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TWO-STAGE INSTALLATION FOR DEEP AIR PURIFICATION FROM FINE-DISPERSED SOLID PARTICLES

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Abstract: This work presents the results of an experimental study on a two-stage installation designed for deep purification of dust-laden air containing fibrous and fine-dispersed mineral particles. The experimental system consists of a cyclone equipped with a string-type coagulator and a scrubber with a moving (floating) packing. The effects of dust-air flow velocity, structural parameters, and operating conditions on air purification efficiency and hydraulic resistance were investigated. The results showed that as the inlet flow velocity increases from 12 to 17 m/s, the purification efficiency rises up to 99.9%, while further increasing the velocity to 20 m/s causes a decrease in efficiency due to the breakdown of coagulated dust aggregates. The optimal air velocity for the two-stage system was found to be 17 m/s, corresponding to a total hydraulic resistance of 820 Pa. Fractional efficiency analysis revealed that particles larger than 60 μm were removed with almost complete efficiency (99.98%), whereas for particles smaller than 5 μm , efficiency reached 86.6%. These findings confirm that the developed two-stage system ensures high purification efficiency while maintaining acceptable energy consumption and compliance with sanitary standards.

Keywords: air purification, cyclone, scrubber, floating packing, coagulation, hydraulic resistance, fine dust, fibrous particles.

Introduction. The practice of using various configurations of two-stage air purification systems at cotton-cleaning plants shows that these units provide a tangible social effect when an air cleaner of the VZP type or a small-diameter cyclone is installed in the second stage of purification [1].

However, high air purification efficiency in the second stage of these systems is achieved only under favorable operating conditions. The degree of dust removal in air cleaners does not exceed 50% due to the high aerodynamic drag and low density of fibrous dust generated at cotton-cleaning factories.

All this dictates the need to intensify the technological process of fibrous dust particle deposition, to improve the design of existing dust collection devices, and to develop new apparatuses for this purpose [2,3]. In other studies, the process of gas-liquid separation in an axial-flow cyclone has been modeled [4]. One of the approaches to preliminary treatment is heterogeneous condensation of water vapor with fine particles acting as nucleation centers, which requires a supersaturated water vapor environment

[5]. In the works of Yang, to achieve a supersaturated vapor phase in the SO₂ absorption zone and in the upper part of a wet desulfurization scrubber, steam was introduced at the gas inlet and above the washing liquid inlet [6]. Other studies have developed an efficient single-stage “wire-plate” type wet electrostatic precipitator for controlling nanoparticles, submicron, and micron particles emitted during semiconductor manufacturing. Tungsten wires of 0.36 mm diameter were used as discharge electrodes, and a fixed voltage of -15 kV was applied to create an electric field and corona ions [7]. However, this is rarely applied in practice. Filtration of fly ash using a fluidized bed at high temperature has been discussed by Liu et al. [8,9]. Nevertheless, questions remain about the applicability of these results to real flue gas fly ash filtration.

In this regard, one of the technical solutions for deep air purification may involve the use of scrubbers with moving (floating) packing, which are characterized by lower energy consumption compared to other air cleaning devices. Therefore, the development of a new two-stage dust purification scheme consisting of a cyclone and a scrubber, based on the intensification of fibrous and mineral particle deposition, represents a relevant scientific and technical challenge.

Methods and Materials. Based on the above considerations, an experimental setup was assembled, consisting mainly of a cyclone with a coagulator and a scrubber with a moving packing. The main purpose of the two-stage experimental stand is to study the influence of various technological parameters on the degree of air purification from fibrous and fine-dispersed mineral particles.

The schematic diagram of the two-stage installation is shown in Figure 1. In the setup, primary air purification from fibrous and fine mineral particles is carried out in the cyclone with a coagulator, while deep (secondary) purification is performed in the scrubber equipped with a moving packing. The dust concentration in the air flow entering the experimental installation ranges from 3500 to 6000 mg/m³.

