ВЕСТНИК
ДОНБАССКОЙ НАЦИОНАЛЬНОЙ АКАДЕМИИ СТРОИТЕЛЬСТВА И АРХИТЕКТУРЫ

ISSN 2519-2817 online
Здания и сооружения с применением новых материалов и технологий
Выпуск 2019-3(137)

UDC 621.928.9

BORIS ROMANENKO, STANISLAV ORLOV, TAMARA ZAGORUYKO
Donbas National Academy of Civil Engineering and Architecture

ENERGY SAVING WHEN COLLECTING DUST IN CYCLONES DUE TO MORE COMPLETE USE OF THE ENERGY EXPENDED

Abstract. The ecological aspects of the current state of the issue of dust removal, the main devices used in modern systems of dust and gas cleaning, methods of improving the cleaning efficiency are considered.

Key words: fine particles, inertial dust collector, cyclone, electric cyclone, triboelectricity.

THE FORMULATION OF THE PROBLEM

Nowadays, one of the main and unresolved issues, associated with pollution of the atmosphere of large cities, is the problem of fine particles in suspension in the air. One of the significant factors of air pollution in urban areas are suspended particles of various fractions. Fine suspended substances, by themselves and in combination with other pollutants, pose a threat to human health [1].

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

The content of small particles of harmful substances in the atmospheric air has a detrimental effect on human health. These particles enter the atmosphere as a result of the operation of automobile engines, combustion of coal and wood, waste, and, of course, from industry, and every year there is an increase in mortality from polluted air [1].

According to new estimates of the World Health Organization, in 2012, approximately 12.6 million people died, because they lived or worked in unhealthy conditions – this is almost every forth person out of the total number of deaths in the world. Environmental risks such as air, water and soil pollution, exposure to chemicals, climate change and ultraviolet radiation contribute to the emergence of more than 100 diseases and injuries.

Protection of the atmosphere is a social and economic problem, which is inextricably linked with the task of creating comfortable conditions for a person's life and work.

Dust-gas emissions from industry have a significant impact on the environment and the atmosphere as a whole. Production of building materials makes a significant negative contribution to the overall environmental performance of the region, since most technological processes are inextricably linked with the formation of dust and its subsequent release into the atmosphere. Such industrial emissions may contain valuable half-finished material that are irretrievably lost. Therefore, cleaning and neutralization of industrial emissions are of sanitary and economic importance [2].

PURPOSE

Analyze the main devices for dust removal from gases. Suggest a way to improve cleaning efficiency.

MAIN MATERIAL

Cyclones are the most characteristic representatives of dry inertial dust collectors [3, 4]. The wide distribution of inertial dust collectors in the industry is associated with the following advantages over other devices of a similar purpose:

1) relatively low cost and simplicity of design;

2) the ability to work in conditions of high temperatures and pressure without any significant changes in the design;

3) the ability to capture and classify abrasives, while protecting the internal surfaces of separators with special coatings;

4) high performance while maintaining the required level of fractional purification efficiency with increasing mass concentration of the solid phase;

5) the possibility of dry material deposition.

In view of these advantages, inertial dust collectors are widespread.

With all the variety of design, inertial dust collectors can be divided into the following types [3]:

– reciprocating (countercurrent) cyclones;

– direct-flow cyclones;

– vortex dust collectors (VDC) or dust collectors with counter-swirling flows (CSF).

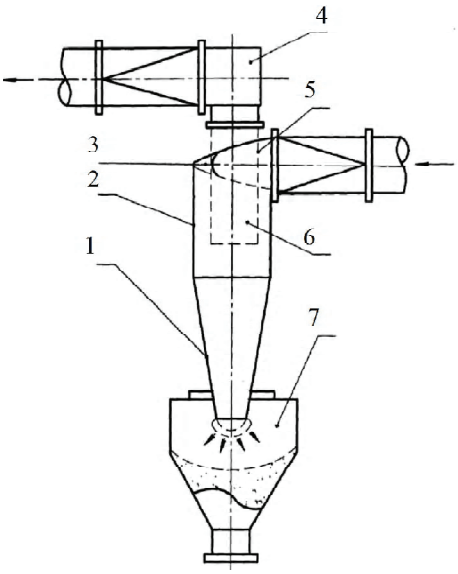

Figure 1 – The cyclone pattern: 1 – conical part of the body; 2 – cylindrical part of the body; 3 – screw cap; 4 – clean gas chamber; 5 – pipe entry dusty gas; 6 – exhaust pipe; 7 – cyclone bunker.

The most popular dry mechanical dust collectors are reciprocating cyclones. They are also called inertial dust collectors or simply cyclones. The cyclone pattern is shown in Figure 1.

At the moment, the most widespread are cyclones of the NIIOGAZ structures, which may have a cylindrical and conical shape.

Cylindrical cyclones of the CN series are used to trap dry dust of aspiration systems. They are proposed to be used for pre-treatment of gases with an initial dust content of up to 400 g/m^3 and mounted in front of filters and electrostatic precipitators.

