$f = \frac{q_0 e^{-t/\tau(P)} \left[C_{un} + \Delta C\left(2e^{-t/\tau(P)} - e^{-2t/\tau(P)}\right)\right]}{PV\tau(P)\left(C_{un} + \Delta Ce^{-2t/\tau(P)}\right)} -$$

$$- \frac{q_0 e^{-t/\tau_0}\left[C_{un} + \Delta C\left(2e^{-t/\tau_0} - e^{-2t/\tau_0}\right)\right]\left(C_{un} + \Delta Ce^{-2t/\tau(P)}\right)}{PV\tau_0\left(C_{un} + \Delta Ce^{-2t/\tau_0}\right)^2}.$$

A defined ion collection efficiency occurs for an electric field strength in the interelectrode space calculated by the equation.

$$E_t = E_0 e^{-t/\tau(P)}.$$

A plane two-phase condenser with purified kerosene ($\varkappa = 1.28 \cdot 10^{14}\ \Omega \cdot m$) as the liquid dielectric was charged to a potential of 4 kV and was irradiated in the UÉDÉ-60-250 standard facility by the scheme of Fig. 1 ($d_{n.p.} = 2$ cm).

The RUM-13 x-ray equipment was used as the radiation source. The kerosene level in the interelectrode space was plotted on a millimeter scale for a specified time, measured by a chronometer from the start of irradiation. The measurement error did not exceed ±0.5 mm and ±0.1 sec.

For the starting data ($\tau_0 = 1200$ sec; $V = 0.2 \cdot 10^{-6}\ m^3$; $C_{un} = 18.8 \cdot 10^{-12}$ F, and $\Delta C = 0.85 \cdot 10^{-12}$ F) and an interelectrode gap width of d = 1 mm, the results of the calculation (on the "Promin" computer) of the ion collection efficiency in ionized kerosene are given in Table 1.

The investigation carried out allows a conclusion to be drawn about the feasibility of determining the ion collection efficiency in ionized dielectric liquids by means of a gas–liquid condenser with a small interelectrode separation using the ponderomotive force of the electric field.

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