ACOUSTIC METHODS OF FOAMING CONTROL IN FERMENTATION PROCESSES

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Introduction. Increasing the production of pharmaceuticals and veterinary products, fodder and supplements, nutrition products, preparations for biological rehabilitation of soils and water bodies, utilization of industrial waste and improvement of their quality level is associated with the introduction of biotechnology achievements and is possible only with the appropriate level of technological equipment. One of the problems in increasing the performance of production of products of biotechnological origin is the rational use of the volume of industrial equipment in which biotechnological, in particular, the fermentation processes take place. It is known that during the vast majority of such processes, a stable foam is created, which can take up to 80% of the volume of the vessel, which leads to a reduction in the volume of the working area of the vessel and, accordingly, a decrease in the output of usable product. In addition, foaming can lead to a partial loss of culture medium due to overflow through the open top edge of the apparatus or its removal through pipelines. The latter, at the same time, worsens the quality of the output product.

In the modern international and national biotechnology industry, mostly used are chemical, mechanical and physical methods of foaming control. All of them have both their advantages and disadvantages. The latter is explained by the fact that the development of each technical foam suppression system is focused on a specific biotechnological process, the characteristics of which, including the foam formed during its course, depend on the physical and chemical characteristics of the components involved in this process and on the operating modes of specific biotechnological equipment[1, 2].

Materials and methods. The research aims is to develop a technical means of destruction of foams formed on the surface of the operating medium during fermentation processes in industrial conditions and to substantiate the possibility of foam extinguishing due to the action of external acoustic radiation.

The subject of research is a foam destruction system of biotechnological origin.

The development of highly efficient foam suppression systems has recently received a lot of attention, which is explained, on the one hand, by the rapid development of biotechnology-based products, and, on the other hand, by the high demand for these products. Previously, foam suppression systems were mainly based on mechanical methods - passive and active - but now the emphasis in the development of such systems is on the use of unconventional methods: aerodynamic, thermal, acoustic, etc. In addition, there is a tendency for a differentiated approach to the development of foam suppression systems depending on the specific biotechnological process and, accordingly, on the characteristics of the foams formed during its course [3, 4].

At present, it is suggested to destroy the dispersed structure of the "gas-liquid foam" type, which occurs on the surface of the working medium during fermentation processes, due to the influence of external acoustic radiation. Dispersed systems of the "gas-liquid foam" type have finite elasticity and strength and can be destroyed by an external dynamic perturbation. As such a perturbation, it is proposed to use acoustic local radiation, the spatial distribution area of which is the volume occupied by the foam. Under the influence of this radiation, compression-stretching zones consistently appear in the dispersed medium, which in the case of foams of biotechnological origin is a liquid film. At the appropriate level and frequency of acoustic radiation, the strength in these zones can exceed the tensile strength of liquid films and thus lead to their breakage. In addition, alternating loading of the films can also lead to liquid leakage from them, which stimulates their thinning and reduction in strength. Ultimately, this leads to the loss of hydrodynamic and structural stability of the foams and their overall destruction.

Results and discussion. When cultivating yeast in media with different carbon sources, foam control issues have been solved mainly by creating specially designed fermenters, selecting cultivation media and cultivation modes that exclude the use of chemical and mechanical foam suppression methods.

Sustainable foams are most often formed in the production of amino acids, antibiotics, enzymes and other products, the fermentation media of which contain a complex of foaming agents.

The biosynthesis of the listed products is carried out in fermenters under aseptic conditions with a filling factor of 0.5-0.7. With this filling and high foam stability, foam control in fermenters is carried out by chemical, mechanical and combined methods.

Fig. 1 presents a cell culture system (CCS). It can be used as a complex approach to the construction of a system for the passive destruction of foams of biotechnological origin by means of external acoustic radiation.