A distinctive feature of this series of devices is the presence of an elongated cylindrical part, the slope of the lid and inlet pipe, respectively, 11, 15 and 24° and the same ratio of the diameter of the exhaust pipe – d to the cyclone diameter $D = d / D = 0.59$.

Modern-day cyclones have a high degree of efficiency in trapping particles as small as 10 microns [4]. Currently, there are a large number of studies on the issue of increasing the efficiency of cyclones, as well as a large number of cyclone types have been created, however, it is impossible to achieve that cyclones are used as an independent apparatus for cleaning gas from dust, therefore cyclones are usually used for pre-treatment gas from dust.

There are also cleaning devices of combined action. They combine the advantages of various types of dust and gas cleaning machines. One of the types of such devices is a centrifugal electrostatic precipitator or electrocyclone. In it a centrifugal dust collector – a cyclone and an electrostatic precipitator is located in the common case. Devices of this type can be divided according to the location of the electrical part into 2 groups:

1) discharge electrodes are located in the cylindrical part of the cyclone, Figure 2;

2) discharge electrodes are located in the exhaust pipe, Figure 3.

Electric cyclones are more efficient than cyclones, they also allow you to catch particles up to 10 microns in size. But this type of apparatus is not widespread. This is due to a significant increase in the cost of maintenance and an increase in the energy costs, with rising energy prices, for creation of electric field, at , is currently not acceptable.

Currently, the energy spent on the spin of the gas stream is not used efficiently. Currently, only centrifugal forces are used in existing cyclones. The concomitant electrization of the dust flow arising from the interaction of particles between

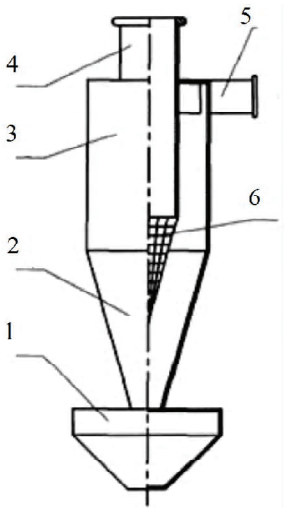

Figure 2 – Discharge electrodes are located in the cylindrical part of the cyclone: 1 – bunker; 2 – cone; 3 – cylindrical part; 4 – exhaust pipe; 5 – inlet; 6 – corona electrode.

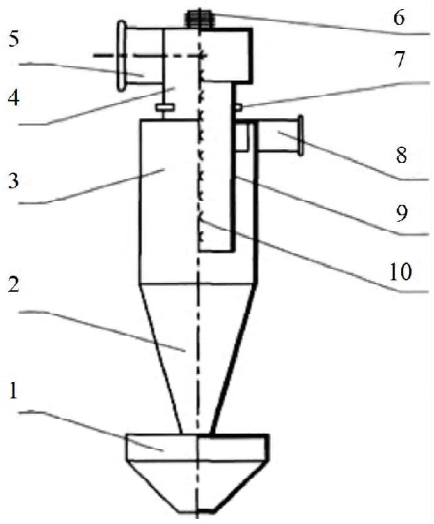

Figure 3 – Discharge electrodes are located in the exhaust pipe: 1 – bunker; 2 – cone; 3 – cylindrical part; 4 – exhaust pipe; 5 – snail; 6 – high-voltage insulator; 7 – fitting; 8 – inlet; 9 – collecting electrode; 10 – corona electrode.

themselves and with the walls of the cyclone is not used. As a result of this interaction, the dust particles acquire a fairly strong electric charge.

The experiments conducted by N. A. Gezichus [5] showed that dust blown off or rolling down from the surface of the formed body should always be negatively electrified, while the body itself must at the same time acquire a positive charge of electricity. Based on his research, the author came to the conclusion that when a smooth surface touches the rough surface of two pieces of the same body, the first of them charges positively (+), and the second negatively (-).

In a cyclone, large dust particles are located near the outer wall of the cyclone, and small ones are7 in the center of the core of the ascending vortex [6]. Thus, inside the cyclone there will be two space charge zones – in the center of the cyclone a zone of negative charge (-), and at the walls of the cyclone a zone of positive charge (+).

CONCLUSION

The cyclone is a fairly powerful triboelectric generator. This phenomenon is very valuable, since it is possible without the use of external sources of electrical energy, to increase the drift velocity of dust particles to the walls of the cyclone, using the Coulomb force, or the Lorentz force.

