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Multispark discharge in water as a method of environmental sustainability problems solution

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The multielectrode slipping (gliding) surface discharge (SSD) developed and tested at the Prokhorov General Physics Institute makes it possible to excite a system of several dense thermally nonequilibrium plasma formations in a liquid medium or in a high pressure gas by relatively small voltage pulses.

The multielectrode discharge system is shown on the Fig.1. When a high-voltage (~ 10 – 15 kV) pulse (with duration ~ 5 -10 μs) is applied to the discharger into the aqueous medium, plasma bunches (plasmoids) appear almost simultaneously in gas bubbles coming through holes made between electrodes. Reasoning from their characteristics these plasmoids generated in the two-phase water-gas medium can be classified (in accordance with recently adopted terminology) as "microplasma" formations, widely used in various applications. According to the results of previously performed experiments the electron concentration in plasmoids attains 10^{17} cm^{-3}, and the gas temperature is 4000 – 5000 K.

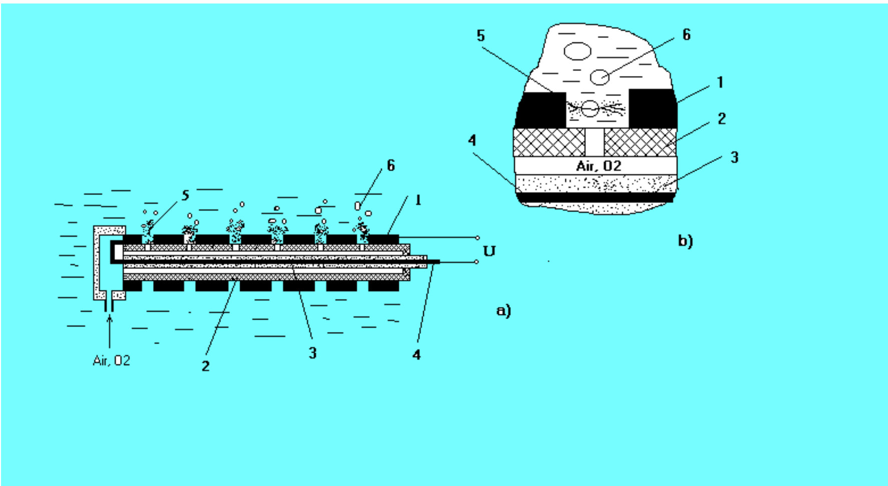

Fig. 1. Multi-electrode gliding surface discharge facility.

1-electrodes; 2,3 – dielectric tube; 4-back-current rod; 5-discharge plasma; 6-gas bubbles.

Multielectrode dischargers (SSDs) exhibit the following general properties:

(i) the discharge excited between the electrodes is a surface slipping discharge (propagating from electrode to electrode over the dielectric surface);

(ii) the discharge under investigation differs from conventional slipping discharges in that the electrodes are in contact not with a homogeneous gaseous medium, but with a water-gas medium (water with bubbles of the gas introduced into the interelectrode gap); the breakdown threshold of the interelectrode gaps is much lower than the breakdown threshold of a homogeneous gaseous as well as homogeneous aqueous medium;

(iii) the area of the surface of all electrodes contacting with water in the multielectrode version can be minimized by introducing insulating dielectric screens ensuring the SSD operation in high-conductivity water (up to conductivities of 10^4 μS cm^{-1}) without substantial reduction of the efficiency of energy supply to the discharge region;

(iv) the discharger has no pointed electrodes, the working surface of the electrodes (unprotected by the dielectric screen) is developed and is either a part of the cylindrical surface of tubular electrodes or the plane surface at the exit sections of the tubes.

Multispark high-current slipping surface discharge in the aqueous medium has been investigated according to the scheme presented on the Fig.2 like a system that bears on a some ecological problems. Among them are following:

- Plasmachemical reactor as an effective device for conversion (recovery) of methane (as well as other natural hydrocarbons) as a gas accompanying oil production;
- Cleaning of water of a natural tanks from pesticides contamination;
- Drinking and waste water cleaning from phenol contaminations;
- Destruction of microorganisms in domestic and industrial wastewaters.

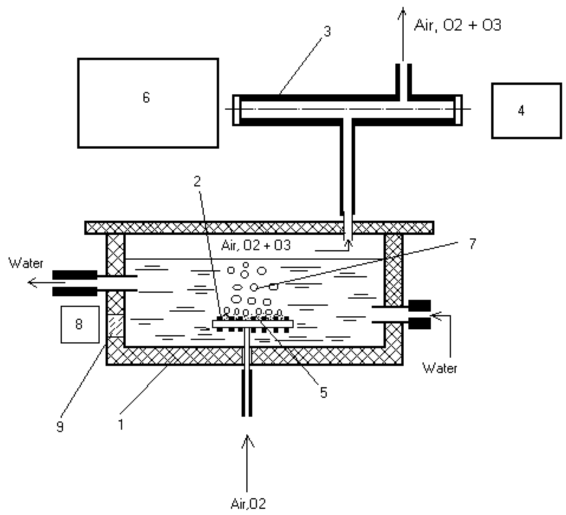

Fig. 2. Experimental layout. 1-vessel filled with water; 2-multi-spark discharger; 3-diagnostic quartz cell;4-deuterium lamp; 5-discharge plasma; 6-MDR-3 monochromator; 7-gas bubbles; 8-MUM-1 monochromator, and 9-quartz window.

Results of experimental investigation of SSD as mean for solving these problems show that such a plasmachemical action on the water manifests very low (sometimes record low) energy cost of treating process. Physical-chemical model explaining these SSD properties has been developed.