PRODUCTION OF CHEMICALLY ACTIVE WATER BY EXPOSING IT TO THE PULSED RADIATION OF SPARK DISCHARGE PLASMA

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It was previously shown that in water under the action of pulsed radiation from a spark discharge plasma, active species are generated: HO2• radicals, hydrogen peroxide, nitrous acid, and a complex (…ONOOH-ONOO−…), which decays into peroxynitrite and peroxynitrous acid [1]. In this work, we measured the concentration of oxidative equivalents in a 5-ml sample of water formed immediately after exposure to radiation for 3 minutes and persisting in water for up to 14 days. The discharge energy per pulse was 0.012 J, pulse repetition rate was 50 Hz. The distance from the water surface to the discharge area was 30 mm. Fricke solution served as a detector of oxidizers, which was introduced into the sample immediately after treatment and then every other day for 14 days after. The concentration of oxidative equivalents was determined by the optical density of the 304 nm band attributable to trivalent iron. The reaction of ferrous iron with oxidizing agents accumulated in the water sample is slow; all oxidizing agents are consumed for 9 days. Therefore, measurements of optical density were carried out 9 days after the introduction of the Fricke solution.

Two modes were used. 1) The direction between the radiation source and the surface of the treated water is open. In this case, all the treated water enters the radiation cone, and the products formed in the discharge can diffuse to the surface of the water and be absorbed in it. This mode will be called "with the light". 2) The direction between the radiation source and the surface of water is blocked by an opaque absorber, but the products formed in the discharge can freely bend around the obstacle and also diffuse to the surface of the water. This mode will be called "no light".

Immediately after "with the light" treatment, the concentration of oxidative equivalents is 22.4 ± 2.5 (mmol. equiv)/L, and "no light" is 20.8 ± 2 (mmol. equiv)/L. Those, the concentration of oxidizing agents within the experimental errors are the same after different processing modes. The concentration of nitrous acid after processing a sample of water for 3 minutes, obtained on the basis of the optical density of the line 371 nm, was: 2.35 ± 0.25 mmol/L in "with the light" mode and 0.65 ± 0.07 mmol/L in "no light" mode. Thus, the concentration of the formed nitrous acid in the regimes "with the light" and "no light" is very different. The concentration of oxidizing agents is about 10 times more the concentration of nitrous acid, therefore, it can be assumed that the main oxidizing agent is a complex (…ONOOH-ONOO−…). This complex interacts with nitrous acid; as a result, the complex itself and nitrous acid are consumed [2]. This can explain the approximately identical yield of oxidative equivalents in the "with the light" and "no light" modes, despite the fact that the yield of nitrous acid in the "with the light" mode is much higher.

Water samples retain oxidative activity up to 10 days, the concentration of oxidative equivalents at 7–10 days after treatment is 0.7–1 (mmol. equiv)/L. The redox potential in the same samples relative to the silver chloride electrode is 620 – 630 mV, the acidity of water is pH = 2.4–2.5. Characteristics of plasma radiation activated water are close to those of plasma activated water.

References

1. I.M. Piskarev, K.A. Astaf'eva, I.P. Ivanova. Biophysics. 2017. V. 62 (4). P. 674–680.
2. I.M. Piskarev. High Energy Chemistry. 2016. V. 50 (5). P. 449–450.