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К вопросу об изучении пылевидных образований в городских экосистемах

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Резюме: По данным Всемирной организации охраны здоровья, более 80% жителей городов подвергаются риску из-за недостаточного качества атмосферного воздуха. Загрязнение атмосферного воздуха является причиной приблизительно 4.2 миллиона смертей в год. Цель работы – дать обзор научных статей, касающихся запыленности природных сред города. Были проанализированы статьи зарубежных и российских исследователей – дано определение городской дорожной пыли, рассмотрены главные техногенные и природные источники генерации пылевых частиц в городе, физические и химические свойства дорожной пыли, их зависимости от климата, типа дорог и архитектуры города, влияние процессов фотолиза на физико-химические показатели мелкодисперсных частиц. Особое внимание уделено негативному влиянию частиц пыли PM2.5 и PM10 на здоровье человека и окружающую среду. Рассмотрен вопрос отсутствия в российской научной практике официально признанной методологии пробоотбора осевшей пыли при обновлении нормативной документации по методике отбора мелкодисперсных частиц, взвешенных в воздухе. Дана рекомендация по созданию нормативной базы, регулирующей процедуры пробоотбора и анализа дорожной пыли, являющейся геоиндикатором состояния окружающей среды, что подтверждается многочисленными выводами как зарубежных, так и некоторых отечественных исследователей.

Ключевые слова: PM2.5, PM10, мелкодисперсные частицы, пробоотбор.

On the question of studyng dust-like formations in urban ecosystems

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Abstract: According to the World Health Organization, more than 80% of urban residents are at risk due to unsatisfactory air quality and air pollution, which causes approximately 4.2 million deaths per year. The purpose of the work is to give an overview of scientific articles related to the dustiness of the city's natural environments. The articles of foreign and Russian researchers were analyzed – the definition of urban road dust was given; the primary technogenic and natural sources of dust particle generation in the city, the physical and chemical properties of road dust, their dependence on climate, the type of roads and city architecture, the effect of photolysis on physical-chemical characteristics of dust particles are reviewed as well. Particular attention is paid to the negative impact of dust particles PM2.5 and PM10 on human health and the environment. The question of the absence in Russian scientific practice an officially recognized methodology for the settled dust sampling with updating the regulatory documentation on the methodology for the sampling of fine particles suspended in the air is considered. Recommendations are given on the creation of the regulatory framework governing the sampling and analysis of road dust, which is confirmed by the numerous conclusions of both foreign and some domestic researchers as an environmental geo-indicator.

Keywords: PM2.5, PM10, ultrafine particles, sampling.

INTRODUCTION

The study of the role of microparticles in the formation of a comfortable and safe environment in cities is currently an urgent scientific and practical problem.

Long-term studies performed by WHO confirm that high concentrations of airborne pollutants increase urban mortality. In the scientific literature the abbreviation PM (from "particulate matter") is a universally recognized designation for dust particles, the number after PM indicates the maximum particle diameter in micrometers – PM1, PM2.5, PM10 (Amato et al., 2011).

SOURCES OF STREET DUST

Sources of dust particles in urban conditions can be both technogenic – erosion of the roadway, road cleaning machines and brake pads, construction machines (Kupiainen et al., 2007), and natural – weathering of urban soils, volcanic ash, etc (Mazzei et al., 2008).

Technogenic sources associated with the functioning of transport can be divided into two subspecies:

- non-exhaust sources are not related to vehicle emissions, while dust particles are formed during mechanical abrasion: tire wear, brakes and road surface and road dust suspension (Rogge et al., 1993);

- exhaust sources associated with vehicle exhausts produce small particles with a diameter of < 2.5 μm and ultrafine particles (UFP) with a diameter of < 0.1 μm with a central core of elemental carbon, on which organic and inorganic compounds are absorbed the – so-called soluble organic fraction (SOF), which includes partially burnt fuel, residues of lubricating oil, tar-like particles and polycyclic aromatic hydrocarbons (PAHs) (Thorpe et al., 2008; Murakami et al., 2005).

The analysis of the data obtained in a number of European cities showed that the PM shares from non-exhaust and exhaust sources in the total volume of dust emissions associated with traffic are approximately equal (Querol et al., 2004).

In foreign studies, fine particles settled on the outer impermeable urban surfaces (roadway, pavement, roofs and walls of buildings, etc) are combined with the term “urban street dust” (Charlesworth et al., 2003). Road dust is listed separately, since transport communications are an important source and factor in the transformation of dust.

