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ULTRASONIC ACTION ON THE MICROORGANISMS CELLS

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Introduction

Cavitation is characterized by destructive action on microorganisms in the water medium. However, these effects could have different influence on the cells, depending on the variety of bacteria. Microbes are characterized by different cell sizes and forms of the outer shells, which may have an ambiguous effect on the process of their destruction and its duration under cavitation action. Therefore, the purpose of the present research was to investigate cavitation influence on the microbia destruction, depending on the size of their cells.

Materials and methods

The objects of investigation for destruction process were the following waters: model waters created based on deaerated distilled water with adding some types of microorganisms (MO). *Diplococcus*, *Pseudomonas fluorescens*, *Bacillus cereus*, *Sarcina lutea* bacterias and *Saccharomyces* yeasts were used as microbial cells for investigations. Effective rate constants of cells destruction (k_d) were calculated after combined action of cavitation and gas influence. Oxygen, carbon dioxide, argon and helium were used as an additional source of bubbles in an aqueous medium and were bubbled during whole process of cavitation action on the cell in the water medium. Saturation of the treated aqueous medium by gases of different nature created additional cavitational embryos in reactive zone. Hence, simultaneous action of gas and cavitation, namely Ar/US, He/US, O_2/US), CO_2/US on the individual bacterial cells were used.

The source of cavitation was US waves from generator UZDN-2T with oscillation frequency of 22 kHz, power of 91 W and intensity of 1.65 W/cm^3. US oscillation were transmitted by the magnetostrictive emitter immersed into the volume of investigated water (V = 75 cm^3). Experimental conditions were T = 298±1K, P = 0.1MPa, process duration (t) – 2 hours.

A nutrient media for cell growth after cavitation treatment were used: for bacteria – meat water (1dm^3), peptone (10g), agar (15g) and for yeast – malty mash (1dm^3) containing solids (6-8%) and agar (2%). Petri dishes were placed in TS-80M-3 thermostat at the 37^{0}C for 48 h (for bacterial cells) and 30^{0}C for 96 h (for yeast cells).

Results and conclusions

Resistance to different types investigated MO was explained by the result of specific cavitation effects on the cells wall and their intergenetic difference in the structures of cells' wall.

There were created dependencies of effective rate constants of MO dectruction on their cells size under conditions: Ar/US, He/US, O_2/US), CO_2/US.
Demonstrated dependence $k_d = d_{(cells)}$ allowed approximate prediction of destruction effectivity of other MO, respecting their cell size. k_d values as a function of MO size, where the increase of k_d values was observed for larger cells. This pattern was observed for all investigated gases, especially for argon. Hence, MO destruction under cavitation action depends on the nature of gas bubbling during the whole process. The highest effectivity of cells destruction was observated under Ar/US conditions regardless of the size of their cells. It was shown that the cells with larger size are easily tending to destruction by gas/US treatment, i.e. the cell stability in cavitational conditions was reversely proportional to the cell size.
The values of effective rate constants of cells destruction were compared, depending on the gas nature bubbling under cavitation conditions, and it was found that the efficiency of cell destruction under Ar/US was approximatelly in two times larger unlike O_2/US, He/US and CO_2/US, regardless of cell size. It was found that yeast cells were destroyed aproximatelly in two times faster than bacterial cells, that could be explained by larger sizes of yeast cells. It was proved that the processes of MO destruction are described by kinetic equation of the first order, independently on genetic origins of MO, their morphology (shape, size, etc.), initial quantity of cells in the unit of volume of water system and nature of bubbled gas.