The experimental setup (Figure 1) consists of a cyclone (4), a screw conveyor (6), a scrubber (7), a sludge collection tank (11), two fans (13), and one pump. The main components of the experimental cyclone include a cylindrical-conical body, an air duct (1) for supplying the dust-laden air stream—where a string-type coagulator (2) is installed—a discharge pipe (3), and a rotary valve (5).

The cylindrical scrubber with a conical bottom mainly contains spray nozzles (8) for water dispersion and a support grid (10) for the moving packing layer (9). The installation is equipped with control and measuring instruments such as micromanometers (12), an AFA filter cartridge (14), and a rotameter (15).

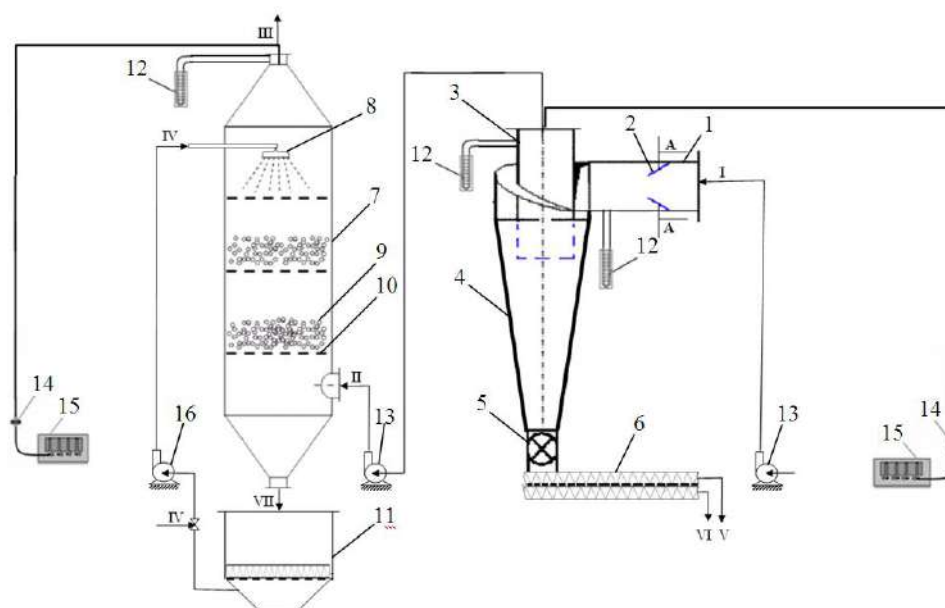


Figure 1. Schematic diagram of the experimental setup for two-stage purification of dust-laden air:

1 – air duct; 2 – string-type coagulator; 3 – discharge pipe; 4 – cyclone; 5 – rotary valve; 6 – screw conveyor; 7 – scrubber; 8 – spray nozzle; 9 – moving packing; 10 – support grid; 11 – sludge collection tank; 12 – micromanometers; 13 – fans; 14 – AFA filter cartridge; 15 – rotameter; 16 – pump. Technological flows: I, II – dust-laden air; III – purified air; IV – irrigation water; V – captured fibrous particles; VI – captured mineral particles; VII – contaminated water.

Dust-laden air containing fibrous and fine mineral particles enters the cyclone through the string-type coagulator (3). When passing through the coagulator, the dust-air flow becomes highly turbulent. Under these conditions, fibrous particles contained in the air stream intertwine and coagulate, forming stable aggregates. As a result, the air purification efficiency of the cyclone increases, since the number of large fractions grows and fine dust particles are captured by larger aggregates.

Results and Discussion. The velocity of the dust-air flow in the apparatuses (ω , m/s) was determined according to the value of dynamic pressure:

$$\omega = \frac{Q}{0,785 D^2}, \quad (1)$$

Where, Q - is the air flow rate (m^3/s) and D - is the diameter of the inlet pipe (m).

During the experiments, the velocity of the dust-air flow was varied within the range of 12–20 m/s. The optimal velocity of the dust-air stream was then determined. The results of the laboratory studies are summarized and presented in Figure 2.