Road dust is considered to be a multi-component mixture of dust particles of different fractions deposited on road and roadside impermeable surfaces formed as a result of physical and chemical processes of natural (erosion of open ground, the ingress of plant materials on the roadway, etc) and anthropogenic (abrasion of the roadway, wear and tear of vehicles, the use of deicing reagents, incomplete combustion of fuel and etc) origin. Road dust particles accumulate toxic metals, metalloids and organic compounds on their surface and carry them billowing into the air by wind or air currents generated by traffic (Chow et al., 1996; Varrica et al., 2003; Amato et al., 2009a; Kosheleva et al., 2018).

Primary sources of road dust were listed in various surveys and include vehicle wear, construction work and roadsides, road maintenance activities, precipitation, plant materials, etc (Amato et al., 2014; Boulter, 2005; Denier van der Gon, 2013; EPA, 2011).

Due to the activation of airflow near the motorways, the dust content is also high there. Moderate winds (> 10 m/sec.) can carry particles of 1 mm in size and even larger ones through the air, as well as briefly lift and transport them in an airstream (so-called “saltation”). Particles < 0.05 mm can be carried even by weak winds. At a low wind speed of 2–3 m/sec., the smallest particles rise from the road surface because of the action of turbulent vortices near the ground and particles up to 1–2 microns in size do not settle under the influence of gravity (Viana et al., 2006; Charron, Harrison, 2005). Motor vehicle traffic leads to blowing dust from the roadway, which generates about 37%

PM10, 15% PM2.5 and 3% of the road transport emissions (Viana et al., 2006; Amato et al., 2009a; Chen et al., 2012).

The amount and chemical composition of road dust depends on the intensity of roadside soils erosion, the volume of emissions from mobile sources, the abrasion of road surfaces and markings, tires and brake pads wear, the corrosion of vehicles metal parts, as well as the traffic conditions, including the speed limit and a number of manoeuvres associated with stopping (Murakami et al., 2007; Irvine et al., 2009; Nazzal et al., 2013).

Different traffic flows affect the enrichment level of road dust for two reasons. The first one is "mechanical" – the higher speeds and blowing rates at highways intensify abrasion and weathering processes, which resulted in an increased proportion of large particles in settled dust comparing with small streets. In opposite, a large number of traffic lights, traffic jams and public transport stops on small and medium streets cause frequent interruptions and intensified abrasion of brake pads, tires and pavement, that increases proportion of fine particles in dust samples. Therefore, congestion and traffic lights, slowing the traffic flow to 20 km/h, lead to an increase in total traffic emissions by 30% (Putaud et al., 2004; Bityukova, Mozgunov, 2019; Matisakov et al., 2016). The second reason is "chemical"; the chemical composition of various types of fuels used for vehicles differs, as well as exhaust gases. The share of passenger transport (buses, trolleybuses, minibuses, etc) is larger on small and medium-sized intra-quarter roads, than on highways, where trucks and personal cars are dominant. Thus, when conducting ecogeochemical assessments of the impact of transport on the environment and ecogeochemical monitoring of urban areas it is necessary to study not only large highways, but also small and medium streets, where the traffic flow and wind speeds are lower and PM1-10 and PM1 accumulate concentrated heavy metals. Among them the most intensively accumulated ones are poorly studied in urban landscapes Sb, Cd, Ag (Varrica et al., 2003; Amato et al., 2009, Wei et al., 2010).

ROAD DUST – PHYSICAL AND CHEMICAL PROPERTIES

Road dust may be used as an informative geoindicator for geochemical assesment of cities in the warm-season, in the absence of snow cover or year-round. The analysis of studies on the chemical composition of road dust is becoming increasingly relevant, chemical and isotopic composition of dust allows tracking the primary sources of elements in the urban environment (Varrica et al., 2003; Ladonin, Plyskina, 2009). Some studies are focused on mineralogical and granulometric composition properties of road dust (DUST…, 2014).

At the elemental level, the distribution of Cd, Pb, Zn, Cu, Ni, Cr, Mn, Fe is studied better than of Sb, Bi, Mo, Ag, As (Day, 1975; Duggan, 1977; Varrica et al., 2003; Ahmed, Ishiga, 2006; Amato et al., 2009b; Quiroz et al., 2013). The maximum concentrations of Zn, Cu, and Cd are found in dust settled near the curbstone; at the distance of 1 m from curbstone concentrations of Pb, Fe, and Ni reach their maximum. Exhaust gases contain Cu, Pb, Sr, motor oil – Fe, Mo, Zn, Cu, Pb, Sb; tire abrasion is the source of Cd, Mn, Fe, Zn, Pb, Co, Ni, Cr, Cu and Sb, brake pad wear – Fe, Cu, Sb, Mn, Zn, Ti, Pb (Limbeck, Puls, 2011; Adachi, Tainosho, 2004; Iijima et al., 2007; Gietl et al., 2010; Quiroz et al., 2013).

