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Application Possibilities of Double Disc Ultrasonic Vibration System for Particle Agglomeration

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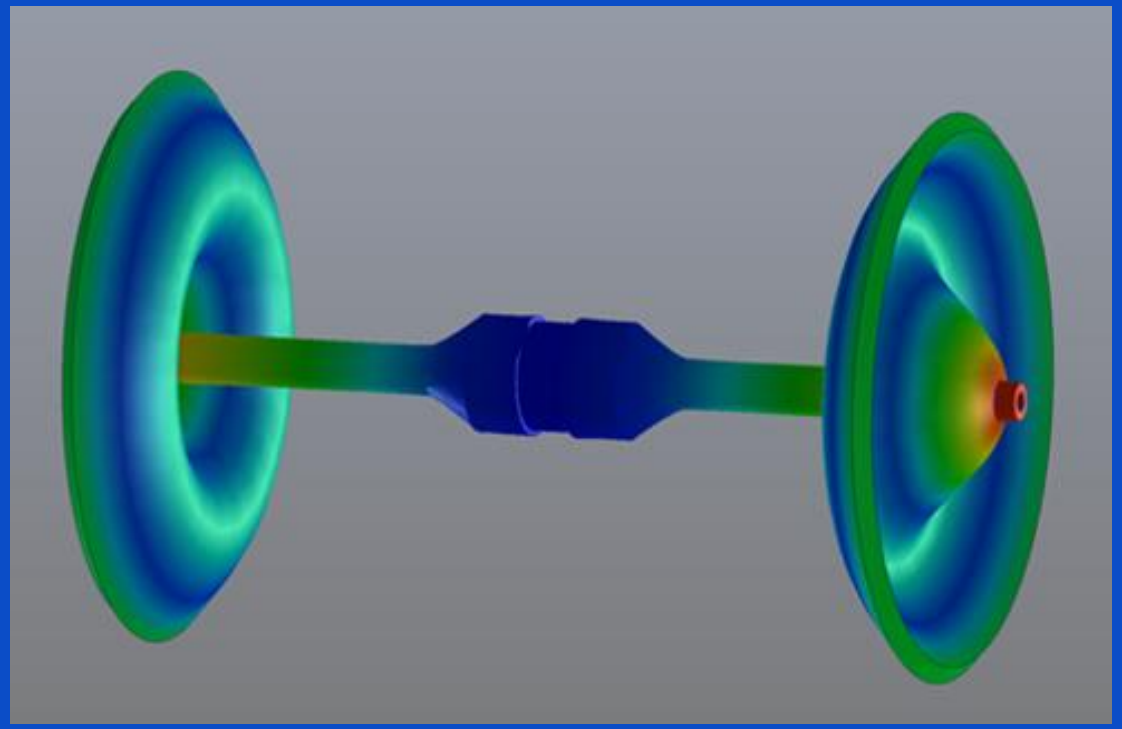
Abstract

A piezoelectric UOS (ultrasonic oscillation system) with a double bidirectional axial concentrator is presented. The entire system is designed, modeled and constructed so that the double transducer in the center works as a single half-wave resonant system. Such a composite design of the ultrasonic oscillation system was designed with the aim of applying it in air purification systems - an acoustic field is formed between the system disks, which forms lower and higher-pressure zones in the air contaminated with particles, constantly changing their location. Particle agglomeration occurs in these zones. The coarsened particles are later cleaned by conventional methods. The ultrasonic oscillation system and its characteristics are presented. A special stand was used for experimental researches. Tests were performed with the stand operating in different modes. The results showed that such an ultrasonic system can help agglomerate solid particles in the air stream.

1. Introduction

The aim of the research is to develop a piezoelectric ultrasonic oscillation system with a double bidirectional axial transducer, which could be used to determine the possibilities of particle agglomeration using ultrasound.