The nutrient liquid and inoculum are introduced into the body of the pre-sterilized apparatus (Fig. 1) through the nozzle, after which gas is supplied to the aerator through the nozzle for aeration of the culture medium and the drive is turned on, which drives the shaft with mixing paddles The rotating paddles mechanically move the medium and cause its circular motion around the housing axis O, the intensity of which is slowed down by the location of the shaft axis O1 with eccentricity relative to the housing axis. At the same time, two ultrasonic emitters 11 with adjustable beam direction are installed outside the housing, opposite to each other. At the same time, two ultrasonic emitters 11 with adjustable direction of the rays are installed outside the housing, in the opposite direction. The ultrasonic emitter from both sides begins to irradiate the side surface of the housing 1 with sound waves, generating circular and transverse waves in the housing material, which will radiate a sufficiently wide beam of sound waves into the culture liquid, which will cause a "coincidence resonance" of several types of sound waves, resulting in excitation zones where a sharp concentration of sound wave energy between the inner and outer surfaces of the housing will occur.

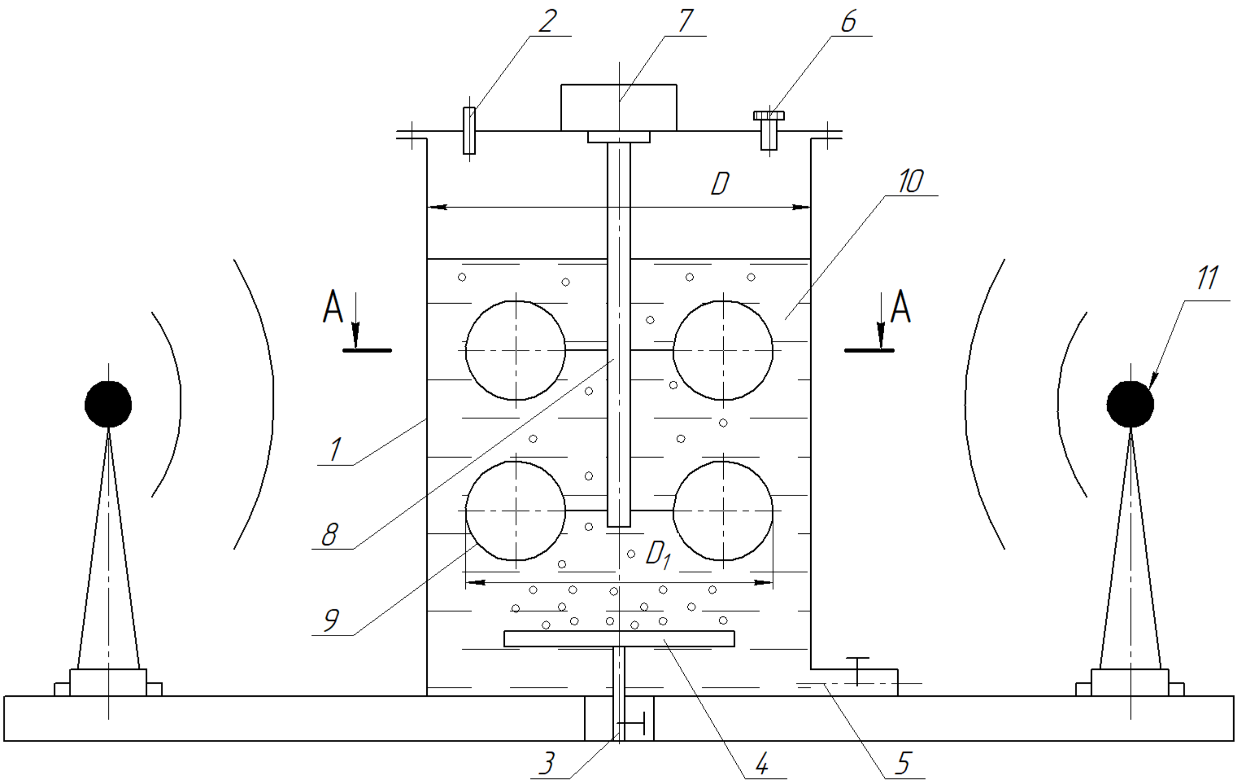

Fig. 1. a)

