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ADHESION OF PARTICLES IN SECONDARY AIR FLOW

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ABSTRACT
This work aims to investigate the influence of secondary air flow on adhesion and precipitation processes of particles in the cyclone separator. It is shown that secondary air flow causes fine (about 1 μm in diameter) particles to collide with one another more often. Results showed, that separation efficiency of fine particles of cyclone separator with secondary air flow can reach 99,93 % which is much higher than that of conventional cyclones.
Keywords: cyclone separator, secondary air flow, separation efficiency

1. bINTRODUCTION
Number of collisions of the moving in the air flow dust particles depends on impressed forces acting on the air flow. This number can be increased if the secondary air flow is used in the cyclone separator. In such case centrifugal force acting on particle increases sufficiently, particles collide more often, some of them adhere to other particles. Adhesion of particles depends on many factors. One of the many theories (known as mathematical-geometrical theory) states that adhesion of particles results from the couplings of surface microroughness of the particles [1, 2]. Deformation theory [3, 4] explains adhesion and increase of friction by mechanical work required for plastic and elastic deformation of the volume of the collided particles. Next group of scientists [3, 5, 6] suppose that adhesion forces have the most influence on the aggregation of particles. Followers of the molecular theory usually don‘t take into account mechanisms of the elastic deformation and evaluate molecular forces only. This approach can‘t be accepted because preliminary displacement of the solid body exceeds the constant of crystal lattice approximately 104 times. Therefore, it is necessary to take into account the others sources of energy dissipation. Energy theory [7, 8] states that energy is converted to another form of energy when particles collide. It causes changes in temperature and mechanical excitations of the crystal lattice with accompanied processes as triboadsorption, triboadhesion, tribodiffusion, triboelectrization, tribophysical changes, tribochemical reactions, etc.
Atomic-molecular theory [3, 9] states that adhesion results from atomic and molecular interaction. Such effects also are studied by tribochemistry [10]. When two particles collide the concentration of local energy occurs, it actuates chemical and tribochemical reactions in contact zone. However it can have no influence on adhesion between particles. Contact of the particles has discrete character i. e. it takes place in the small areas, called contacts spots. The shape of contacting particles and theirs surface roughness usually have stochastic character, which can be analyzed employing probability theory methods. Besides statistical investigation other combined theories [11] (for example molecular-mechanical theory) are used. Above-mentioned theories are more suitable to evaluate friction coefficient, friction force and wear, but they are not enough to fully explain adhesion of the

particles. It is considered that combination of mentioned theories is most suitable for such case. Therefore this paper investigates problem of adhesion of particles, introducing secondary air flow into the cyclone which increases probability of collisions between particles.

2. OBJECT OF INVESTIGATIONS

Figure 1 presents scheme of air flows of cyclone separator with secondary air flow nozzle. Secondary swirling air flow is supplied from the bottom of cyclone by means of axial fan. Cleaned air passes through an additional filter which is used to evaluate the separation efficiency of the cyclone separator.

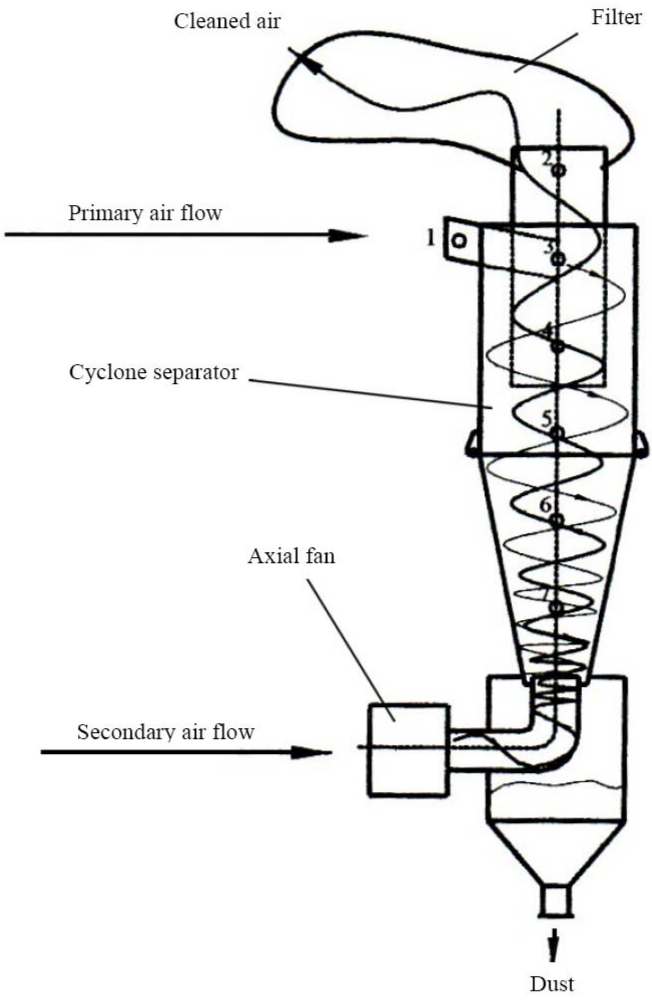

Figure 1. Scheme of cyclone separator with secondary air flow: 1–7 – measurement points

3. EXPERIMENTAL PROCEDURE AND RESULTS

The direction of rotation of secondary air flow was opposite to direction of rotation of primary air flow. Pressure of secondary air was 0.2 kPa, flow rate – 171.5 m^3/h. Air pressure distribution graphs are presented in Figure 2, vertical velocity graphs are shown in Figure 3. The results of measurements of particle separation efficiency are presented in Figure 4.