In Russia the accumulation of heavy metals and metalloids in road dust was studied only in several cities – in the Perm Territory, Ekaterinburg, in the Selenga River Basin (the Republic of Buryatiya), Voronezh and some areas of Moscow (Kaigorodov et al., 2009; Ladonin, Plyaskina, 2009; Fedotov et al., 2014; Vlasov et al., 2015; Bityukova et al., 2016; Sereda, 2015; Prokof'eva et al., 2017; Ladonin et al., 2018; Seleznev, 2018; Kasimov et al., 2019b).

Urban road dust created by vehicle traffic is a depot for polycyclic aromatic hydrocarbons (PAHs), widely spread in urban environments; one of the main sources of PAHs is the incomplete combustion of fuel in internal combustion engines.

Polycyclic aromatic hydrocarbons (PAHs) are persistent and ubiquitous pollutants in urban environments. Some PAHs, such as benzo[a]pyrene, benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene and indeno [1,2,3-cd]pyrene, it is reported to be toxic and mutagenic (Nisbet, LaGoy, 1992; USEPA, 1993; Soltany et al., 2015), while benzo[b]fluoranthene is recognized as a carcinogen (Baird et al., 2005).

Most international studies of PAHs in road dust have focused on chemical characteristics based on fraction size, seasonal variations, types of road surfaces, traffic intensity, types of vehicles, speed and other aspects of the urban environment, with particular attention being paid to Tokyo metropolitan areas, Japan (Murakami et al., 2005), Dalian, China (Wang et al., 2009), Cairo, Egypt (Hassanien, Abdel-Latif, 2008), Ulsan, South Korea (Dong, Lee, 2009), Guangzhou, China (Wang et al., 2011), Sydney, Australia (Nguyen al., 2014) and Esfahan, Iran (Soltani et al., 2015).

The Russian history of studying the pollution of PAHs of settled dust particles is relatively short, and performed by a research group led by Academician N.I. Kasimov, studied the differentiation of benzo[a]pyrene in the dust of various types of roads in the administrative districts of Moscow and Alushta. A hazardous environmental situation characterizes Moscow road dust pollution, the average content of benzo[a]pyrene in the dust is 264 ng/g, which is 13.2 times more than the maximum permissible concentration for soils, and corresponds to an extremely dangerous environmental situation. The pollution level is exceptionally high in the northern, central and eastern parts of the city, mainly in the courtyards of residential buildings. The dust of the main highways and the Third Transport Ring is less polluted due to renewal of the road dust substance as a result of frequent sweeping and washing of the roadbed by city services (Kasimov et al., 2017; Vlasov et al., 2018; Kasimov et al., 2019). The average content of benzo[a]pyrene in road dust in Alushta as a whole is 97.3 ng/g, and of the PM10 fraction – 238.2 ng/g, which exceeds the maximum permissible concentration by 5 and 12 times, respectively (Bezberdaya et al., 2017).

Road dust is not only the main depot for polycyclic aromatic hydrocarbons (PAH), but also for substances converted (transformed) from PAH – transformed PAH products (TPPs) (Gan et al., 2009; Gupta and Gupta, 2015). TPPs can occur directly or indirectly in the process of fuel combustion and post-emission conversion and PAH degradation (Albinet et al., 2006, 2007). Currently there is a growing research interest in the distribution and transformation of PAHs in the environment due to the harmful effects of these pollutants on human health and the environment. Some of the TPPs have been studied and recognized as carcinogenic, mutagenic and oncogenic (Abdel-Shafy, Mansour, 2016; IARC, 1987). Several studies have confirmed the hypothesis that the toxic effects of PAHs and TPPs are affected by the processes of their post-emission transformation and degradation (Gan et al., 2009; Jia et al., 2014).

Some TPP species, such as oxygenated PAHs (OPAH) and nitrated PAHs (NPAH), are potentially more toxic than their parental PAHs. NPAHs such as nitropyrene and dinitropyrene have a direct mutagenic effect on living organisms (Albinet et al., 2006, 2007). However, there is a lack of research on the origin and transformation of TPP after emission (Achten, Andersson, 2015; Albinet et al., 2007), especially in road dust, although there is a high potential for harmful effects of TPP by inhalation.

