

Particular matters: a threat for human health

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ABSTRACT

Air surrounding us is a vital element as breathing is our life. The quality of the air we breathe is directly related to the physical state of the atmosphere from the emission of primary production and secondary pollutants in it. Pollutant is any substance which directly or indirectly emitted by man into the ambient air and likely to have harmful effects on human health and the environment. Therefore, the particulate matters are pollutants. The study of the presence of particulate matter in the atmosphere and their impact on human health and the environment is a very complex issue for the global scientific community. This is due to the heterogeneity of physical and chemical characteristics, depending on the source of emission and the generation mechanism, as well as differences in their concentrations according to season, region and the weather conditions. The effects of particulate matters are important and vary in all areas of the environment, but for the health in particular, the impacts which are caused depend mainly on their diameter, chemical composition as well as by the existence of other pollutants, which they react with.



Keywords: Particulate matters, health effects, chemical composition of particulate matters, sources of particulate matters.



Citation

O. Velentza. Particular matters: a threat for human health. Scientific Chronicles 2016;21(3): 233-244

INTRODUCTION

The term "suspended particulate matter" or "particulate matters" describes the dispersed air, solid or liquid particles of a size greater than that of simple molecules, but less than 500mm. Particulate matter come from a wide variety of sources and have a significant range of different morphological, chemical, physical and thermodynamic characteristics.

There have been detected concentrations of suspended particles in the atmosphere as of the mass of a few micrograms mg/m³ up to several hundred mg / m³ and this being in atmospheric polluted areas. [1]

The particles in the atmosphere differ from the gases in two points. Initially, a gas is composed of individual atoms or molecules which are separated, but a particle consisting

of an aggregation of molecules and atoms which form a bond. Secondly, unlike the gas the air particles exist in liquid or solid form.

CLASSIFICATION OF PARTICULATE MATTERS

1. Ranking according to their way of formation.

Depending on their origin, either from primary sources or from secondary processes, the particles are divided into: primary and secondary.

Primary particles are emitted directly from sources. Their atmospheric concentrations are usually proportional to the emitted quantities. A category of primary particles comes from the crushing of larger masses and resuspension of debris from the air. This category of particles is subjected to minimum transformation processes after their emission. Because of their relatively large size, they don't easily unite, but blend with other atmospheric constituents by mass transfer processes in the gas phase. A particularly important category of primary particles are the elemental carbon particles which are formed from the combustion processes.

Secondary particles are called those which are formed in the atmosphere from converting gases directly emitted from sources. The main precursors for the secondary particles are sulfur dioxide, ammonia and nitrogen oxides. Also, many volatile organic compounds (VOCs) can be transformed into particles. The majority of these transformations is the result of intense photochemical reactions. [2]

2. **Depending on how they are formed**, the suspended particles are classified into:

Dust: Small solid particles resulting from crushing of larger masses during procedures such as pressing, rubbing, explosion. Typical size of 1 to 10,000 microns.

Smoke: Small solid particles resulting from the incomplete combustion of organic materials such as coal, tobacco or wood. Typical size of 0.5 to 1mm.

Fly ash: Small non-combustible mineral or metallic particles emitted from the chimney during the burning of coal. Typical size of 1-1000 microns.

Carbon black: Small, solid particles formed by the condensation of vapors of solid materials, often metal oxides (such as oxides of zinc and lead) and elemental carbon. Typical size from 0.03 to 0.3 microns.

Spray: Liquid particles are formed by spraying liquid, such as pesticides or herbicides. Typical size of 10-1000 microns.

Fog: Liquid particles or droplets generated by condensation. Typical size of 0.1 to 10 microns.

Haze is called the aerosol which is produced under similar conditions with the fog, but with visibility greater than 1000 m. The typical particle size of the cloud is from 2 to 80 microns.

Finally, there are the **liquid particles** that occur in the atmosphere at a size larger than 100 microns, they have very little suspension and their name is identical of that of visible phenomena of rain. [3]

3. Classification of the size

The particles have various shapes and therefore it is impossible to express the common size parameter, since many properties of the particles depend on their size (volume, mass deposition rate).

Fine are called the particles with an aerodynamic diameter size up to 2.5 micrometers. Usually these particles are produced secondarily from gaseous compounds.