From Figure 2, it can be seen that as the inlet velocity of the dust-air flow increases from 12 to 17 m/s, the purification efficiency rises to 99.9%. However, a further increase in velocity from 17 to 20 m/s results in a decrease in purification efficiency to 96%. This phenomenon can be explained by the fact that at high air velocities, the coagulated

dust particles in the first stage of purification are destroyed. It should also be noted that the purification efficiency is higher at greater dust concentrations than at lower ones.

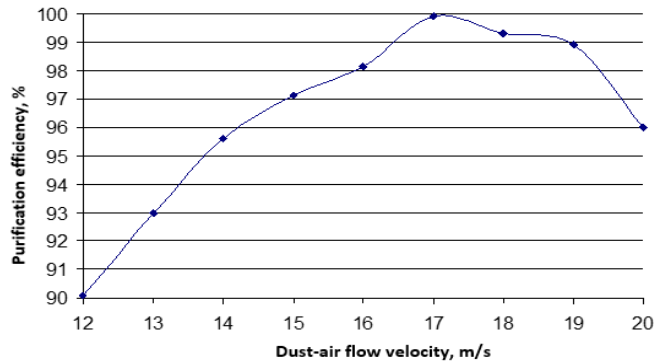


Figure 2. Effect of dust–air flow velocity on purification efficiency

To determine the effect of structural modifications on the hydraulic resistance of the two-stage system, a series of experiments was carried out. Pressure loss was measured by recording the pressure at the inlet and outlet of the apparatuses using U-shaped micromanometers. The difference in total pressure between the inlet and outlet was taken as the hydraulic resistance of the apparatus. Based on the magnitude of the hydraulic resistance, the energy losses in the apparatus under different operating parameters (at inlet velocities from 12 to 20 m/s) were evaluated. The hydraulic resistance coefficient of the model apparatus was calculated using the formula:

$$\xi = \frac{\Delta P}{\frac{\rho \omega^2}{2}}, \tag{2}$$

where ΔP is the pressure drop in the apparatus (Pa), ω is the inlet air velocity (m/s), and ρ is the air density (kg/m^3).

The pressure loss in the cyclone was calculated using the following expression:

$$\Delta P = \xi \frac{\rho \omega^2}{2}, \tag{3}$$

where ξ is the hydraulic resistance coefficient of the cyclone.

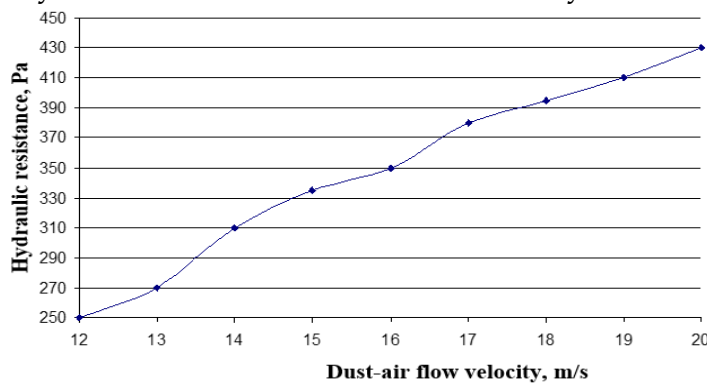


Figure 3. Effect of dust–air flow velocity on the hydraulic resistance of the model cyclone

From Figure 3, it can be seen that at a flow velocity of 12 m/s in the first stage, the cyclone’s hydraulic resistance is 250 Pa, and the air purification efficiency is 90.1%. As the flow velocity increases to 20 m/s, the hydraulic resistance of the cyclone rises to 430 Pa, and the purification efficiency increases to 96%.

Based on the experimental results, the optimal values were determined as follows: dust–air flow velocity – 17 m/s, purification efficiency – 99.9%, and cyclone hydraulic resistance – 380 Pa.

The total hydraulic resistance of the two-stage installation was also determined (Figure 4). As shown in Figure 4, at a flow velocity of 12 m/s, the overall hydraulic resistance of the installation is 400 Pa, whereas at 20 m/s, it increases to 1170 Pa. The optimal dust–air flow velocity of 17 m/s corresponds to a hydraulic resistance of 820 Pa [10,11].