2. Numerical simulation of an ultrasonic oscillation system

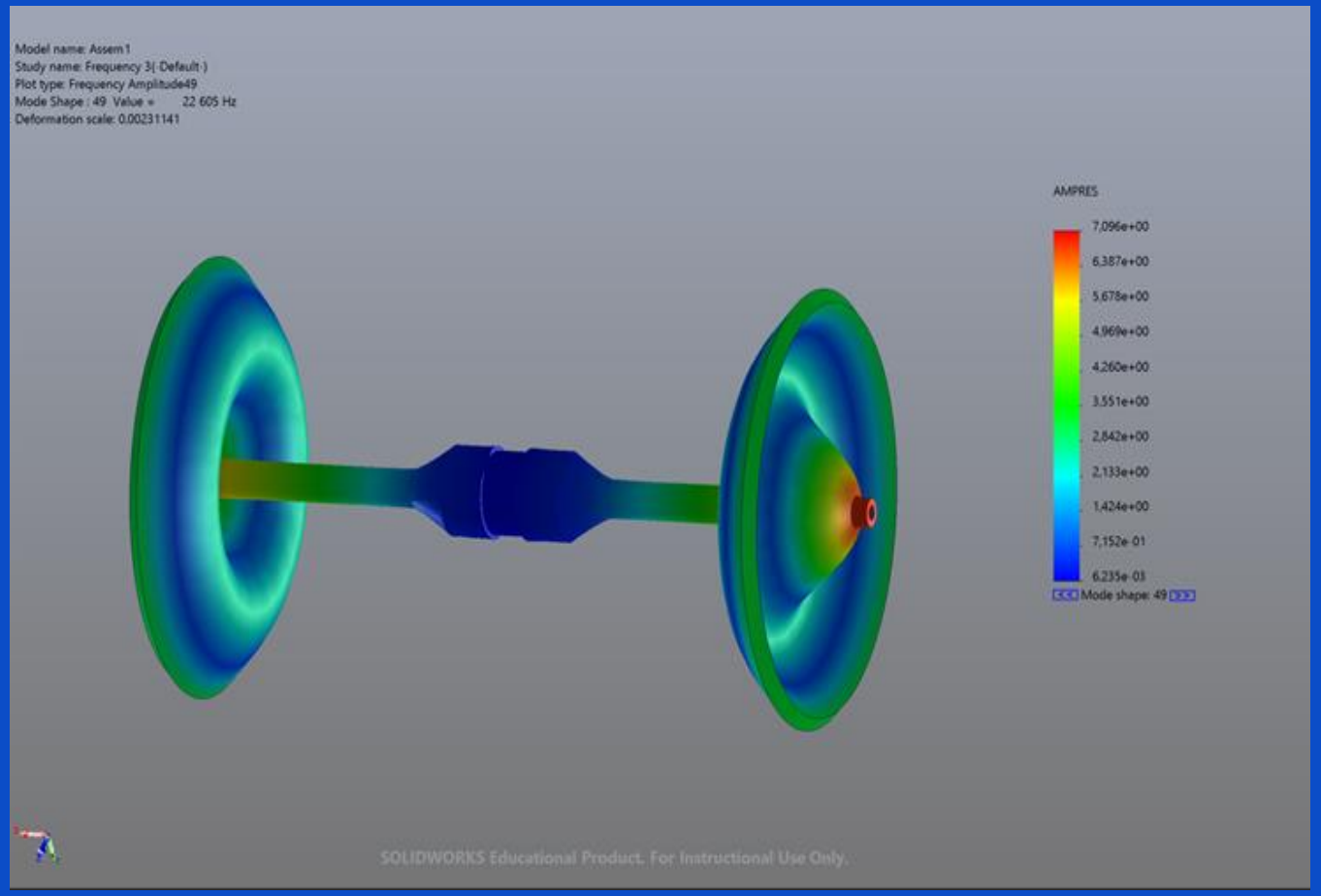


Fig. 1 Modal vibration pattern of a double bidirectional axial concentrator with two disks mounted perpendicular to its axis of symmetry (22.605 Hz)

