MECHANISMS OF THE IMPACT OF HYDRODYNAMIC CAVITATION ON CELLULAR STRUCTURES

Nedbailo A.E., Gozhenko L.P., Ivanitsky G.K.
Institute of Engineering Thermophysics, NAS of Ukraine, Kiev
tel. +38 (044) 424 14 96, ittf_tds@ukr.net

The purpose of this work is to reveal the mechanisms of the effect of cavitation on biological cells to create new technologies and equipment, as well as to improve existing ones.

When extracting plant materials, the intensity of the process is determined by the difference in the concentrations of the target component in the cell and the extractant and the sum of the internal and external resistances. Traditional methods of intensification of extraction, associated with a decrease only in external resistances. Internal resistances, which are orders of magnitude higher than external resistances, consist of resistances of the cell wall and intercellular space. The process of cavitation is caused by a drop in the pressure of the medium to negative values and its instantaneous increase, which causes the emergence of vapor-gas bubbles and their subsequent collapse. This phenomenon can occur inside the cell, which affects the internal resistance of diffusion transfer. At the stage of growth of a gas bubble, a liquid with a target component will be displaced through the cell membrane by filling the cell space with a vapor-gas bubble. Under alternating pressure conditions, this process occurs repeatedly, which causes the maximum yield of the target substance. Complete destruction of the plant cell wall is undesirable, since In addition to the target component, ballast substances will be released into the extract. Therefore, to obtain high-quality extracts, it is necessary to select the optimal parameters of the cavitation process, depending on the specific raw materials.

The mechanisms of cavitation pasteurization and sterilization are based on the destruction of the cell wall of microorganisms. We have considered two possible mechanisms for the destruction of bacterial cells: 1) the impact on the cell wall of shock impulses; 2) the impact of shear stresses, as a result of the superposition of radial flows that occur in the vicinity of their growth and collapse. The evaluation of the magnitude of the shock pulses emitted by the cavitation cluster and the ultimate strength of the investigated microorganisms showed that the shock pulses are commensurate with the strength of the cell wall or exceed it depending on the type of microorganisms. According to the results of theoretical experiments, it was found that the shear rate is 10^5 ... 10^6 s^{-1}, which according to the literature data is enough to destroy most microorganisms. These studies can be used in the development of new equipment. At the same time due attention should be paid to the calculation of process parameters to achieve specific goals.