According to the measurements, the average hydraulic resistance coefficients of the apparatuses in the two-stage experimental setup are as follows: cyclone – $\xi = 1.01$, scrubber – $\xi = 4.72$.

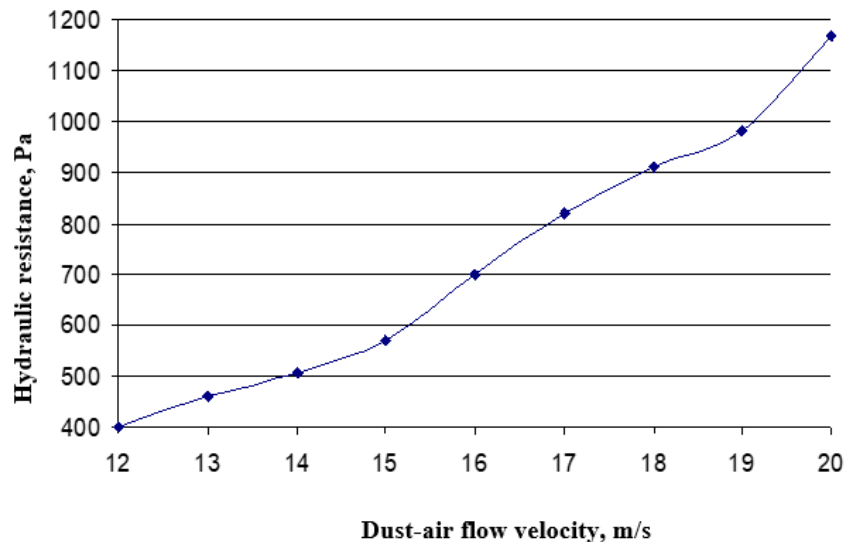


Figure 4. Effect of dust–air flow velocity on the total hydraulic resistance of the two-stage experimental setup

During the studies, measurements were carried out to determine the flow rate and dust concentration of the dust–air stream, pressure losses, and the particle size distribution of the dust. The research aimed to study the hydrodynamic characteristics [12] of the model process line and the patterns of dust particle capture using the effects of coagulation and recirculation of purified air.

The experimental results made it possible to establish the effect of the inlet velocity of the dust–air flow on the fractional purification efficiency [13,14] in the model technological line.

The table below presents the results showing the dependence of the fractional purification efficiency on the dust–air flow velocity.

To determine the influence of the fractional composition of cotton dust on the air purification efficiency in the two-stage installation, a series of experiments was performed.

Pressure losses were measured at the inlet and outlet of the apparatus using U-shaped micromanometers. The difference in total pressure between the inlet and outlet was taken as the hydraulic resistance of the technological line. Based on the obtained hydraulic resistance, energy losses in the apparatuses were evaluated under different operational parameters. The air–dust flow velocity was varied within the range of 12–20 m/s.

The pressure drop in the scrubber was determined by the following equation (Pa):

$$\Delta P_{\text{скр}} = K_{\text{ч}} \cdot P_{\text{в1}} (Q_{\text{в1}}/Q_{\text{г1}}) \tag{4}$$

where $K_{\text{ч}}$ is the total contact energy, $Q_{\text{в1}}$ and $Q_{\text{г1}}$ are the volumetric flow rates of water and gas at the scrubber inlet (m^3/s), and $P_{\text{в1}}$ is the spray liquid pressure (Pa).

Table 1. Effect of inlet dust–air flow velocity (at dust concentration $3500 \text{ mg}/\text{m}^3$) on the fractional purification efficiency in the model two-stage installation.

