POLYCYCLIC AROMATIC HYDROCARBONS – GENERAL CHARACTERISTICS AND TOXICITY

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Abstract

Polycyclic aromatic hidrocarbons (PAH) are found in our everyday life. They cause several disorders on human health with both acute (lung disorders) and chronic disorders (cancer). This paper presents the summing up of PAH characteristics and structure, of the major effects produced by these on both human and animal health.

Key words: polycyclic aromatic hydrocarbons, contamination, toxicity.

PAH are general contaminations of the environment. It is a group which contains more than one hundred different chemical substances. In this complex group we find organic components with different chemical structure: some of them contain only C and H atoms, others have attached to aromatic nuclei substitute groups, and there are others which contain more aromatic nuclei.

PAH are components that result following to an incomplete burn on high temperature of some organic substances, one part as a result of cooling precipitates and get to the surface of dust and smoke etc. In the air have been identificated till now 18 types of PAH, and most of them are cancerigenic (7). In the presence of nitrooxids they are transformed into nitro-PAH. The effect on human beings (of course blended with other contaminations in the air) are headache, vomiting, respiratory troubles, coughing, thoracle pain (9).

From the PAH take part: naphtalene, acenaphtylene, acenaphten, fluoren, fenantrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3,c,d)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene, etc (4). PAH is less soluble in water, because of the high melting and boiling point.

The most common of all PAH is the *3-4 benzpyrene*. Because of this, it is used as an indicator for PAH. The primary source of 3-4 benzpyrene and other PAH is the same as a result of the emitted gas by cars, after an incomplete burn of gasoline. Others are the result of an incomplete burn of carbon, solid fuel used by companies, household heating installation, the smoke, cost by tires on for or asphalt road, the industrial residual waters, preservatives for wood, etc (2). All these sources are antropogen. There are natural sources too, which are less dangerous as: vulcanic erruption, the composition of the organic material, deforestation, eradication, etc. (Table 1.).

Table 1.

Comparison of emissions, cancer risk and toxicity between PCDD/F and PAH (12).

Process:	**PCDD/F g I-TEQ/yr**	**PAH's ton/yr**	**BaP kg/yr**	**Cancer risk BaP:TEQ**	**toxicity BaP:TEQ**
Iron and steel production:	118.000	1.859	18.59	8	32
Household heating:	53.000	33.457	334.57	316	1263
Incineration of household waste:	9.170	0.029	0.29	2	6
Industrial heating:	3.400	1.093	10.93	161	643
Electricity generation:	1.470	0.078	0.78	27	106
Road transport:	1.100	111.700	1117.00	50773	203091
Backyard barrel burning (per 1000 ton):	0.790	0.045	0.45	28	114
Dieselmotor of three ships:	0.108	0.033	0.33	154	615
Soot of Düsseldorf airport fire (per ton):	0.052	4.986	0.26	255	1019
Wood smoke composition (per 1000 ton):	25.000	0.050	2.65	5	21

From the above sources the most important are those from vehicles. These are polluting the air from the surrounding, I mean the air that man inhales. If the quality of the water is number one in influencing the environment, that affects the human, then air pollution shares the same place with it.

There are huge contradictions between the benefits that transportations are offering and the distruction that occurs against the human life. In this way those who benefit, owners of vehicles and services, consider that the vehicle is one of the most important element, regarding confort of modern life. But on the other hand the ecologists, medical doctors, sociologists and other specialists who examen human relationship with engine pollution, and environment are driving attention about the enormous distruction that transport brings up especially the one having engines with internal burning, to the human health (1).

It is well known that the function of the engines are not idealistic. They are not consuming the entire quantity of gas or diesel in any circumstances, like above oceans, different weather conditions, road qualities professionalism of conductors, status of the engine. Based on research each second engine of ex-soviet production and each fourth one built in Western Europe have CO emission of high level. Basically from 3 – 25 % of gas or diesel entering the engine is not transformed in CO_2 and water vapors, but in CO, Hydrocarbons, polyciclics, radicals of these, peroxides and aldehids.

In these way an engine evacuates about 200 chemical toxins into the environment.

Today, according to the evaluations we can say, that 100 vehicles in each 24 hours are evacuating about 2500 kg CO, 500 kg hydrocarbons, 300 – 400 kg natrium-oxids and about 1 kg aldehids (1).

Otherwise 1000 kg gas burned in the cylinders of engine beside CO_2 and vapors – non toxics – is transformed in about 50 kg CO, 23 kg hydrocarbons, 16 kg NO, 2 kg sulf-oxid, 1 kg aldehid, 0.4 kg led toxics, if this is an etilate gas. The majority of these components are noxious, they are toxic, provoking cancer and excitents.

A study made in the ’70s of the 20th century, presents, that on the roads of a medium size European city, 20000 kg of dust were products by transportation on asphalted roads, 100 kg of which where carcinogenic.