Coarse are called the suspended particles with aerodynamic diameter size greater than 2.5 micron. They are usually produced by mechanical means. [4]

The larger particles, for example those with a diameter of 10 microns, can remain suspended in the atmosphere of 10 to 20 hours, before precipitating in the lower part of the troposphere.

Accordingly, *smaller diameter particles* from 0.1 to 1 micron, it is possible to move up to several hundred kilometers from their point of emission.

A small proportion of suspended particles can reach the upper part of the troposphere and remain suspended for long periods of time for up to one year. [5]

4. Ranking in terms of penetration in the body.

The effect of particles in the human body is a matter of intense concern to the scientific community, and it is still being studied. However, to date conclusions seem to be found in the following subgroups of total suspended particles (TSP):

Inhalable particles. They are the suspended particles which enter the upper respiratory tract (oropharynx). They include particles of up to 10mm diameter, and the majority of particles with diameters greater than 10 microns are retained in the buccal and nasal cavity.

Thoracic particles. The suspended particles constitute the fraction of inhalable particles which manage to pass through the upper airways (oropharynx). It is considered to have a size less than 7mm.

Respirable particles. The particulate fraction with aerodynamic diameter smaller than 2.5 microns, is the most important in terms of impact on human health.

These particles generally manage to penetrate to the depths of the lungs, and for this reason are called respirable. [6]

Definitions: Measurement of particulate pollutants

Based on the ranking of total suspended particle size (coarse and fine) and in association with their penetration in the human body (inhalable and respirable), defined the two main categories measured particulate fractions between PM10 and PM2,5.

Both these fractions are included in the pollutant- criteria for the quality of air and both Europe and the USA have set the maximum permitted concentration limits in the outdoor atmosphere.

According to the definition as stated in EU directives, we have: «**PM10** means particles

passing through the chosen orifice size, which holds 50% of the aerodynamic diameter of 10 microns" and «PM_{2,5} means particles passing through the orifice size chosen, which retains 50% of particles of aerodynamic diameter 2,5mm."

It is observed that in urban areas where the dominant source of particles is the movement of vehicles, the UFPs constitute more than 90% of the total particles in the atmosphere. [6].

SOURCES OF PARTICULATE MATTERS

The sources of particulate matter is either primary (emitted into the atmosphere) or secondary (i.e., formed in the atmosphere from gaseous compounds by homogeneous or heterogeneous chemical reactions) (Table 1).

Human sources

Emissions from vehicles. The main sources of the emission of particulate matter come from vehicles are vehicle exhaust fumes and the wear of the tire and the brakes. Emissions from diesel engines mainly contain soot, i.e. particles of elemental carbon, volatile organic compounds and some sulfates from the sulfur content of the fuel.

When the organic compounds and sulfates are discharged from the exhaust of the vehicle to the environment, are concentrated on particulate matters and especially onto the carbon particles, which exist in the same exhaust gases. The particles which are formed in this way have a size from 0.01 to 2.5 microns.

The movement of vehicles on the roads cause resuspension of dust of the road. Particles are also emitted as a result of the wear of the brakes and the tires during use. These particles are estimated to be in the size range of 3-30 microns. [7]

Industrial emissions. Industrial emissions contribute to the production of particulate matters in urban areas, depending on the distance of the industry from the residential area and the technology which they use. The particles from industrial emissions generally have a size of 0.5 to 100mm, depending on the particular characteristics of the source.

An important source of fine particles are the energy producing industries.

Forest and agricultural fires. The overall contribution to air pollution from the smoke of the fire is temporary. However, in areas that there are large forest fires, this source can become very important. Both direct emissions and the resuspension of particles from the burned earth, can constitute an important source of particulate matters.

This pyrogenic material is composed of organic matter, elemental carbon and inorganic materials. Its great presentence is less than 10 microns and can easily be resuspended due to the wind.

Domestic sources. The most popular method of home heating is the burning of oil, which is a major source of fine particles. [8]

Surface ocean	Droplets which contain various salts from the effect of wind on the sea surface
Soil Surface	Dust
Volcanic eruptions	Includes primary and secondary particulate matters
Biogenic material	Primary and secondary particles concentrating organic compounds emitted by plants
Burning biogenic material	Smoke
Natural gas conversion products in particle	Sulfates by sulfur compounds emitted from the surface of the oceans

Table 1. Natural sources of particulate matters

CHEMICAL COMPOSITION OF PARTICLES

According to surveys, the mass of particulate matters consists of the following main categories of ingredients: (Ohta et al. 1998) (Table 2).