REFERENCES

1. Оценка взвешенных частиц PM10 и PM2,5 в атмосферном воздухе жилых зон [Текст] / Р. В. Орлов, А. Б. Стреляева, Н. С. Барикаева // Альтернативная энергетика и экология. – 2013. – № 12. – С. 39–41.
2. Методическое пособие по расчету, нормированию и контролю выбросов вредных (загрязняющих) веществ в атмосферный воздух [Текст]. – Введ. 2012-01-01 / ОАО «Научно-исследовательский институт охраны атмосферного воздуха». – СПб. : ОАО «НИИ Атмосфера», 2012. – 50 с.
3. Балтренас, П. Б. Обеспыливание воздуха на предприятиях стройматериалов [Текст] / П. Б. Балтренас. – М. : Стройиздат, 1990. – 184 с.
4. Очистка промышленных газов от пыли [Текст] / В. Н. Ужов, А. Ю. Вальдберг, Б. И. Мягков [и др.]. – М. : Химия, 1981. – 392 с.
5. Гезихус Н. А. Электризация пыли [Электронный ресурс] / Н. А. Гезихус // Журнал «Самообразование». – Режим доступа : http://www.bolshoy-beysug.ru/zhurnal/1125-elektrizatsiya-pyli.html.
6. Lacks, D. J. Effect of particle size distribution on the polarity of triboelectric charging in granular insulator systems [Text] / D. J. Lacks & A. Levandovsky // J. Electrostatics. – 2007. – № 65. – P. 107–112.

Получено19.03.2019

Б. Р. РОМАНЕНКО, С. М. ОРЛОВ, Т. И. ЗАГОРУЙКО
ЭНЕРГОСБЕРЕЖЕНИЕ В ЦИКЛОНАХ ЗА СЧЕТ БОЛЕЕ ПОЛНОГО ИСПОЛЬЗОВАНИЯ ЗАТРАЧЕННОЙ ЭНЕРГИИ
ГОУ ВПО «Донбасская национальная академия строительства и архитектуры»

Аннотация. Рассмотрены экологические аспекты современного состояния вопроса пылеудаления, основные устройства, используемые в современных системах пылегазоочистки, методы повышения эффективности очистки.
Ключевые слова: мелкодисперсные частицы, инерционный пылеуловитель, циклон, электроциклон, трибоэлектричество.

Б. Р. РОМАНЕНКО, С. М. ОРЛОВ, Т. І. ЗАГОРУЙКО

ЕНЕРГОЗБЕРЕЖЕННЯ В ЦИКЛОНАХ ЗА РАХУНОК БІЛЬШ ПОВНОГО ВИКОРИСТАННЯ ВИТРАЧЕНОЇ ЕНЕРГІЇ

ДОУ ВПО «Донбаська національна академія будівництва і архітектури»

Анотація. Розглянуто екологічні аспекти сучасного стану питання пиловидалення, основні пристрої, що використовуються в сучасних системах пилогазоочистки, методи підвищення ефективності очищення.

Ключові слова: дрібнодисперсні частинки, інерційний пиловловлювач, циклон, електроциклон, трибоелектрика.

Романенко Борис Романович – аспирант кафедры теплотехники, теплогазоснабжения и вентиляции ГОУ ВПО «Донбасская национальная академия строительства и архитектуры». Научные интересы: энергоресурсосбережение в системах отопления, вентиляции и кондиционирования воздуха.

Орлов Станислав Михайлович – кандидат технических наук, доцент кафедры автоматизации и электроснабжения в строительстве ГОУ ВПО «Донбасская национальная академия строительства и архитектуры». Научные интересы: автоматизация процессов и аппаратов систем ТГВ.

Загоруйко Тамара Ивановна – доцент кафедры иностранных языков и педагогики высшей школы ГОУ ВПО «Донбасская национальная академия строительства и архитектуры». Научные интересы: методика преподавания иностранных языков, роль преподавателя в учебном процессе, проблемы воспитания студенческой молодёжи.

Романенко Борис Романович – аспірант кафедри теплотехніки, теплогазопостачання та вентиляції ДОУ ВПО «Донбаська національна академія будівництва і архітектури». Наукові інтереси: енергоресурсозбереження в системах опалення, вентиляції та кондиціонування повітря.

Орлов Станіслав Михайлович – кандидат технічних наук, доцент кафедри автоматизації і електропостачання в будівництві ДОУ ВПО «Донбаська національна академія будівництва і архітектури». Наукові інтереси: автоматизація процесів і апаратів систем ТГВ.

Загоруйко Тамара Іванівна – доцент кафедри іноземних мов та педагогіки вищої школи ДОУ ВПО «Донбаська національна академія будівництва і архітектури». Наукові інтереси: методика викладання іноземних мов, роль викладача в навчальному процесі, проблеми виховання студентської молоді.

Romanenko Boris – graduate student, Engineering, Heat and Gas Supply and Ventilation Department, Donbas National Academy of Civil Engineering and Architecture. Scientifics interests: energy saving in heating, ventilation and air conditioning.

Orlov Stanislav – Ph. D. (Eng.), Associate Professor, Automation and Power Supply in Construction Department, Donbas National Academy of Civil Engineering and Architecture. Scientifics interests: automation of processes and devices of DVT systems.

Zagoruyko Tamara – Associate Professor, Foreign Languages and High School Pedagogy Department, Donbas National Academy of Civil Engineering and Architecture. Scientifics interests: teaching methods of foreign languages, lecturer's functions in a teaching process, students' education problems.