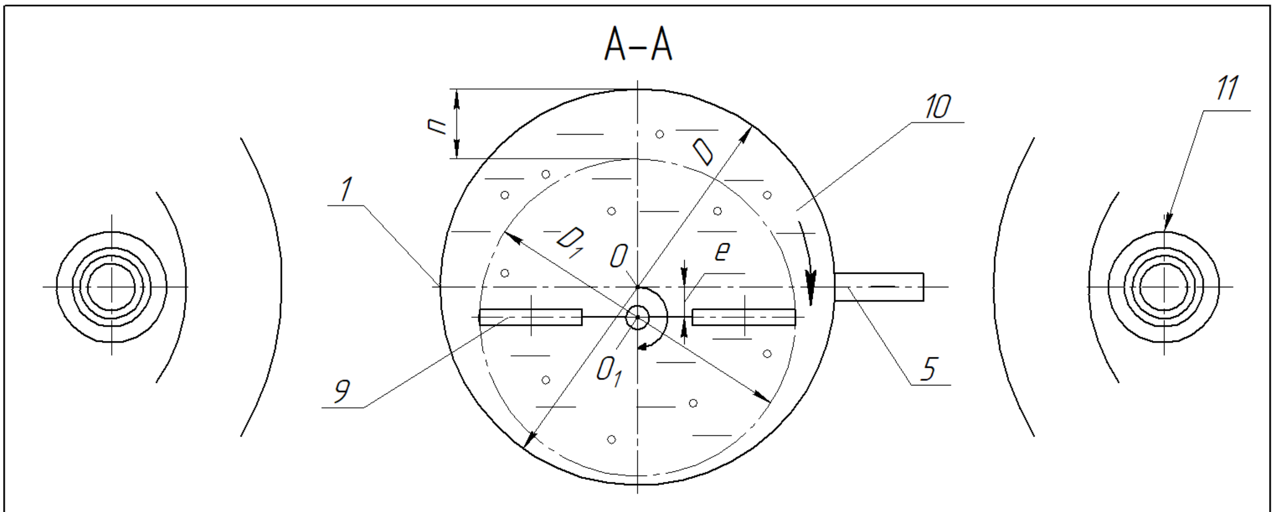

Fig. 1. b)

Fig. 1. Pre-sterilized apparatus: a) General view of the equipment: 1 - cylindrical body, 2 - nozzles for inlet of nutrient liquid and inoculum, 3 - nozzle, 4 - aerator, 5 - nozzle for removal of culture liquid, 6 - nozzle for removal of exhaust gas, 7 - drive, 8 - shaft, 9 - mixing paddles, b) Top view: 10 - working fluid, n - clearance

They will increase the amplitudes of oscillations of the culture fluid by intensively turbulizing it over the entire height of the vessel, which eliminates the appearance of stagnant zones [5]. Since the zones of sound energy concentration will lead to intensive spatial mixing of the working fluid along with high-altitude circulation, instead of one-dimensional movement, the intensity of the mixing process and, accordingly, mass transfer will increase. The absence of any protrusions on the inner surface of the casing diameter D ensures smooth braking of the medium, eliminates cell injury and leads to an increase in the yield of a quality product. At the same time, stagnant zones are eliminated, which accelerates cell growth and increases productivity. Thus, the ultrasonic emitter will continuously displace the foaming from the bubble film and reduce the film thickness until it breaks.

Conclusions. Acoustic defoamers in fermentation processes are one possible strategy to improve the quality and efficiency of the fermentation process. Foaming can be a problem in residual fermentation processes, reducing the efficiency of the reaction and can lead to product loss.

Acoustic agents can be effective in combating foaming in fermentation processes. foam is usually formed in fermentation and other fermentation processes where gas is released.

Ultrasonic treatment can reduce the level of foaming. Studies have shown that ultrasonic waves affect the microorganisms involved in fermentation, reducing their number and activity. This is to reduce gas release and foaming. only, ultrasonic treatment can increase the speed of the fermentation process and improve the quality of the product.

The artificial formation of the energy activity of the working fluid by an ultrasonic beam at the resonance level allows effective control of the technological process, ensures the sterility of the product, controls the energy state of the working fluid, and increases its productivity. This technical implementation of the design significantly reduces foaming over the entire surface of the device.

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