3. Schematic diagram of the operation of an ultrasonic system in a ventilation duct

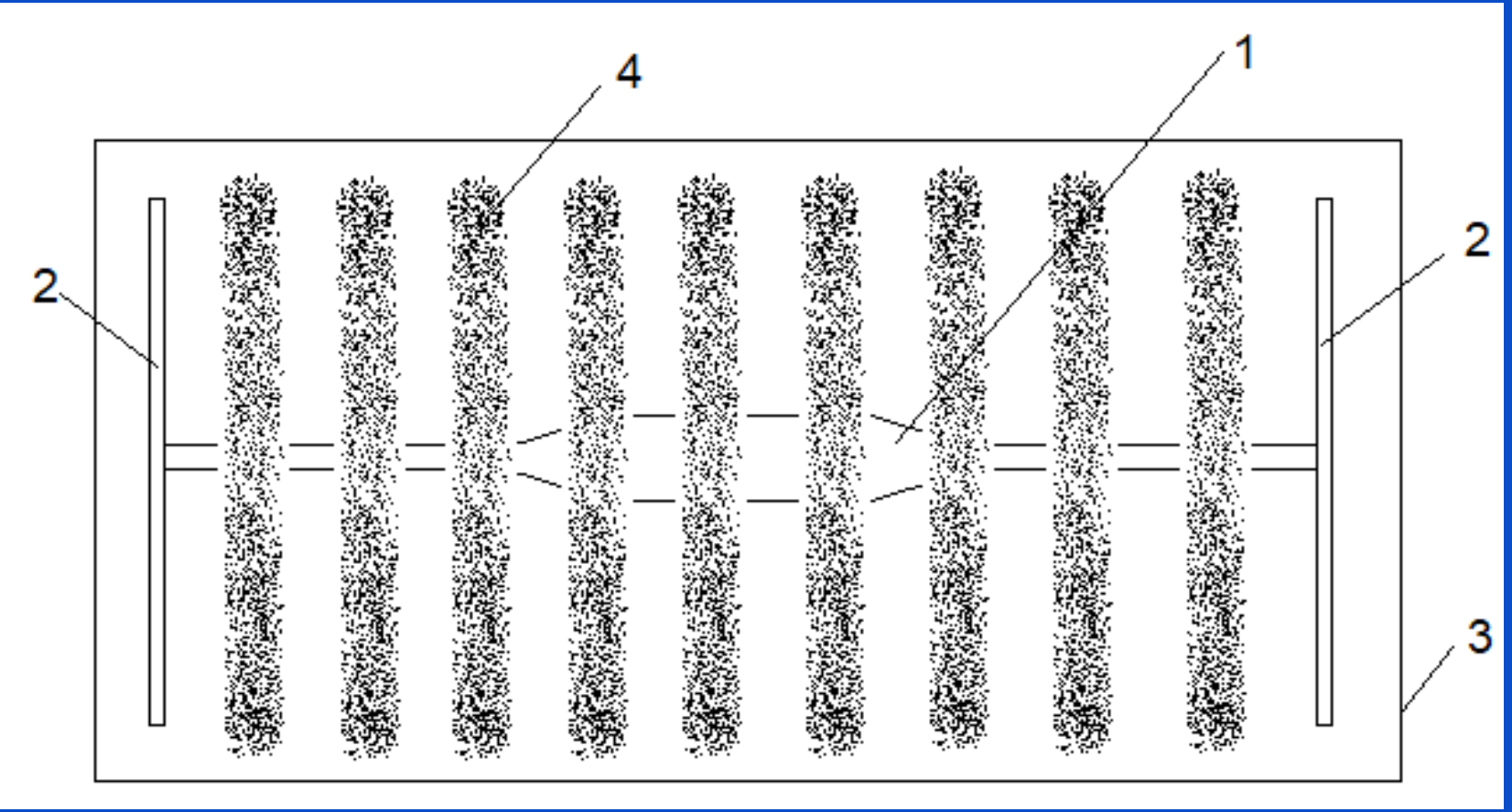


Fig. 2 Schematic diagram of the operation of an ultrasonic oscillation system in a ventilation duct: 1 – bidirectional axial longitudinal vibration transducer; 2 – discs; 3 – ventilation duct; 4 – probable particle compaction zones