Results shows that separation efficiency of 1 µm particles reaches 99.93 % in the cyclone with secondary air flow (Figure 4). Conventional cyclone ensures 1.53 % less separation efficiency.

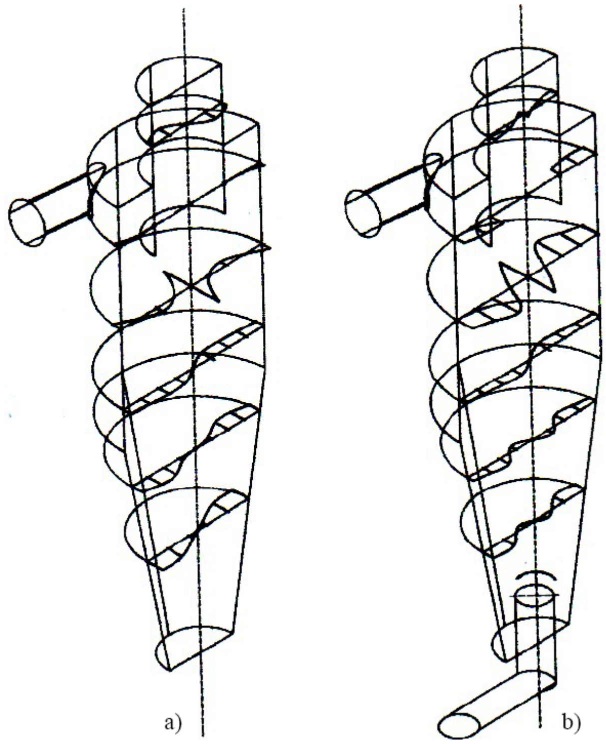

Figure 2. Air pressure distribution in cyclone separator: a) – without secondary air flow; b) – with secondary air flow

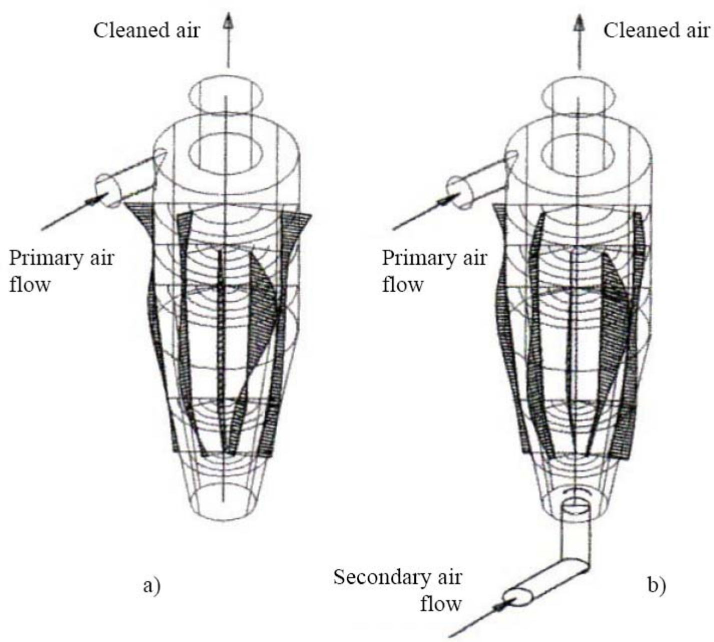

Figure 3. Vertical velocity distribution in cyclone separator: a) – without secondary air flow; b) – with secondary air flow

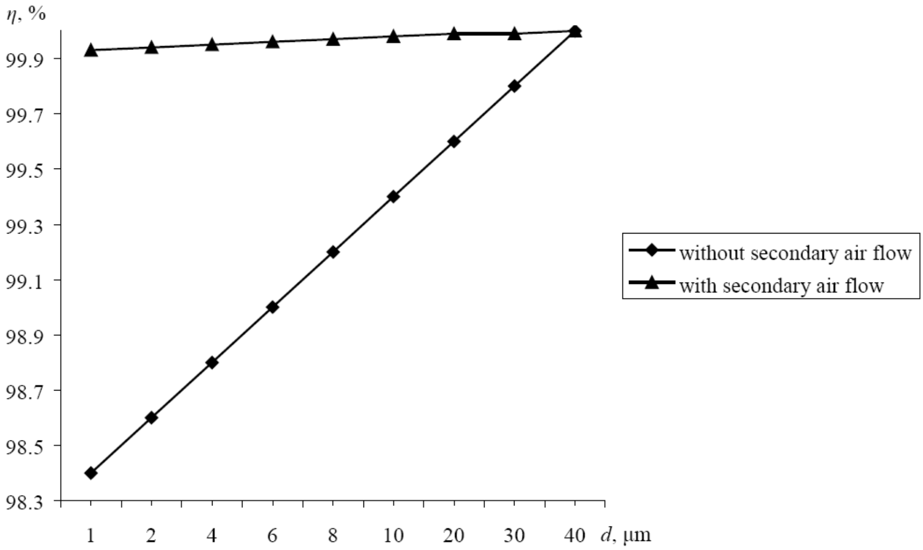

Figure 4. Separation efficiency η of the cyclone separator as function of particle size d and design

4. CONCLUSIONS

In accordance with the results of experiments we may draw the following conclusions:

- Separation efficiency of fine particles increases when secondary air flow is introduced into cyclone separator.
- As it is evident from velocity and pressure distribution graphs, probability of collisions between particles sufficiently increases in cyclone with secondary air flow.

5. REFERENCES

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