Photolysis is one of the key processes by which PAHs and TPPs can transform and decompose in dust particles that cover urban road surfaces (Gupta, Gupta, 2015; Zhang et al., 2010). Photolysis is the process of splitting chemical bonds due to the absorption of solar radiation (Vione et al., 2006). Because of the conjugated π-orbital electron systems, PAHs are classified as photoactive pollutants and are capable of absorbing photons (Jia et al., 2015). PAHs can absorb solar electromagnetic radiation in the UV and visible wavelength ranges of 280–400 nm and 400–760 nm, respectively (Arfsten et al., 1996; Fu et al., 2012; Mallakin et al., 2000; Yu et al., 2006).

Activated PAHs can then undergo photophysical and photochemical processes, especially in the presence of coexisting molecules such as oxygen, ozone, hydrogen and NO_x, followed by the formation of various TPPs. Transformation and degradation processes often lead to the formation of oxygenated PAHs, nitro-PAHs, aldehydes, ketones, carboxylic acid and phenols (Gbeddy et al., 2019). According to our knowledge, no studies have been conducted to evaluate the photoconversion and degradation of PAHs and TPPs on road surfaces. Existing studies are mainly related to soil and particles suspended in the atmosphere, whose compositional characteristics differ from settled dust particles.

DEPENDENCE ON SEASONAL PATTERNS AND CITY LANDSCAPE/TYPE OF ROADS

The ratio and composition of the PM0.1, PM1 and PM2.5 fractions prevailing in the cities are highly dependent on meteorological conditions and vary according to the seasons (Zhang et al., 2013).

Seasonal variations of dust load indicators in the urban environment depend on the climatic conditions. In countries with a snowy winter, the maximum dust load occurs in spring months after snowmelt, when particles of sand, salt, chemicals and road surfaces, worn out with studded tires, are directly released to the urban environment in a short time. In dry and hot climate the maximum dust load is recoreded in summer, in the hottest and driest months (Thorpe et al., 2008).

Sources of road dust vary significantly with a diversity of factors, such as the industrial specialization of the city, population, development of urban and housing infrastructure and the number of vehicles, etc, so the research results obtained in one city is unlikely to be representative of the situation in another (Vermette et al., 1991; Amato et al., 2011); however, in several studies the composition of road dust pollutants was analyzed depending on the size of the city (Fergusson, Ryan, 1984; Charlesworth, 2003).

In the study, performed by Ferguson and Ryan in 1984, 26 elements were found in street dust samplesobtained in London (UK), New York (USA), Halifax (Canada), Christchurch (New Zealand) and Kingston (Jamaica). Cities were divided into two groups: large (London and New York) and small (Halifax, Christchurch and Kingston). The elements were separeted into two groups as well: those that come mainly from the soil (for example, Al, K, Na, Th, Ce, La, Sm and Ti), and those that mainly come from other sources, including construction work, worn tires, vehicles emissions and salt (Ca, Cd, Pb, Cr, Zn, Cu and Au). Some rules were revealed: the first group elements are less concentrated in London and New York than in other cities, while the opposite is true for the second group of elements; concentrations of most elements increase with decreasing dust particle size.

INFLUENCE ON HEALTH

The main reason for the large amount of street dust research that has been accumulated over the past three decades in the foreign scientific literature – at least in developed regions of the world – is the concern about the potential effects of exposure by inhalation, ingestion and skin contact. Numerous studies have tried to establish various aspects of this problem, both for home and outdoor dust: the number and size of dust particles in the environment of the house/street, the deposition rate on the surface of the house/city, the rate of transfer into the human body, sources and the chemical composition of house/street dust, effects on the behaviour of children living in urban areas with high levels of toxic chemicals, etc (Pope, 2009).

In an urban atmosphere small particles have a negative effect primarily on the health of older people, pregnant women and children, who are most susceptible to them. The finely divided chemical constituents of PM have a strong health effect due to their carcinogenic or mutagenic nature. Most studies have shown that exceeding the permissible levels of PM10 and PM2.5 in the air affects health due to the chemical composition of dust particles. Dust particles bypass the protective mechanisms of the body, penetrate deep into the respiratory system and carry a mixture of substances harmful to human health (heavy metals, polyarenes, etc).