№	Dust-air flow speed, m/s	Hydraulic resistance of the installation, Pa	Average fractional cleaning efficiency, % (by fraction)						
			Dust particle size, μm						
			<5	5-10	10-20	20-40	40-60	>60	
1	12	400	65,3	74,6	81,5	89,2	95,5	97,3	
2	13	460	68,4	77,5	84,4	89,9	95,9	97,9	
3	14	505	73,5	81,2	87,9	90,6	96,7	98,3	
4	15	570	74,9	84,4	89,6	92,8	97,1	98,8	
5	16	700	79,7	86,8	91,2	93,8	98,2	99,2	
6	17	820	86,6	89,5	94,1	96,6	99,65	99,98	
7	18	910	85,7	88,6	93,9	96,1	98,5	99,3	
8	19	980	85,1	88,01	93,3	95,8	98,1	98,8	
9	20	1170	84,2	87,3	93,0	95,1	97,8	98,2	

From the obtained experimental data, it follows that as the inlet dust–air flow velocity increases from 12 to 17 m/s, the purification efficiency rises from 86.6% (for particles $<5 \mu\text{m}$) to 99.98% (for particles $>60 \mu\text{m}$).

Further increasing the velocity to 20 m/s adversely affects purification performance, causing efficiency to decrease from 84.2% to 98.2%.

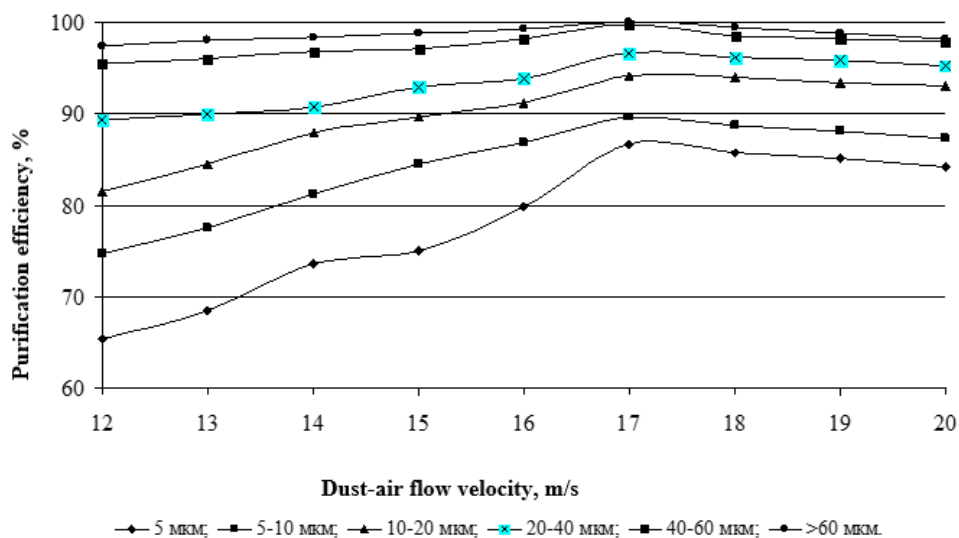


Figure 5. Effect of inlet dust–air flow velocity on fractional purification efficiency for various particle size ranges

The overall hydraulic resistance of the two-stage model installation is 400 Pa at a flow velocity of 12 m/s, and increases to 1170 Pa when the velocity reaches 20 m/s. The optimal dust–air flow velocity of 17 m/s corresponds to a total hydraulic resistance of 820 Pa.

Conclusion. Based on the results of the conducted experimental research, it can be concluded that the two-stage installation for deep air purification, comprising a cyclone with a string-type coagulator and a scrubber with a floating packing, provides a high dust collection efficiency of up to 99.9% while meeting sanitary concentration limits (≤ 80 mg/m³). The system effectively captures both fibrous and fine mineral dust particles through the combined mechanisms of coagulation, centrifugal separation, and wet scrubbing. The optimum operational parameters were determined as a dust–air flow velocity of 17 m/s and a hydraulic resistance of 820 Pa, ensuring efficient and stable operation with minimal energy losses. The obtained results demonstrate the technical feasibility and practical potential of the developed two-stage unit for implementation in industrial air purification systems, particularly in cotton-processing and similar dust-intensive industries.

