OC-36: Effect of Hydrodynamic Cavitation on Microbial Inactivation: Potential for Disinfection Technique

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Effect of hydrodynamic cavitation on disinfection of *E. coli, B. cereus* cells and *B. cereus* spores was investigated in laboratory scale using rotary cavitation device, where multiple factors impact on microorganisms, leading to cellular damage. This study showed that hydrodynamic cavitation is a simple and perspective technique and could be potentially used for water disinfection.

Water disinfection aims at the destruction of hazardous pathogenic microorganisms and, therefore, is the most essential final treatment in a view of human health. The drawbacks of conventional disinfection technologies, for example production of undesirable disinfection by-products, long duration of treatment etc., decrease their efficiency. Therefore, there still is a need for new approaches to reduce the adverse effects of conventional techniques. Application of cavitation is an alternative solution of disinfection problems. Generally, it is believed that at cavitation in the collapse phase high pressures and temperatures are generated leading to homolytic cleavage of water molecules (the theory of ‘hot spot’) with the formation of hydroxyl radicals ·OH (Suslick, 1989). According to the way of cavitation initiation all processes can be divided into of periodic impact (ultrasonic horn, bath), single impact (Venturi tube, orifice plate, throttling valve) and mixed effects (rotary devices of various designs, hydrodynamic sirens and whistles).

The objective of this study was to determinate the direct effect of cavitation, induced by rotary cavitation device (with variable rotation speeds 4000÷11000 rpm) on inactivation of bacteria in water. The experiments were carried out in laboratory scale using as test-organisms vegetative cells of bacterial culture of ***Escherihia coli (E. coli)*** and ***Bacillus cereus (B. cereus), B. cereus*** spores. Initial concentration of cells/spores was~ 2×10^4 colony-forming units CFU/ml. The disinfection efficiency was estimated by counting the number of survived CFU in control and treated samples. To exclude a thermal effect on inactivation all experiments were carried out under water cooling (t=35°C).

The phenomenon of cavitation which associated with the formation, growth and the collapse of microbubbles, leads to the generation of very high pressures and temperatures locally, which can cause cellular damage (Jyoti, 2003). It was found that the treatment efficiency proportionally depended on rotation speed, so the operation mode at 11000 rpm (maximum for our device) was selected for further studies. The disinfection effect was expressed as the $\log_{10}$ reduction in CFU, before (N_0) and after treatment (N). Inactivation of *E. coli* cells was 100% after treatment in one minute. The same efficiency for complete inactivation *B. cereus* cells was achieved after 50 min. In the case of *B. cereus* spores one log reduction was achieved after 90 min of treatment. The experimental value of disinfection obtained for two different test-organisms can be attributed to the fact of different the cell wall structure and content of intracellular components, primarily murein.

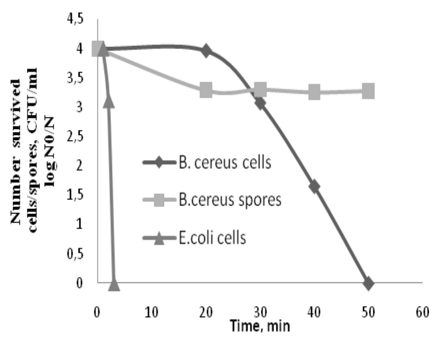

Figure Inactivation of E. coli and B. cereus during treatment. V=0.8 L, 11000 rpm, t=35°C

In rotary cavitation device, water is throttled as it passes through several periodic overlaid gaps between rotor and stator. As a result, multiple factors impact on contaminated water: the turbulent fluctuations, the mechanical effects of the structural elements, the shear stresses in the gaps, intense pulsed acoustic and hydrodynamic cavitation, and hydraulic shocks. That significantly affects the overall disinfection efficiency. Despite incomplete inactivation of *B. cereus* spores, hydrodynamic cavitation treatment provides simple, economic and effective water disinfection.

References

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