Currently, the main attention is paid to the environmentally most dangerous PM0.1 and PM1, penetrating into the pulmonary alveoli and bronchioles; less dangerous are PM1–2.5, which enter the lungs and bronchi, as well as PM2.5–10, which are retained by the upper respiratory tract (Tager, 2005). Reducing the size of aerosols increases the risk of mutagenesis, the maximum of which is fixed for PM2.5 and dust of a smaller diameter (Pagano et al., 1996). The list of diseases, the occurrence of which is associated with exposure to fine dust particles are given in Table 1.

Due to rapid urbanization, urban dust pollution is becoming a serious environmental problem in China and countries in the Asian region (Wang et al., 2008; Long et al., 2016). Most studies in this region have established a correlation between increased concentrations of toxic elements in street dust and the observed frequency of a particular effect in a population, mainly the dustiness of cities is identified as one of the factors that increase the proportion of lung cancer patients (He et al., 2001; Hu et al., 2011).

Table 1. Diseases associated with exposure to fine particles

Diseases	**References**
Pneumonia	Adar et al., 2007a Araujo, 2010 Brook, 2008 Driscoll, 2000 Dye et al., 2001
High blood pressure	Baccarelli et al., 2011 Bartoli et al., 2009 Hoffmann et al., 2012 Schwartz et al., 2012 Zanobetti et al., 2014
Microvascular impairment	Brauner et al., 2008
Increased blood coagulation and the likelihood of thrombosis	Baccarelli et al., 2007, 2008 Bind et al., 2012 Bonzini et al., 2010 Carlsten et al., 2007 Gilmour et al., 2005 Nemmar et al., 2002
Acceleration of atherosclerosis	Adar et al., 2010 Allen et al., 2009 Araujo et al., 2008 Bauer et al., 2010 Bhatnagar, 2006 Sun et al., 2005, 2008 Suwa et al., 2002 Tzeng et al., 2007
Oncology	Nafstad et al., 2003 Pope III et al., 2002 Tango et al., 1994
Premature birth	Bell et al., 2010 Kloog et al., 2012
Asthma	Acosta et al., 2011 Dominici et al., 2006
Diseases of children	Gent et al., 2009 Nicolai et al., 2003 Zheng et al., 2010
Diseases of the elderly	Adamkiewicz et al., 2004 Adar et al., 2007 Brook et al., 2010

ENVIRONMENTAL INFLUENCE

Soil formation

In urban ecosystems, the profile-forming process conducted under the influence of natural factors is often accompanied by a constant or periodic supply of material to the soil surface, which leads to the soil profile upward grow and to the formation of a layered stratum of different thickness and composition (Aparin, Sukhacheva, 2015).

Near motorways, where the process of dust transfer is intense, the possibility arises of not only the ingress of dust into the soil but also the formation of soil horizons from dust-aerosol deposition. The process of fine and coarse dust particles accumulation on urban surfaces is significantly accelerated with low-quality street cleaning and violation of the norms and rules of landscape planning (Klepikova et al., 2016; Vlasov et al., 2019).

In urban areas, there are few source materials for soil formation, the role of dust as a soil-forming material is especially high – settled dust particles must be considered as starting soil material, and their effect on the properties of urban soils should be studied (Kwasowski et al., 2009; Prokofieva et al., 2015). The settled dust particles can be treated as fundamentally new mineral phases, the genesis of which has been actively studied in recent decades. Ephemeral quasi-soil bodies, urban soils are characterized mainly by relatively small age, the dependence of the mineral composition on the geological structure of the territory, a wide granulometric composition, the presence of organic matter, and a variety of technogenic particles (Wei et al., 2010). Dust deposition processes in the urban environment are involved in the formation of substance flows at all stages, being both a source of pollution and a transit and depositing medium (Prokof'eva et al., 2015).

Plants

Due to this dustiness of the urban environment, plants suffer first of all from stomata covering with dust particles, which leads to changes in cells/tissues, leaf necrosis, pigment loss and chlorosis. Long-term deposits of dust on the surface of the leaves alter photochemistry, leading to a delay in crown growth. Currently, there are studies on the abrasive effects of dust, especially at high wind speeds, supporting secondary effects, such as the growth of plant diseases and pests since the protective cuticle of a leaf has been physically removed. Changes in the chemical composition of the soil due to dust deposition lead to a change in the nutritional value of the soil (Grafkina et al., 2016; Grantz et al., 2003; Leonard et al., 2016).

Particles of road dust enriched with heavy metals and PAHs can be washed away by water in urban bodies of water, which results in acidification and general inhibition of aquatic biota (Boonyatumanond et al., 2006).