References

1. **Research report (TsNIIKhProm).** *Development of a sedimentation–discharge device for capturing large fractions of cotton dust contained in exhaust air* (Final report). Tashkent, 2001. pp. 8–21.
2. **Belousov, V.V.** *Theoretical Fundamentals of Gas Cleaning Processes*. Moscow: Metallurgiya, 1988. – 255 p.
3. **Romankov, P.G., Kurochkina, M.I.** *Hydromechanical Processes of Chemical Technology*. 2nd ed., revised and enlarged. Leningrad: Khimiya, 1974. – 288 p.

4. **Yajun Deng, Lin Zhang, Hao Hou, Bo Yu, Dongliang Sun.** Modeling and simulation of the gas–liquid separation process in an axial flow cyclone based on the Eulerian–Lagrangian approach and surface film model. *Powder Technology*, Vol. 353, 15 July 2019, pp. 473–488.
<https://doi.org/10.1016/j.powtec.2019.05.039>
5. **S. Heidenreich, U. Vogt, H. Büttner, F. Ebert.** A novel process to separate submicron particles from gases — a cascade of packed columns. *Chemical Engineering Science*, Vol. 55, No. 15, 1 August 2000, pp. 2895–2905.
[https://doi.org/10.1016/S0009-2509\(99\)00554-0](https://doi.org/10.1016/S0009-2509(99)00554-0)
6. **Linjun Yang, Jingjing Bao, Jinpei Yan, Jinhui Liu, Shijuan Song, Fengxian Fan.** Removal of fine particles in a wet flue gas desulfurization system by heterogeneous condensation. *Chemical Engineering Journal*, Vol. 156, Issue 1, 1 January 2010, pp. 25–32.
<https://doi.org/10.1016/j.cej.2009.09.026>
7. **Tzu-Ming Chen, Chuen-Jinn Tsai, Shaw-Yi Yan, Shou-Nan Li.** An efficient wet electrostatic precipitator for removing nanoparticles, submicron and micron-sized particles. *Separation and Purification Technology*, Vol. 136, 5 November 2014, pp. 27–35.
<https://doi.org/10.1016/j.seppur.2014.08.032>
8. **Kuang-Yu Liu, Ming-Yen Wey.** Filtration of fly ash using a fluidized bed at 300–500 °C. *Fuel*, Vol. 86, Issues 1–2, January 2007, pp. 161–168.
<https://doi.org/10.1016/j.fuel.2006.06.020>
9. **Bo-Chin Chiang, Ming-Yen Wey.** Control of acid gases using a fluidized bed adsorber. *Journal of Hazardous Materials*, Vol. 101, Issue 3, 1 August 2003, pp. 259–272.
[https://doi.org/10.1016/S0304-3894\(03\)00141-9](https://doi.org/10.1016/S0304-3894(03)00141-9)
10. **Khurmamatov, A.M.** Study of the influence of operational and structural parameters of a cyclone on the efficiency of air purification from fibrous particles. *Uzbek Chemical Journal*, Tashkent, 2008, No. 3, pp. 114–117.
11. **Salimov, Z.S., Yuldashev, N.Kh., Khurmamatov, A.M.** Study of the settling velocity of fibrous particles in a centrifugal field. *Uzbek Chemical Journal*, Tashkent, 2007, No. 3, pp. 45–47.
12. **Morgulis, M.L., Mazus, M.G., Mandriko, A.S., Birger, M.I.** *Bag Filters*. Moscow: Mashinostroenie, 1977. – 256 p.
13. **Khurmamatov, A.M., Baltaev, T.S., Khudayberdiev, A.A.** On the aerodynamics of fibrous particles in a centrifugal field. In: *“Training Competitive Specialists: Experience and Challenges”* — Proceedings of the Republican Scientific-Practical Conference, Part II. Namangan, 2007, pp. 95–96.
14. **Khurmamatov, A.M.** Study of the influence of operational and structural parameters of a cyclone on the efficiency of air purification from fibrous particles. *Uzbek Chemical Journal*, 2008, No. 3, pp. 114–117.

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