AIR POLLUTION MONITORING AT THE WORKSTAND AND IN THE AMBIENT AIR

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In the article methodological and legal basis of poison gases monitoring at the industrial workstands and ambient air has been presented. Particularly, one concerned for nitrogen compounds as the danger factor for the health. This paper contains analysis of toxicity of nitrogen compounds for people and the environment. The article presents maximum permissible concentration selected poison gases at the workstand and natural environment

Conclusions, which arise from presented analyse, are the base for the elaboration of the acoustical method of nitrogen oxide investigation.

Keywords: monitoring of air pollution , nitric oxides, gas-poisons

1. INTRODUCTION.

Development of air pollution monitoring devices is steering on creation such devices, which would be able to have wide use in industrial measurement. This use by necessity of inspection of strongly toxic pollutions concentrations is determined. To such pollutions among others belongs nitrogen compounds, created during combustion process. Processes of combustion of fuels, transportation and industrial processes are the main source of primary air pollutions [1] at the workstand and in the ambient air. Threats resulting from it extort creation new of precise monitoring systems of the state of air. Taking into account nature of poison gases and requirements placed by suitable legal settlements, air pollution monitoring devices one can divide on: devices to short-recurrent and of quick tests, analysers of continuous activity (portable), personal monitors, indicator of leak, stationary measuring devices, analysers to monitoring emission and low emission. Most often accuracy and measuring range of the mentioned devices depends on the type of the measurement and a maximum of permissible concentration (NDS) of toxic substances defined by Polish Standards.

2. MONITORING OF GAS-POISONS.

The most often monitoring air pollutions are: SO_2, NO_x, hydrocarbons, CO and dusts. These air pollutions are at the first place on the list of the environmental poisons creased by Committee of Environmental Toxicology PAN [2], which has been arranging the toxic substances by their of harmfulness. Fragment of mentioned list presents the Table 1.

All the air pollutions can be monitoring by physical or chemical methods. Many of these methods (especially electrochemical method and luminescent method) found use technical solutions for devices production by many firms. Repartition of physical-chemical methods in Fig. 1 is shown [2].

TABLE 1.

Name	Index of environmental harmfulness
SO_2	114
DUST	108
PAH*	88
NO_2 and derivatives	83
F2 and compounds	72
Pb and compounds	52
Cd and compounds	42
Nitrogenous fertilizer	42
Pesticides	28
Carbon monoxide	25

* polycyclic aromatic hydrocarbons

In monitoring of gas-poisons three ranges of concentrations according on place of emission of gas-poisons and place of measurement are considered. In Fig. 2 measuring ranges of gas-poisons concentration in waste gases, in air at the workstand and in the ambient air are presented [2,3]. The maximum permissible values of concentration (MPC) of toxic substances considering large harmfulness a lot of gaseous substances present in a place of work, are regaled by Order of Minister of Work and of Social Politic [4,13]. Fragment of list of toxic substances and their MPC values MPC in Table 2 is presented. Similarly, the highest permissible concentrations of harmfulness substances in ambient air have been defined.

In the table 3 some from them according to the Center of Investigations and Inspection of Environment PP in Silesia (Poland) [5,6,14].

