5th Central European Symposium on Plasma Chemistry

Balatonalmádi, Hungary, 25-29 August 2013

Final scientific programme & Book of abstracts

ISBN 978-615-5270-04-8

CHEMICAL AND BACTERICIDAL EFFECTS OF DC TRANSIENT SPARK DISCHARGE ON *E. COLI*

K. Tarabová, B. Tarabová, K. Hensel, Z. Machala

Faculty of Mathematics, Physics and Informatics,
Comenius University, Bratislava, Slovakia
hensel@fmph.uniba.sk

Chemical effects induced by the positive transient spark discharge generated in air (a) above a *water electrode*, or (b) with water *electro-sprayed* through the discharge were investigated and linked with bactericidal effects induced in water contaminated with *Escherichia coli*. The chemical effects induced in the discharge treated water were detected by pH and conductivity probes, concentrations of hydrogen peroxide H_2O_2 and peroxynitrites $ONOO^-$ were evaluated by absorption and fluorescence spectroscopy, and bactericidal effects were measured by plate count method. The water solutions of various initial pH and electrical conductivities were used: phosphate solution mimicking tap water, physiological saline solution, as well as their buffered counterparts.

The discharge setup for *water electrode* experiments (a) consisted of point electrode placed above the adjustable inclined plane with a narrow water channel and flow driven by means of peristaltic pump. The volume and the flow rate of water, the discharge power and the treatment time have been varied. The discharge setup for *electro-spraying* experiments (b) has been described in detail in [1]. The constant water flow rate of 0.5 mL/min and discharge power of 1-2 W were applied. The paper summarizes the results on chemical and bactericidal effects of transient spark discharge generated in both systems. The comparison of the data was performed for the given volume of liquid (5 mL) processed with the constant discharge energy and treatment time.

The results for non-buffered solutions showed that their acidity and conductivity increased almost linearly with the discharge treatment time. After 10 minutes of discharge treatment, the pH of tap water decreased from initial ≈ 5.0-5.5 to 3.5, and of physiological solution from ≈ 6.2 to 2.5-3.0. The conductivity σ of water increased from ≈ 600 μS/cm to 800-900 μS/cm, and of physiological solution from 6.0 to 5.7- 6.4 mS/cm. The temperature of the solutions increased by approximately ≈ 1.5°C. The relative changes in pH, conductivity and temperature in both systems were quite similar. On the other hand, the concentration of H_2O_2 was found higher with the *liquid electrode*: 0.75 and 0.65 mM in tap water and 0.90 and 0.65 in physiological solution were found for *liquid electrode* and *electro-spray* system, respectively. The concentrations of petroxynitrites, nitrites and nitrates and dissolved ozone were evaluated and compared too. The bactericidal efficacy of the discharge expressed as logarithmic reduction of *E. coli* population showed up to ≈ 6-log reduction both in water and saline solutions for *electro-spray* system. With the same discharge energy input and treatment time, logarithmic reduction of only ≈ 3-4 logs in the *water electrode* system was observed. In buffered solutions, significantly lower bactericidal effects were obtained. The higher bactericidal efficacy of the *electro-spray* system is due to the effective contact of the discharge with electro-sprayed water droplets in the high electric field region, compared to the contact of discharge with the liquid layer on the grounded electrode in the *water electrode* system. Synergistic effect of nitrites, nitrates and peroxides in acidic conditions seems to be the most probable mechanism responsible for bactericidal properties of water treated by the air plasma.

Acknowledgement
This work was supported by VEGA 1/0668/11 and APVV SK-RO-0024-12 grants.

References

[1] Z. Machala, B. Tarabová, K. Hensel, et al., *Plasma Process. Polym.* (2013) in press.