Infime quantity of benzpyrene is produced by each cigarette. This fact is important because smoking is very highly common in the whole world, equally practiced by males, females and children affecting life and health of millions. This has many causes, but the most important is the drug effect of nicotine, existing in every product resulting from tobacco leaves. In edition the major impact on human an individual behavior was determined by decommercialization of the tobacco within cheap cigarettes, light and very economically efficient, kept in the mouth without using hand for, in the same time human using hands for other purposes. On the other hand tobacco is dangerous not only because during the smoking process nicotine is being inhaled but also because of the pesticides used during its growth those being absorbed by the human skin.

From these reasons smoking is recognized as an important factor risk for human health; in many countries severe lows regarding tobacco consumption are being adopted: educational programs promoting a healthy public attitude, forbidding smoking in public places. (Table 2.)

Table 2.

Number of cigarettes daily smoked by a person. Tendency of the individual cigarettes consumption (OMS, 1970–1997). (3)

	Daily individual cigarettes consumption (number of cigarettes)	Annual evolution rate (%)
Africa	10	+1,2
America	18	–1,5
Europe	18	0
South-Eastern Asia	14	+1,8
Eastern Asia	16	+3
Developed countries	22	–0,5
Developing countries	14	+2,5
Total mondial	15	+0,8

Carcinogenic action of tobacco smoke was proved by studies on different animal species. Druckrey injected guinea pigs subcutaneous with tobacco smoke and Blaclok in bronshcick obtained tumors in those areas (2). It is proved that lung cancer is for certain provocted by tobacco smoke which contains substances that storts and favorizes cancer (3). (Tabel 3.)

Table 3.

Death rate in different forms of cancer due to smoking in the USA, 1991. (3)

The form of cancer	Death rate (%)	
	Men	Women
Pulmonary cancer	90.3	78.5
Oesophagus cancer	78.2	74.3
Larynx cancer	81.2	86.7
Oral cavity cancer	91.5	61.2
Urinary bladder cancer	46.5	36.7
Kidney cancer	47.6	12.3
Pancreas cancer	28.6	33.3
Uterus cancer	–	32.4

PAH enters atmosphere as aerosol, small, ferm or vaporized pieces invisible for human eye, (in a city atmosphere the aerosolic parts can be 200 times bigger (20mg/m^3) compared to the air above the ocean (0.1 mg/m^3)). In the soil these enter mostly through the dust. Their resistance differs mostly by their components, but there is a relationship between the weight of molecular composites and resistance, in the sense that resistance increases proportionally with molecular weight.

PAH can be desintegrated by aerobic degradation, but this may last for years.

The attack of PAH are: digestive, pulmonary and skin (4). Enters lung mostly combined with dust very thin which cannot be pertained by nose, both animal and human. Degradation products are diol-epoxy components which causes cancer. For instance benzpyrene, which is the best know PAH diverts in the cells into 20 toxic components in laboratory conditions is proved to be carcinogenic beside benzpyrene, benzanthracene, d/pyrene, h/anthracene, 1/methyl/fenanthrene (6).

Bioaccumulation and biomagnification

Plants are weak accumulators of PAH, because they fasten the organic material in the soil. Neither the vertebrates can accumulate well, because of the fast metabolism of the PAH.

Toxicity

Regarding the toxicity of PAH, we know that they present a photoinduced toxicity resulting from two photochemical processes: photosensitivity and photomodification (14). Regarding the toxic effect on living organisms, few data is found in scientific papers. It is well known the fact that at in vertebrates, toxicity causes a late transformation of larvae into adults as well as the alteration of blood biochemistry. At vertebrates, toxicity causes hepatomegaly (duck), weakening, disorders of the haemopoetic system, of the immune system, skin, mammary glands (10).

In case they penetrate the organism during the parturition period, they change the hormonal synthesis forever.

Because of the modifications of genes, in time, it can cause the appearance of tumors. These modifications are produced both during the intrauterine and extrauterine period. Because of the alteration of genes, both the physiology of cells and its receptory are disturbed (6).

The most common effect of PAH (especially which can't be substitued) is the producing of malignant and benign tumors. After some experiments made on animals, is proved that, components which contain 2-3 benzene rings are not carcinogenic, but which has 4-7 benzene rings are responsible for the appearance of malignant tumors (80 % benzpyrene) (6). It was mentioned, the appearance of tumors tissues presents a growing tendency, mostly among the human population. This is caused by different effects in which PAH plays an important role through cigarettes (smoking), the emission of escapement gases (inhaling, sediments of gas particles on surface of plants), the consuming of fried meat, etc. The maximum limit of PAH value in Hungary is 1 ng/m^3. There is a region in Hungary, where a value of 54 ng/m^3 was measured (6). Beside PAH exist other factors which contribute to the appearance of cancer for example the meat of animals treated with oestrogen (for a better development, hormonal castration).

In the prevention of the nocuous effects of PAH is a good way the right exploration of the transportation, renouncing to drive if it's possible to walk, or ride bicycle or other non polluting installation, to give up smoking, especially in public places, buildings.

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