4. Prototype of a dual bidirectional ultrasonic system

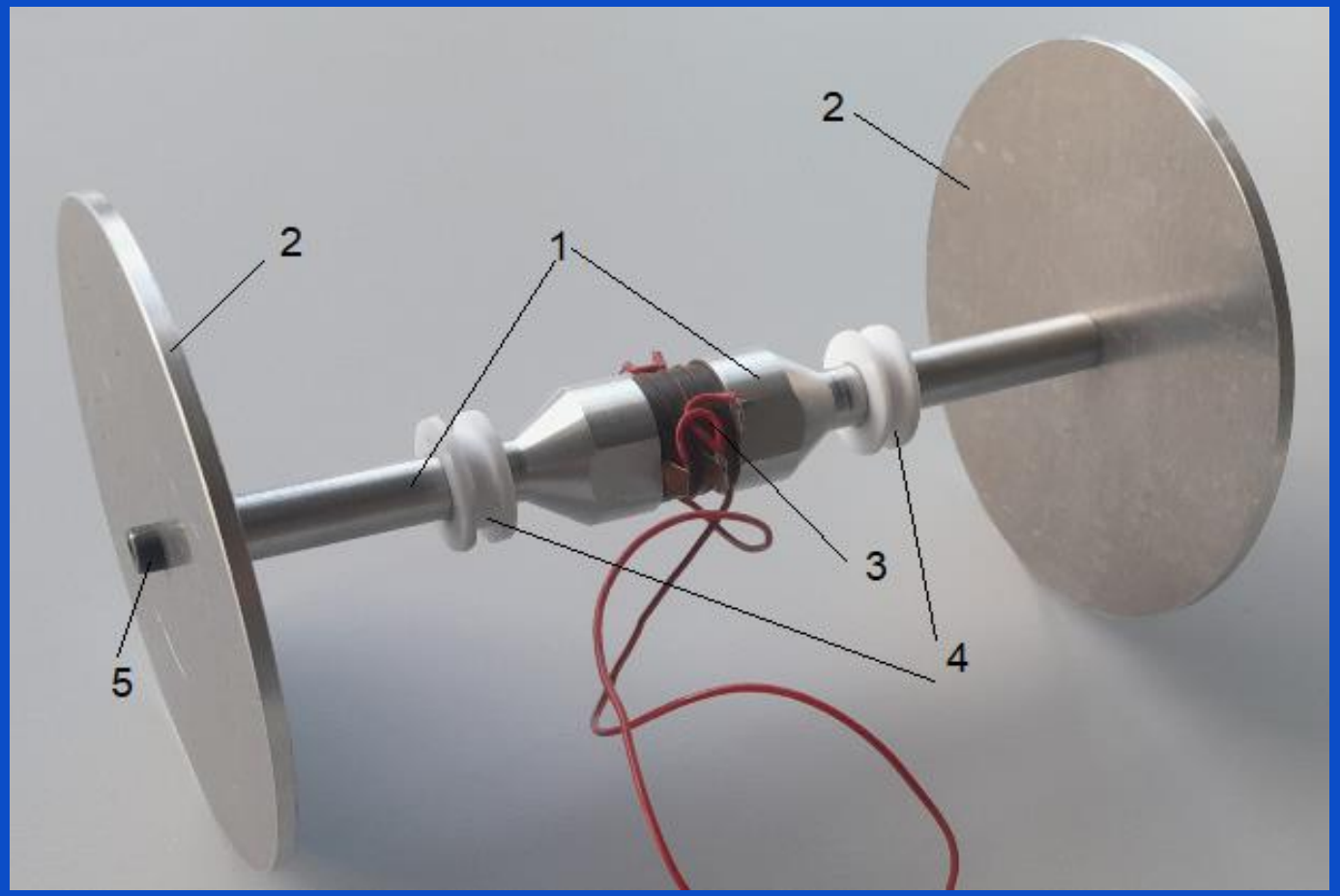


Fig. 3 Double bidirectional axial concentrator with two disks arranged perpendicular to its axis of symmetry: 1 – longitudinal vibration concentrators; 2 – disks; 3 – piezoelectric elements; 4 – ultrasonic system mounting elements; 5 – disk mounting screws

