# PECULIARITIES OF FLUID MEDIUM PERTURBATION UNDER THE INFLUENCE OF ULTRASONIC RADIATION

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**Abstract**
*Most modern biotechnological production facilities face typical challenges during operational processes in equipment used for cultivation, which are related to ensuring effective heat and mass transfer, the presence of turbulent and stagnant zones, high energy consumption, and low heat transfer coefficients when working with viscous fluids. The primary objective of the research was to determine the optimal geometry of the system design for remote influence on the medium in order to control heat and mass transfer processes in bioreactors, as compared to mechanical methods of influence.*
**Keywords:** *bioreactor, aberration, caustic zone*

**Introduction**. In most industries that encounter liquid and gaseous media, one of the fundamental processes is the mixing process – a process based on bringing two or more mobile phases into close contact with a stationary medium to obtain a uniform distribution of one phase over the other, intensification of heat and mass transfer processes and conducting a chemical reaction. Biotechnology is one of the top priority industrial sectors, which puts forward certain requirements for typical technological processes. For example, the mixing process is found in almost every industry, but in most of these industries the question arises not only about conducting a quality process, as evidenced by the equalization of concentration throughout the medium, but also do not allow foreign components to enter the mixed environment [1].

The most common way to carry out the mixing process is to apply energy through mechanical stirring with a mixer. To implement the proposed method, it is necessary to introduce a shaft of a mixing device with a stirrer mounted on the shaft, but in this case a number of problems arise, the main one is the sealing of the shaft insertion point. Main difficulties in the simulation of mechanical mixing in the turbulent regime arise from the change in the scale of turbulence (the size of the vortex and the path of its mixing). In a small volume of the apparatus, the scale of turbulence is correspondingly small and the mixing is carried out more intensively than in a large volume of apparatus [2]. Firstly, the shaft seal does not guarantee that the leakage of foreign microorganisms and contaminants from penetrating the apparatus's volume, and secondly, the establishment of any seal results in a loss of friction power in it.

Also, the main difficulties in modelling mechanical mixing in a turbulent mode arise due to a change in the scale of turbulence (the size of the vortex and its mixing path). In a small volume of the apparatus, the scale of turbulence is accordingly small and mixing is carried out more intensively than in a large volume of the apparatus [3].

Another possible way is the supply of energy due to air or oxygen bubbles that pass evenly through the layer of the working fluid, this method is more appropriate from the point of view of preventing the ingress of foreign substances, but is accompanied by the formation of stagnant zones in the volume of the apparatus, and also has a significantly lower specific productivity in Comparison with mechanical energy supply.

**Materials and methods.** The study was conducted on a test bench, based on a UZK-700-35 cascade ultrasonic emitter, a rod emitter with a total power of 700 W and an ultrasound frequency of 35 ± 2.0 kHz, mounted in a specific stainless steel shell section.

In the field of ultrasonic radiation is placed a cylindrical glass container filled with liquid. A metal square is inserted into the volume of the fluid and attached to one side, exactly in the middle of that side (Figure 1).

