UDC 663

COMPUTER SIMULATION OF ULTRASONIC OSCILLATION DISTRIBUTION IN AIR PURIFICATION SYSTEMS OF PHARMACEUTICAL PRODUCTION

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To ensure the proper functioning of any pharmaceutical production, every technological process must meet the requirements of Guideline 42-4.0: 2020 "Medicines. Good manufacturing practice ". The guideline regulates the creation of controlled production conditions to obtain products of appropriate quality. One of the most important control parameters is the quality of ventilation air. The air must be cleaned of bacterial contaminants, the average content of which is 1000-100 cells per 1 m^3, but can rise to 10^4, and dust of organic and inorganic nature, water vapor. The total amount of pollutants can reach 10^9 in 1 m^3.

The separation of the smallest particles requires the largest investment. Therefore, the question of finding ways to reduce the load on the sterilization filters in order to increase the service life of the filter baffles and reduce the value of hydraulic resistance arises. The solution to this problem may be pre-treatment of air that goes to filtration by acoustic fields of high intensity or frequency, in order to coagulate aerosols.

But for the full implementation of acoustic coagulation technology in the technological schemes of air purification of pharmaceutical industries, it is necessary to go a long way from the concept to the existing equipment. Computer simulation is required to reduce the cost of implementing such equipment before conducting physical experiments [1].

To study the effect of ultrasonic oscillations on the process of coagulation of airborne particles, it is necessary to build a computer model that could assess the degree of influence of various factors on the formation of the acoustic picture in the environment under study. The creation of a computer model is based on the choice of equations to describe the process and specify the conditions of unambiguity. Such conditions of unambiguity in the general case are: geometric, physical, boundary and initial conditions.

One of the most popular software proposals for modeling various physical processes is the universal software system of finite element analysis ANSYS. This system is used in the field of automated engineering calculations (CAD or CAE) and finite element solutions of linear and nonlinear, stationary and nonstationary spatial problems of deformed solid mechanics and structural mechanics, fluid and gas mechanics, heat transfer, electrodynamics, acoustics, and acoustics of related fields. Harmonic Response was chosen for modeling from all the variety of modules used in ANSYS [2].

The first stage of modeling was to develop a 3-D model for further simulation.

The model consists of an emitter, which is represented by an annular cylindrical piezoelectric element, and an acoustic medium – a parallelepiped with the dimensions of an air duct.

The oscillations in the system are modeled by applying a conditional voltage to the outer and inner cylindrical surfaces of the emitter using the boundary condition "Voltage". The acoustic environment was created by the "Acoustic Body" with the following physical properties, density ρ=1.2041 kg/m^3, speed of sound in the environment v=343.24 m/s. For the system, the maximum value of the oscillation frequency is 25 kHz, and the solution method is "Full".

As a result of modeling, contours of Acoustic Pressure distribution in the air duct section of the ventilation system are obtained (Fig. 1). The maximum value of acoustic pressure is 5.65 Pa, and the minimum is -7.168 Pa. The distribution of oscillations corresponds to the propagation of a spherical wave. In the inner cavity of the radiator there is a significant zone of rarefaction, and the highest pressure is near the inner walls of the radiator and under it.

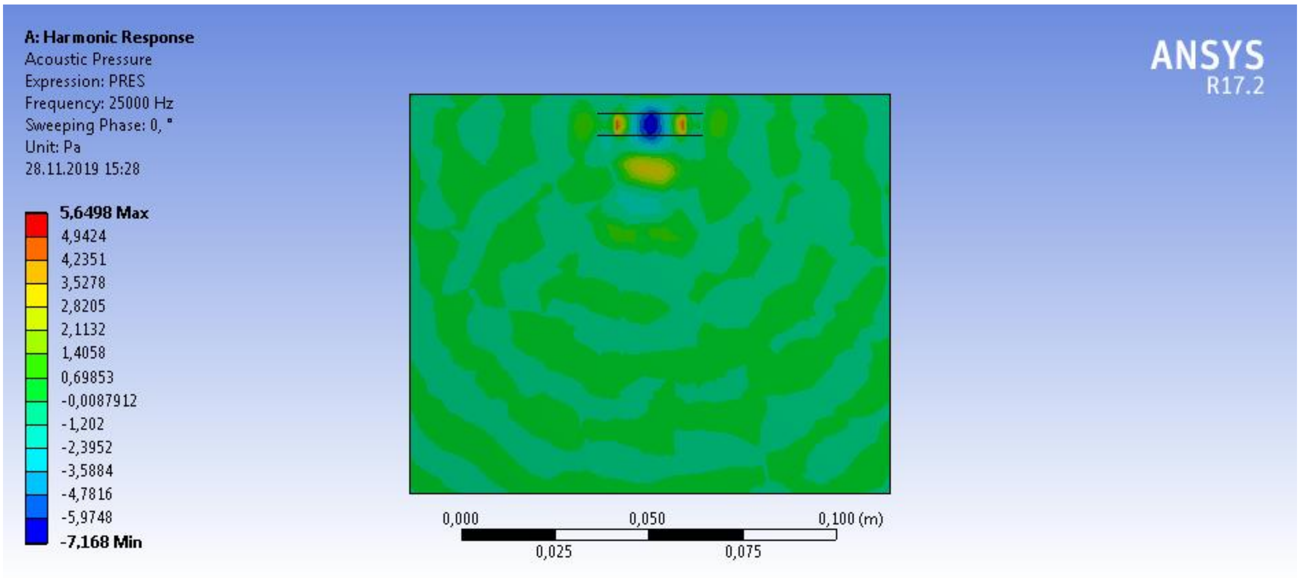

Fig. 1 Acoustic pressure distribution contour

The next stage of this work is to analyze the influence of the parameters of the channel and the emitter on the establishing of optimal coagulation conditions.

References:

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