5. The result of the impedance-frequency characteristic

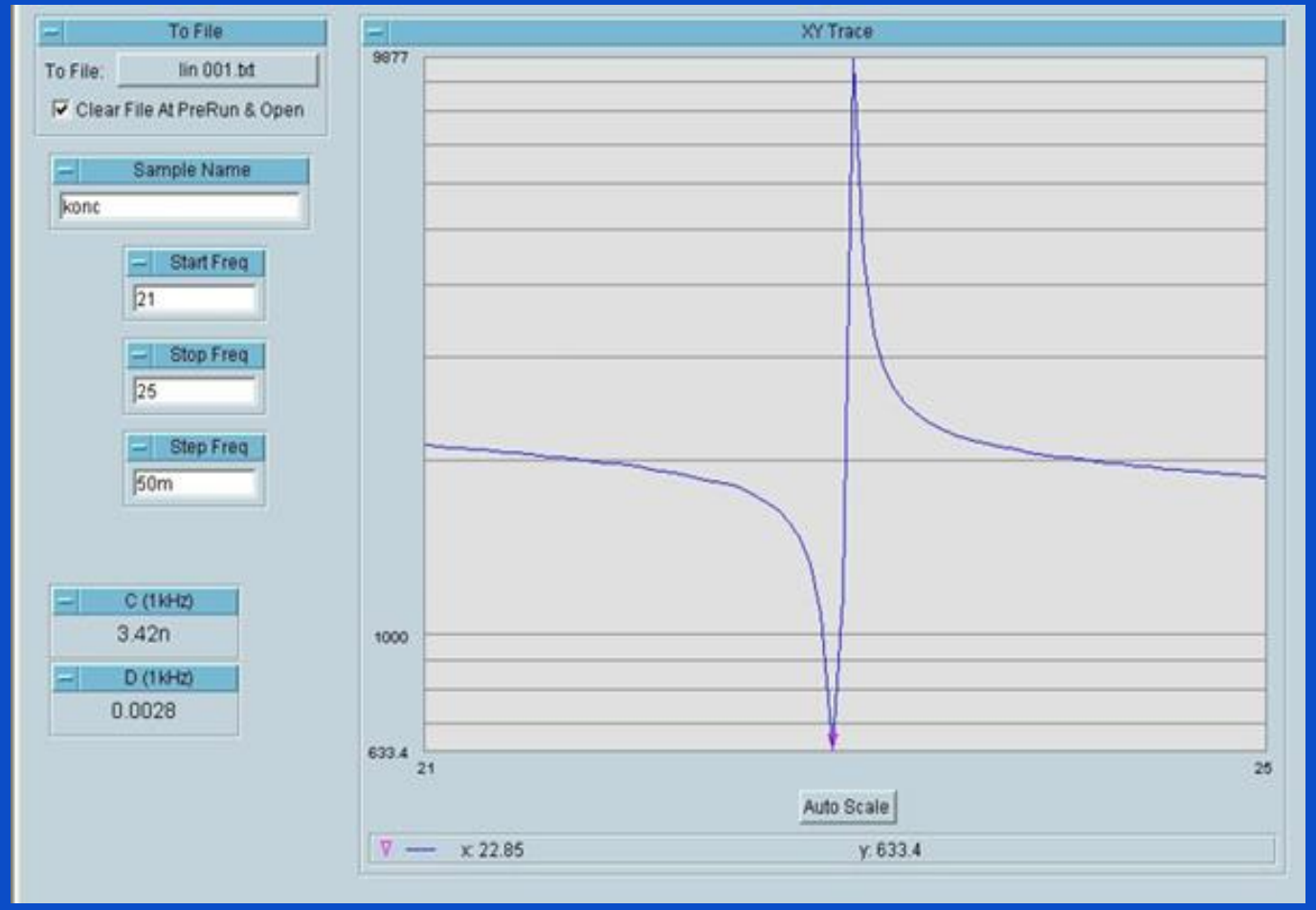


Fig. 4 Impedance-frequency characteristic of an ultrasonic vibration system

6. Scheme of the research equipment

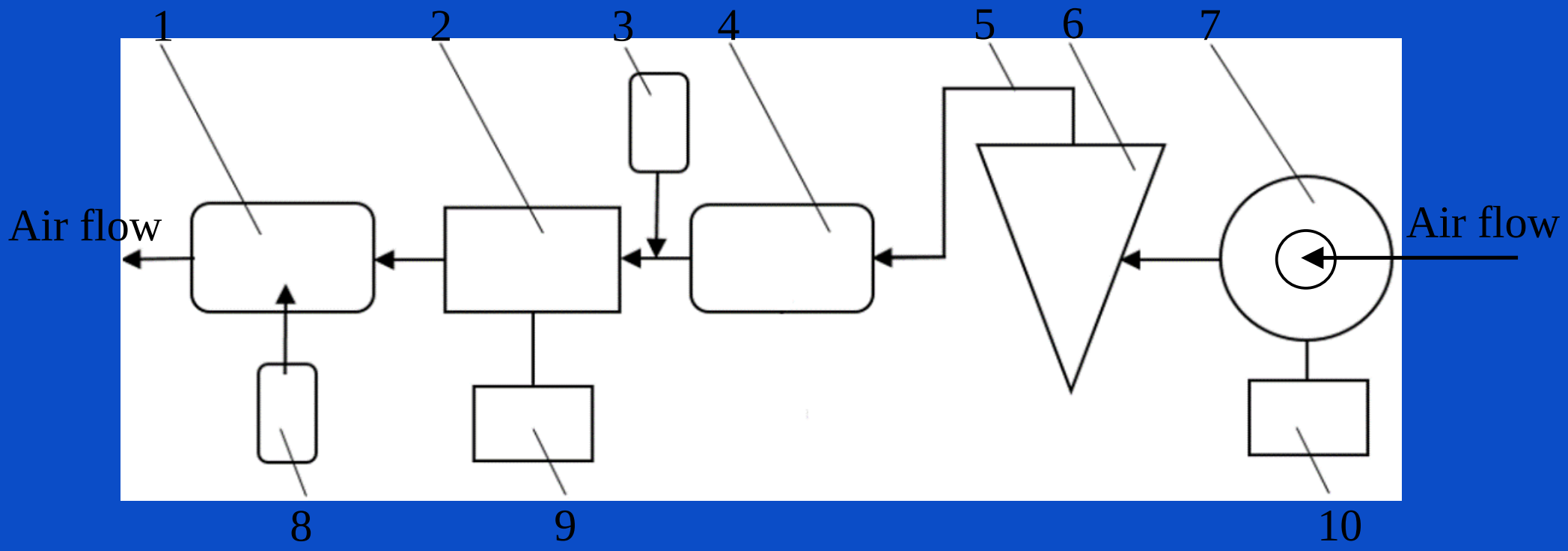


Fig. 5 Schematic diagram of the test bench:1 – particle quantity measurement zone, 2 – ultrasonic two-disk transducer, 3 – air flow velocity meter, 4 – air duct, 5 – duct, 6 – cyclone, 7 – fan, 8 – particle counter, 9 – piezo element controller, 10 – fan motor frequency converter