STUDY METHODOLOGY

In Russia, there are no regulations governing the study of urban settled dust and an assessment of its environmental parameters. In this regard, researchers use proprietary techniques that are based on principles developed by the US Environmental Protection Agency (EPA USA). The procedure for the selection of dusty formations deposited on the surface of the roadway is carried out with a brush and a scoop by sweeping from the road surface along a regular grid of 600–800 m (Vlasov et al., 2017; Kasimov et al., 2017; Kosheleva et al., 2018; Kasimov et al., 2019).

In foreign research practice, in addition to EPA procedures, their variations are applied – vacuum suction usage, the method of collecting wet dust samples, etc. A description of dust deposition sampling methods is presented in Table 2.

When studying the properties of urban dust, as a rule, researchers applied the analytical methods used in the study of soils - determining the composition, gross content of heavy metals and metalloids, polyarenes, radionuclides, polycyclic aromatic hydrocarbons, electrical conductivity, pH, the amount of organic matter.

The quantification of resuspension of road dust in an urban environment is carried out using mathematical modelling (Multilinear Engine, PMF2). Statistical processing of the obtained data and the identification of possible sources of heavy metals and PAHs make extensive use of factor and cluster analysis in combination with correlation dependence analysis (Lu et al., 2010).

Table 2. Classification and description of dust sampling methods

Method	Largest fraction	Method summary	Sources
AP-42	75 μm	• Collection of dust material from the road surface using a brush/whisk/broom and a vacuum cleaner • Sieving in the laboratory to determine the fraction • Using the AP-42 emission model to calculate the emission factor depending on traffic and type of road surface	EPA, 1993a EPA, 1993b EPA, 2011
PI-SWERL/Mini PI-SWERL	PM10	• A device which is a sealed cylinder with two circular rings (inner diameter = 39 cm, outer diameter = 51 cm), which rotates at the height of 6 cm above the road surface. • Dust and sand are mobilized using a vortex created by rotating rings. • The concentration of dust in the chamber that spans the rings is measured using light scattering, which is used as a substitute for the indicator of mass concentration of solid particles.	Etyemezian et al., 2007 China, James, 2012
Vacuum method	PM10	• Collection of dust material from the road surface using a vacuum suction with integrated PM10 inlet • Air is sucked into the deposition chamber • PM10 particles are deposited on the filter	Amato et al., 2013
Wet dust sampler	2 мм	• Dust particles are washed off with high-pressure water from a selected section of the road • Using compressed air, contaminated water is sucked into the inner container	Lundberg et al., 2019

In Russian studies, for the data interpretation a technique is used based on the calculation of concentration, enrichment, and total pollution factors (Vlasov et al., 2017; Kasimov et al., 2017; Kasimov et al., 2019).

In Russia, the methodological aspects of sampling and studying atmospheric pollutant samples are regulated by the normative document RD 52.04.186-89 adopted by the State Hydromet Committee and the USSR Ministry of Health in the late 1980s. Despite its updating in 2016, this document does not reflect all the current specifics of studying the dusty formations of the urban environment; however, this problem has been developed since the time when this document was approved, 30 years ago.

In 2010 by the resolution of the Chief State Sanitary Doctor of the Russian Federation of April 19, 2010 (No. 26 GN 2.1.6.2604-10, supplement No. 8 GN 2.1.6.1338-2003) the regulation "Maximum permissible concentrations (MPC) of pollutants in the atmospheric air of populated areas" was approved and supposed to limit the maximum permissible concentration of suspended particles PM10 and PM2.5 in atmosphere.

In the FSBI "Main Geophysical Observatory named after A.I. Voeikova" (FSBI "GGO") and in the regulatory document (approved by Roshydromet RD 52.04.830–2015) "Mass concentration of suspended particles PM10 and PM2.5 in atmospheric air" there is a detailed description of the method for measuring the concentration of suspended dust particles. When choosing a method, the authors tend to recommend the gravimetric method developed by the European Commission for Standardization (CEN) for sampling and measuring suspended particles PM, recognized in the EU as a reference.

CONCLUSION

The creation and organization in the Russian Federation a monitoring system for atmospheric air pollution with suspended particles PM10 and PM2.5 shows that the goverment understands the importance of controlling the dustiness of urban environments because of the harm that small particles can do to human health.

However, the attention is predominantly focused only on PM10 and PM2.5 particles suspended in the air, while the settled ones are being ignored.

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