IMPACT OF PARTICULATE MATTER

Impact on the human body

Many a number of epidemiological studies attribute the exposure to particulate matter PM₁₀, PM_{2,5} and UFPs to serious health effects. The symptoms reported in the literature are numerous.

Exposure to particle pollution can cause or aggravate respiratory problems, cardiovascular diseases affect the self-cleaning mechanism of the body from foreign particles, can damage lung tissues, carcinogenesis and premature death.

These effects include some even less painful ones, such as persistent cough, phlegm, dizziness and sickness. [9]

It is generally recognized that long-term human exposure to high concentrations of suspended particles can reduce the life span of 1-2 years on average.

According to the WHO (World Health Organization), exposure to particulate matter is the cause of approximately 3.000.000 deaths per year worldwide. It is characteristic that the World Health Organization states that "available data on the long and short term exposure of the population to particulate matter PM₁₀ and PM_{2,5} do not allow the assessment of specific concentration limits under which exposure to particulate pollution shows no impact on human health» [10].

In epidemiological research which was posted in the online edition of the journal Lancet in February 2011, air pollution is

becoming the most important factor triggering a myocardial attack.

The sharp increase in particles smaller than 10 μm (PM10), the atmosphere became more important at the population level by using cocaine, vigorous exercise, a heavy meal and the sexual act, factors that have been implicated in several cases preceded minutes or hours of the heart attack.

The practical value of the study is the possible reduction of air pollution. It is estimated that in most major European cities and the USA, to reduce pollution at 10 μm / m^3 would lead to reduction of heart attacks by 1.6%.

The corresponding reduction would be 4.8% in a few European cities with higher levels of concentration PM10, if the concentration of PM10 by 30 μm / m^3 was reduced. [11]

Impact on our DNA

There are studies showing the differences between people living in rural areas and those living in cities in the mucosa of the nasal cavity in the tissue, cellular and DNA, which means that exposure to pollutants leave marks in humans. The fact that there are not always visible symptoms to those exposed to fine particulate matter does not mean they are not harmed.

The risk for pregnant women

Danger is lurking for the pregnant woman, since an induced damage is not readily visible from the effect of pollutant to the fetus. They are associated with congenital

abnormalities seen in the long run. In addition to particulate matters, there are usually other atmospheric pollutants such as nitrogen oxides, sulfur oxide, ozone, and dioxins. Recently the congenital anomaly of harelip is associated with exposure to dioxins. [12]

More sensitive subpopulations to exposure to particulate contamination are the very young and those with respiratory and cardiac diseases. Particularly, with regard to preteenage children, the effects caused by the exposure to suspended particles have intensely troubled the scientific community over the last decade.

High concentrations of particulate PM10, PM2,5 and UFPs, and black smoke has been found to be associated with respiratory symptoms in young people, absences from school and increased use of medication for children with asthma. The increased sensitivity of the children as to the atmospheric pollution is due to physiological and immune system which is still under development. [13, 14]

Method of effect of the different particulate fractions

Generally the particles larger than 10 microns are removed from the body by retention of the mouth or nose. The PM10, instead is possible to escape from the retention mechanisms, and for this reason are called respirable.

The bulk but the coarse particles is discharged from the upper respiratory tract.

Eventually, 10-60% of these are likely to be deposited in the lungs.

The fine particles PM_{2,5} manage to penetrate deeper in the bronchi and cause significant damage. In their path, the particles penetrate through the bronchi and it is possible to reach up to the alveoli of the lungs, through which oxygen enters the blood.

The particles which are trapped in these hypersensitive tissues interfere with the oxygenation of the blood. Meanwhile during the course, toxic and carcinogenic compounds which are transported initially adsorbed to the particle surface are subsequently adsorbed in different parts of the lungs. [15]

Owing to changes in the air flow in the tracheobronchial area, the particle deposition places are mainly near the bronchi. In these places there are accumulated many nerve endings.

The mechanical stimuli caused by the particles, often lead to reflex cough and systole of bronchi. The sensitivity of the nerve endings to chemical stimuli results in increasing the rate of breathing and reducing lung capacity to function as efficiently in the variations of pressure during respiration.