7. Equipment of Research

Fig. 6 Photo of the research stand

8. Results

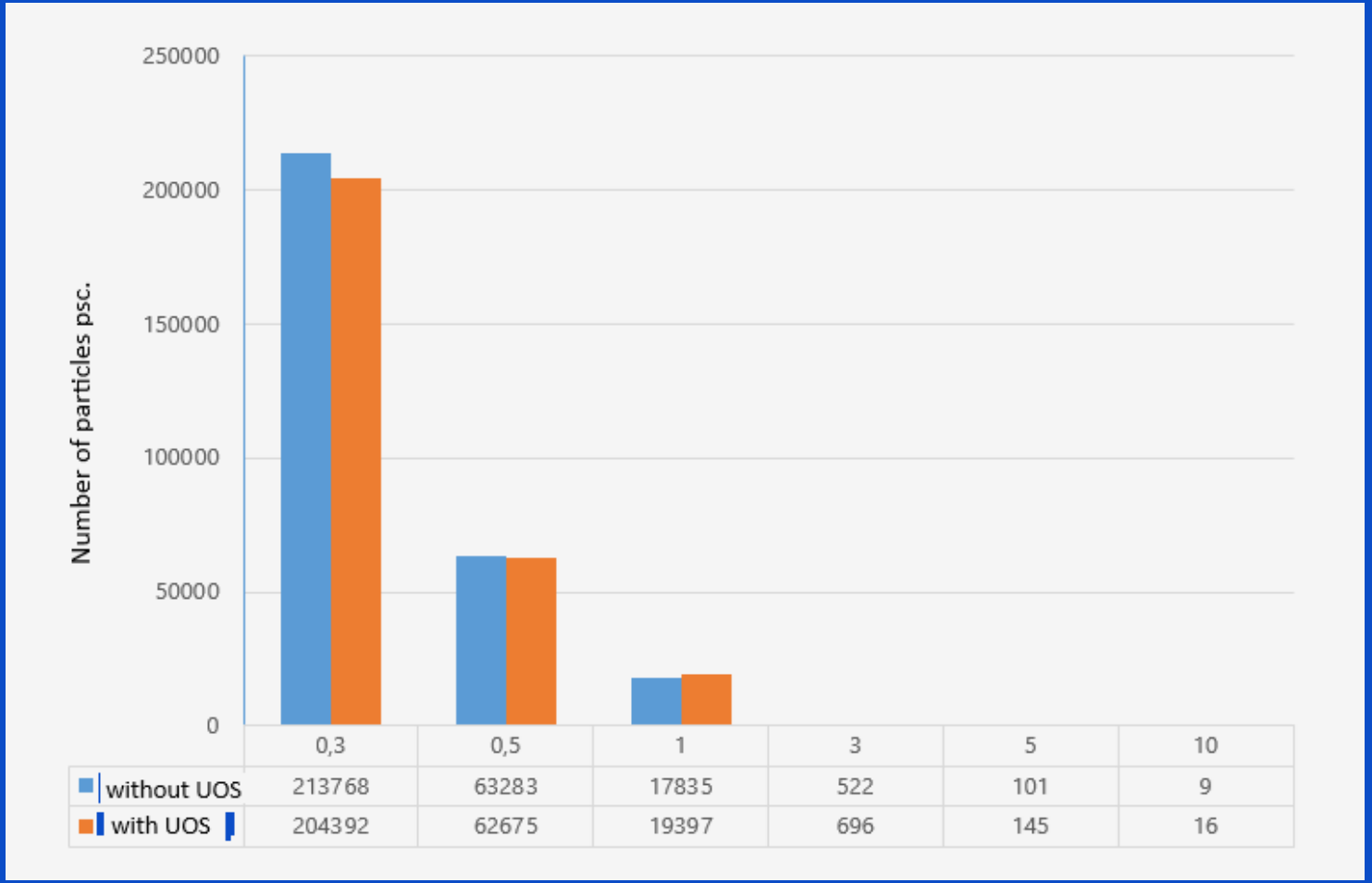


Fig. 7 Results of experimental research on particle agglomeration

9. Conclusions

1. A new design of a dual bidirectional axial transducer with two disks arranged perpendicular to its axis of symmetry is proposed;
2. It has been found that it is possible to match the longitudinal oscillations of the bidirectional concentrator in resonance with the concentric resonant oscillations of the disks (operating frequency 22.85 Hz);
3. The effect of ultrasound produces an agglomeration effect of particles.
4. The effect of particles by ultrasound can be applied to air purification from particles smaller than 10 μm.