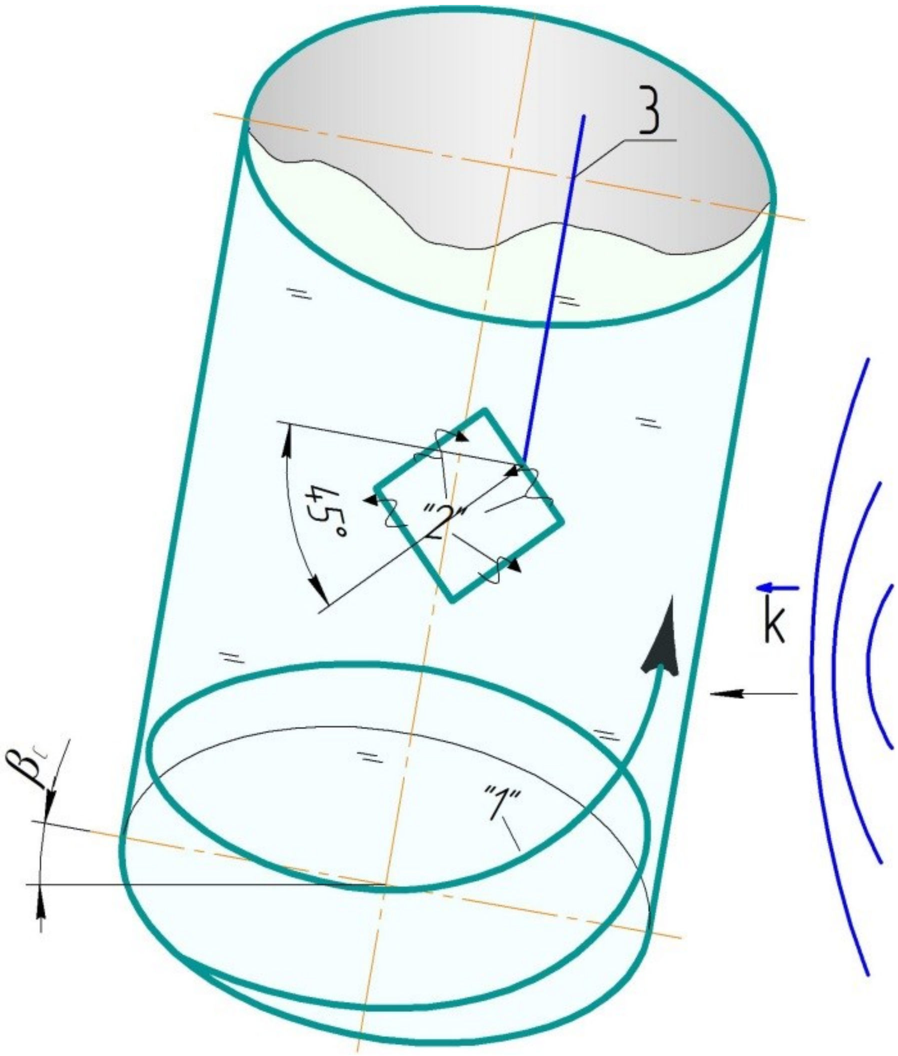


**Fig. 1. Schematic diagram of ultrasonic radiation on the construction of a metal square immersed in the volume of working fluid: "1" – global moving stream, "2" – local streams, 3 – square stirrer, k – wave vector.**

In order to increase the efficiency of radiation exposure and to significantly increase the energy activity passing through the shell and into the volume of the working fluid, it is necessary to place the body of the test vessel at an angle of coincidence $\beta_c$ to the direction of propagation of the ultrasonic radiation.

**Results and discussion.** Sound waves generated by the emitter, which pass through the walls of the body and penetrate into the working fluid, form a zone of concentration of sound energy and cause the fluid to move along the inner surface of the tank on an ascending cylindrical spiral, forming a global motive flow all over the stream. into the active state. The activity region is also observed in the plane of the square where local fluxes are formed, rotating around a metal bar, thus creating a vortex and removing layers of fluid from the inside (Fig. 1). The use of this method of energy supply enables the prevention of the use of mechanical mixing devices, the function of which can perform penetrating acoustic radiation.

**Conclusion.** Definitions of specific irradiation parameters make it possible to more widely apply the properties of resonant manifestations of the influence of sound waves on the volume of working fluid with minimal energy expenditure.

The possibility of remote supply of energy needed for mixing the environment inside the apparatus is substantiated and proved.

The formation of a global driving flux under the action of sound beam and local, less powerful fluxes has been experimentally proved.

It is determined that sound waves emitted by a longitudinal wave of a vessel into a liquid serve to accumulate sound energy, which generates a powerful upward flow stream in the form of a cylindrical spiral. Thus, there is fluid turbulence throughout the volume of the medium, which is supplemented by areas of concentration of sound energy in the square plane.

## References:

1. Fesenko S.V. Formation of energy activity by high-frequency acoustic fields // International scientific journal "Internauka". – 2016. – №11 (21). – P.1. – P. 108-110.

2. Фесенко С.В. Ультразвукове випромінювання, як спосіб турбулізації середовища. Всеукраїнська науково практична конференція «Біотехнологія XXI століття», Київ: КПІ ім. Ігоря Сікорського. (20 квітня 2018), ст. 155

3. Фесенко С. В. Забезпечення стрімкого росту енергетичної активності робочої рідини у газліфтному барботажному апараті // Міжнародний науковий журнал "Інтернаука". — 2018. — №21. https://doi.org/10.25313/2520-2057-2018-21-4499