Secondary health impacts

The observed health problems, when exposed to suspended particles are not solely attributed to their penetration in the respiratory system and their toxic action, but secondarily, to weakening of the body. Numerous studies prove that exposure to particular matters may cause the appearance

of respiratory problems, deterioration in lung function and the self-cleaning mechanisms, and creating inflammation in them. [13]

These symptoms lead to increased sensitivity of the body, which favors the concentration of fluid in the lungs, especially for people with heart disease. Exposure to particular matters may also increase the susceptibility of the lungs to infection by bacteria or viruses.

This causes increase case of pneumonia for the group of vulnerable people. [16]

Impact on the environment

The gas particulate pollution can alter our perception of the colors, of the objects we observe in the atmosphere and colors of the atmosphere itself. The reduction of visibility is a direct result of the interaction of the particles with an aerodynamic diameter less than 2.5 microns and solar radiation.

The PM_{2,5} act as a kind of filter as in the solar radiation, resulting that only a fraction of that manages to pass through, while the rest is diffused, absorbed by the particles or reflected. The reduced and distorted solar radiation leads to reduced visibility. [4]

The impact of suspended particles on the climate is also important. Their impact varies in space and time and it strongly depends on local emissions of particles, their relative short life and the interaction of these particles with solar radiation.

Depending on the size and degree of the reflection of the suspended particles can reflect the shorter wave length incoming to earth UV or long wave length outgoing from

Earth infrared radiation. In the first case occurs freezing, while in the second case it is caused by the heating of the atmosphere, known as greenhouse effect. Particulate matters, however, act in a more indirect way on the global climate.

This indirect action results from the manner in which the particles affect the cloud microphysical properties of the clouds. [17]

To ensure air quality so as to exclude adverse effects of air pollution on humans, animals, plants and the material of the environment air quality standards have been adopted by different countries and organizations. These standards are legal or statutory suggested for pollutant concentration values for defined periods of time.

The air quality standards are expressed as limit values or guide values. The first is maximum (limit) permitted concentrations of pollutants for a specified time. The aim of limits is primarily the protect the health of people.

The guiding values express the desired air quality as determined by specific targets. The guide values apply for specified periods of time, as well as the limit, and are intended to serve for long-term preventive health care and protection of the environment and as reference points for the establishment of special regimes in different regions. [18]

The institutionalization process of the air quality standards is complex and differs from country to country. The basic axis of this process is the air quality criteria.

These are values pollutant concentrations and exposure times to those associated with

specific effects on humans, animals, plants and the environment generally.

Based on the criteria of air quality air quality standards are developed. The final configuration of the standards involved and other parameters such as atmospheric dispersion of every place, the atmospheric chemical processes that take place and above all economic, technical and political parameters.

This has led to a number of different levels from country to country. In Greece the applicable limits are set or proposed by the European Union for the Member States based on results of relevant studies of the WHO or other research centers. [9, 19]

CONCLUSIONS

Exposure to air pollution is one of the most serious environmental health problems if you take into account the extent and the involuntary nature. In our country we do not seem to have realized its importance and thus even the statutory emergency procedures do not apply.

It has been observed that the increased air pollution causes serious health problems to humans or to other organisms. It is associated mainly with respiratory problems and heart disease. Long-term exposure to air pollution can cause cancer and damage to the immune system as well as neurological problems and even death.

In general, air pollution is an atmospheric imbalance.

Human activity has always been an additional aggravating factor and by the early 18th century, the increased energy needs resulted in various activities which these in turn, were harmful to atmosphere. [5]

Apart from human activity the atmosphere is polluted to some extent by natural sources.

The basic composition of the atmosphere as far as nitrogen and oxygen might not change, however the increase of gases concentration in the composition of the atmosphere makes air quality increasingly low and inappropriate.

The effects of this pollution seem both in human health of people as well as the entire ecosystem.

The assessment and control of concentrations of air pollutants are considered most necessary for management of quality, according to European Union directives, and are simultaneously distinct signs that lead to better quality of life, which requires a healthy environment. [20]

DISCUSSION

The environment is a dynamic system that evolves and constantly adapted to changing influences and reactions between biotic and abiotic factors of which it is composed. The survival of living organisms is based on abiotic factors and the normal functioning of those directly associated with living organisms, showing strong interdependence and interaction relations.