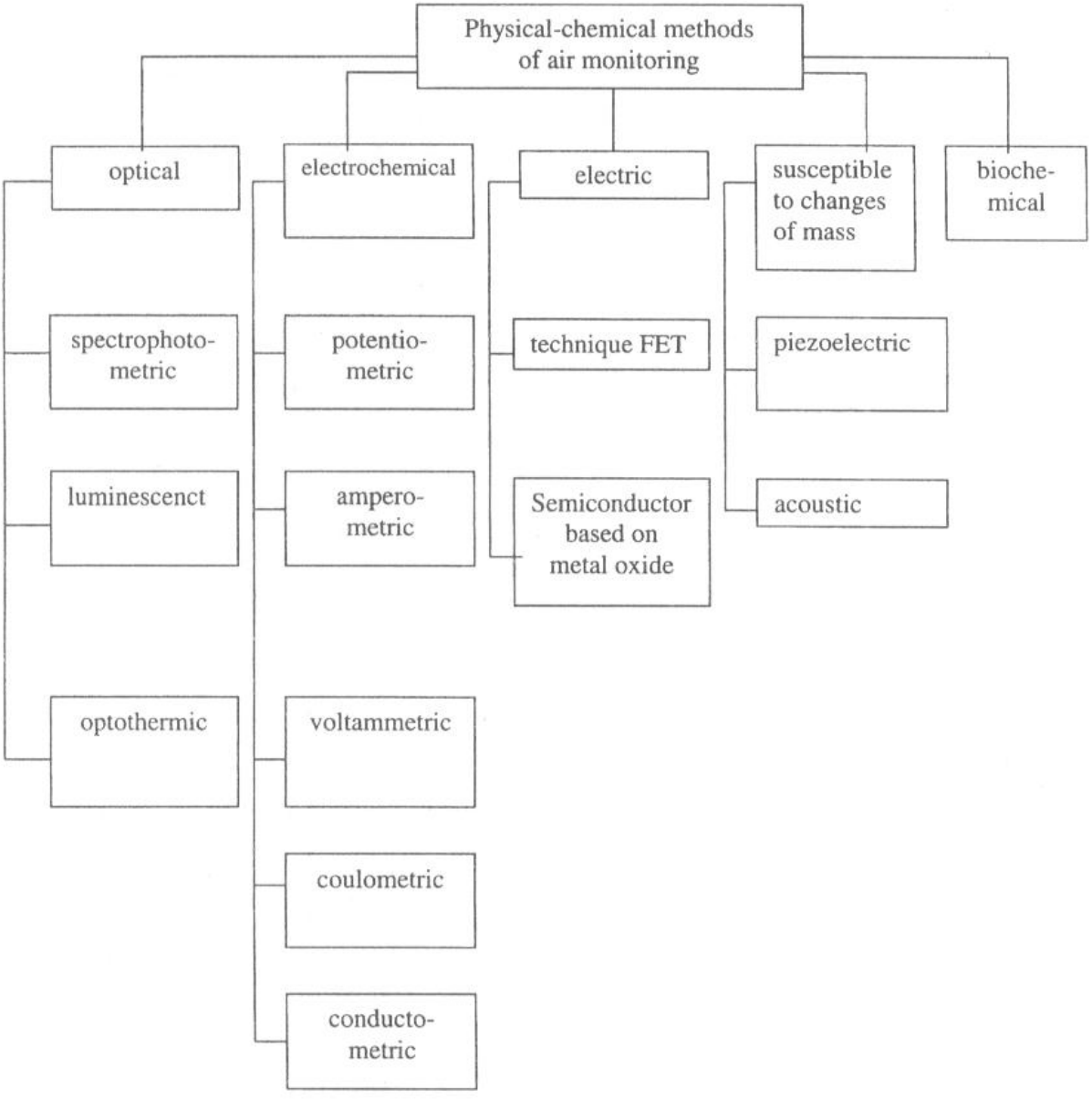

Fig. 1. Classification of physical-chemical methods used in air monitoring [2].

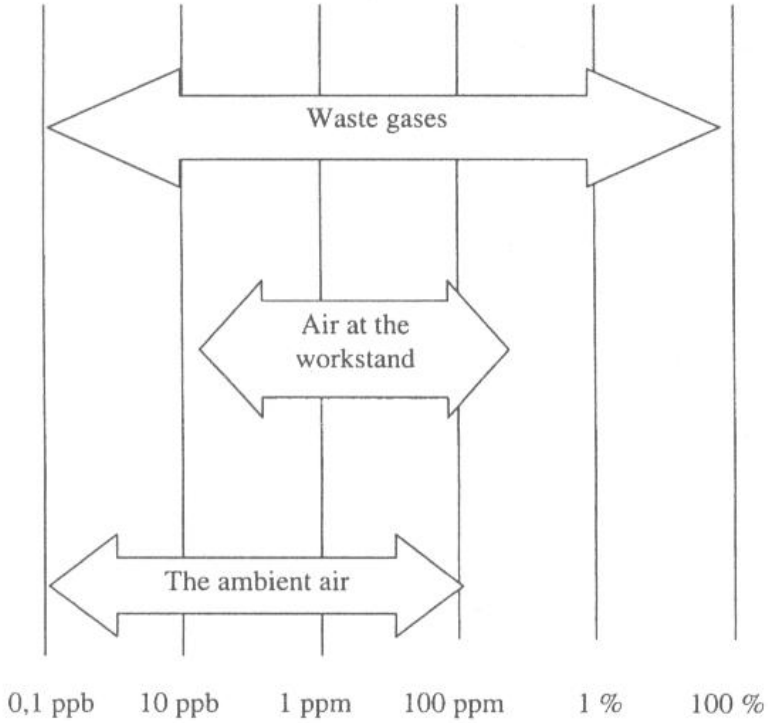

Fig. 2. The levels of gas-poisons concentration in waste gases, in air at the workstand and in the ambient air.

TABLE 2.

List of the values of the highest permissible concentrations of noxious for health agents in work environment

No	Noxious agent	Highest Permissible Concentration during a daily wage at the workstand			
		MPC*		MMPC**	
		mg/m^3	ppm	mg/m^3	ppm
1	Ammonia	20	26,4	27	35,6
2	Nitric oxides	5	2,4	10	3,5
3	Monoxide carbon	30	24	240	192
4	Sulfur dioxide	2	0,7	5	1,75
5	Ozone	0,1	0,05	0,6	0,28

* Maximum Permissible Concentration
** Maximum Momentary Permissible Concentration

TABLE 3

List of values of highest permissible concentrations of noxious agent in ambient air

Ordinal number	Name of air pollution	Highest Permissible Concentration in the ambient air*			
		Twenty four hours		instantaneous	
		$\mu g/m^3$	ppm	$\mu g/m^3$	ppm
1	Sulphur dioxide	150	0,053	500	0,175
2	Nitric dioxide	150	0,073	500	0,243
3	Monoxide carbon	5000	4,000	20000	16,00
4	Ozone	110**	0,051**	lack of norm	-

* instantaneous concentration are stating in of appropriate unit of measure for 30 minutes

* * concentration for 8 hours

3. PROPERTIES OF NITRIC OXIDES.

Nitrogen belongs to the inert chemically elements. It's resulting from exceptional stability of triple bond in molecule N_2. At increased temperature nitrogen reacts with lithium, magnesium, calcium, aluminium, silicon.

There are difficulties to common bond oxygen and nitrogen. Typical nitric oxides [7] in Fig.3. are presented.

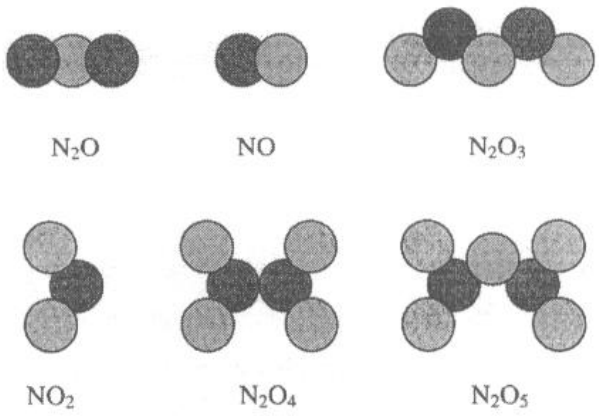

Fig. 3. Nitric oxides

Nitric oxides are created in combustion processes, generally by direct high temperature synthesis of nitrogen and oxygen contained in fuel and in atmospheric air.

Combustions gases generally compose from nitrogen oxide, which oxidize in atmospheric air to the nitrogen dioxide. Nitrogen dioxide proves large toxicity in influence on upper air passages [9]. Nitric oxides are in yellowish-brown colours (NO – colourless) and they have characteristic strongly pungent scents. Nitric oxides among strongly poisonous gases are classified. Staying in the atmosphere containing them it causes emesis, as well as causes strong headache and cough and even pneumonia and death [7,8,9]. Characteristic feature of poisoning by nitric oxides it is an yellowish tinge of skin and hairs.

Nitric oxide NO it's colourless gas, with difficulty water-soluble. In natural processes NO creates during atmospheric discharges and during bacterial digestion of organic matter. In atmosphere of air, nitrogen oxide easy oxidizes to nitrogen dioxide [8]. Nitrogen oxide is practically harmless – its harmfulness results from the susceptibility of NO to oxidation to NO_2. Nitrogen oxide in contact with water and with oxygen gives nitric acid HNO_3. Concentrated nitric acid is strong oxidizing agent. It causes painful and with difficulty healing scalds on a skin.

Nitric acid dilutes all metals, except gold and except some of platinum metals. In reactions with metals, nitric acid reduces to NO_2 if it is used as concentrated acid, and reduces to NO or when the nitric acid is less concentrated .

Nitrogen dioxide is a brown gas which well melting in water [7]. In ambient temperature two NO_2 molecules couple themselves in dimer N_2O_4 , which is unstable after its heated [8]. Nitrogen dioxide is very toxic chemical compound and it is the most current in the human environment.

Nitrogen trioxide (N_2O_3) is anhydride of unstable nitrous acid and nitrogen pentoxide (N_2O_5) is anhydride of nitric acid [8].