Man belongs, depends on the environment and, at the same time, drastically interferes in its configuration. Human life without the environment has no chance of continuity, but even more important is the fact that the quality of human life is determined by environmental quality.

Man, on the evolutionary course to meet the daily needs, has changed the environmental structure with activities representative for the each time cultures, which showed in human history.

The impact of these interventions reflected not only in the quality of human life, but also affects the quality of the environment. [21]

The modified environment undermines the likelihood of qualitative survival of future generations.

The prevalent view, which contributed to the deterioration and disturbance of natural ecosystems, is that man is in a hierarchically superior position than other kinds of life, placing them under his absolute sovereignty justifying their reckless exploitation by man.

This anthropocentric and fragmentary view of the world, which places human as dominant of natural systems and ignores the interdependence and interactions between them, led to over-exploitation of nature and natural resources, considered as 'inexhaustible' consumer goods, to deterioration of the natural environment and generally to the creation of serious environmental problems. [9, 21]

The real solution of the environmental problems is found in a change of viewing from an anthropocentric view of facing the

world to a biocentric which humanity experiencing will recognize with humility the need keep pace with the planet than to dominate over it.

It is therefore essential for the planet sustainability, the dissemination of fundamental knowledge, the radical change of those social attitudes, mentalities and, the most important, behavior that contributed to the creation of the environmental crisis.

Their formation must be done in such a way so as to take always into account the environmental factor, not as something separate and isolated from humans, but as the key to human survival.

The sad news concerns the environmental problems and their causes but the optimistic message is that we have the technology to avoid the activities that degrade our planet and replace them with other environmentally friendly.

The conflicting views, on the degree of risk of environmental issues and their handling are the result of education that we receive from our culture. Investing in education of citizens, we all have the opportunity to actively participate in environmental decision, exercising our right to choice. [21, 22]

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Αιωρούμενα σωματίδια: μια απειλή για την υγεία του ανθρώπου

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ΠΕΡΙΛΗΨΗ

Ο αέρας, που βρίσκεται γύρω μας, αποτελεί στοιχείο ζωτικής σημασίας μιας και η λειτουργία της αναπνοής είναι η ζωή μας. Η ποιότητα του αέρα που αναπνέουμε, σχετίζεται άμεσα με τη φυσική κατάσταση της ατμόσφαιρας και από την εκπομπή πρωτογενών και παραγωγή δευτερογενών ρύπων σε αυτή. Ρύπος είναι κάθε ουσία η οποία εκπέμπεται άμεσα ή έμμεσα από τον άνθρωπο στον αέρα του περιβάλλοντος και ενδέχεται να έχει επιβλαβείς επιπτώσεις στην ανθρώπινη υγεία και στο περιβάλλον.

Επομένως, τα αιωρούμενα σωματίδια είναι ρύποι. Η μελέτη της παρουσίας των αιωρούμενων σωματιδίων στην ατμόσφαιρα και της επίπτωσής τους στην υγεία του ανθρώπου και στο περιβάλλον είναι ένα εξαιρετικά πολύπλοκο ζήτημα για την παγκόσμια επιστημονική κοινότητα. Αυτό οφείλεται στην ετερογένεια των φυσικών και χημικών χαρακτηριστικών τους, ανάλογα με τη πηγή εκπομπής και τον μηχανισμό δημιουργίας τους, καθώς επίσης και στις διαφορές των συγκεντρώσεών τους ανάλογα με την εποχή, την περιοχή και τις μετεωρολογικές συνθήκες.

Οι επιδράσεις των αιωρούμενων σωματιδίων είναι σημαντικές και ποικίλες σε όλους τους τομείς του περιβάλλοντος, ενώ ειδικότερα για την υγεία οι επιπτώσεις που προκαλούν εξαρτώνται κατά κύριο λόγο από τη διάμετρό τους, τη χημική τους σύσταση καθώς και από την ύπαρξη άλλων ρύπων, με τους οποίους δρουν συνεργιστικά.



Λέξεις ευρετηρίου: Αιωρούμενα σωματίδια, επιπτώσεις στην υγεία, χημική σύσταση των σωματιδίων, πηγές αιωρούμενων σωματιδίων



Παραπομπή

Ο. Βελέντζα. Αιωρούμενα σωματίδια: μια απειλή για την υγεία του ανθρώπου. Επιστημονικά Χρονικά 2016; 21(3): 233-244

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