Nitrogen oxides take part in creation of photochemical smog [10] as well as in creation of greenhouse effect [12]. Nitrogen oxides have got absorbing capacity of the Earth radiation in range of infrared electromagnetic spectrum and belong to greenhouse gases. Comparing to other gases, nitrogen oxides participation in greenhouse effect is very considerable, on account of long time live of nitric oxides in atmospheric air - about 150 years [12].

Nitric oxides add to create the rain acid effect in accordance with the chemical equation:

$$2NO + H_2O + O_2 \longrightarrow HNO_3 + HNO_2$$

$$2NO + O_2 + H_2O \longrightarrow 2HNO_3 + O_3$$

The above chemical equation describes the equilibrium state – sc. the photosteady state.

Nitrogen dioxide decomposes under influence of light solar on nitrogen oxide (NO) and oxygen into the form of free radical [10,11]:

$$NO_2 + h\nu \longrightarrow NO + [O]^*$$

$$[O]^* + O_2 \longrightarrow O_3$$

Created in this reaction ozone reacts with nitric oxide:

$$O_3 + NO \longrightarrow NO_2 + O_2$$

In Table 4 toxic properties of different concentrations of nitrogen dioxide have been described [7,9]. Even concentration 100 mg/m^3 of nitrogen dioxide in air creates threat with serious poisoning, whereas at higher concentration then 190 mg/m^3 exists a threat of a loss of life if time of a person sojourn in a treating room was above 30 minutes [9].

A man easily accustoms himself to smell of nitrogen dioxide and symptoms of poisoning in time are pushed, what creates an additional threat. High risk of people poisoning by nitrogen dioxide consists in that the nitrogen dioxide concentration of less 200 mg/m^3 is imperceptible to detect by smell. So a poisoning with a deadly result can be access without conscious of a victim.

TABLE 4.

Physiological activity of various NO_2 concentration.

Contents NO_2 in air		Time of operation and symptoms
ppm	Mg/m^3	
19,5	40	Activity during few hours without special influence to human body
29,2	60	At short duration activity – the irritation of mucous membrane and throat
48,7	100	At short duration activity – mucous membrane, eyes, nose and throat irritation. Long duration activity – serious danger poisonings
92,5	190	At short duration activity – danger for live
185	380	Death during a few minutes

4. RECAPITULATION.

Photochemical oxygenation processes and photochemical smog production are basic and well-known threats for health and environments, which are result of emission of nitrogen oxides [10]. Actually there grows up the consciousness of the immediate threat of health by NO_x . Nitrogen oxides causes irritation of lungs, bronchitis, pneumonia and general increase of susceptibility human body on viruses infections. Simultaneously, in the acid rains –very dangerous civilization effect, the participation of nitric acid is about 30% [10]. Basic source of nitrogen oxides in the world, there are combustions of hard coal (2-7 million ton NO_2), brown coal (1-3 million ton NO_2), petroleum (1-3 million ton NO_2), natural gas (2-3 million ton NO_2), industry (1 million NO_2), motor-cars (4-8 million ton NO_2) and combustion of biomass (ok. 12 million ton NO_2) yearly [12]. Quantity of nitrogen oxides in atmosphere increases at the average about 0,25% yearly.

These chemical atmosphere compounds investigation, their detection and stability at proper level of permissible concentration in accordance to Polish Standard (particularly - at the workstand) are the principle of safety. Therefore exists strong reason of application on works over development of detection methods of toxic gases and of detectors. Constantly increases demand on new methods and technique of measurements and monitoring, considering necessity of assurance safety of works at the workstand by employers.

Arising from presented analysis conclusions will be base for the investigation over new methods of detection and monitoring nitrogen oxides in the Department of Environment and Safety Management and in Institute of Physic at Silesian University of Technology (SUT) in Gliwice (Poland) The proposition of the new acoustical method of nitrogen oxide detection, elaborated in Institute of Physics at SUT in [15] is presented.

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REFERENCIES

1. P. Górka, St. Kowalski, *Investigation of air pollutions,* SUT, Gliwice 2000.
2. I. Trzepierczyńska, *Physical-chemical analysis of air pollution*, OWPW, Wrocław 1997.
3. J. Namieśnik, *Collecting of environment samples to analysis,* PWN, Warszawa 1995.

4. *Order of Minister of Work and Social Politic,* from 21 day of October 1991, Dz.U. No 114.
5. *Report of regional environment monitoring (air),* Center of Investigation and Inspection of Environment PP in Katowice, 1999.
6. *Permissible concentrations of substances air polluting,* Dz.U. No 15, 1990.
7. S. Knapik, *Ergonomics and work protection*, AGH, Kraków 1991.
8. K. M. Pazdro, *Chemistry*, PWN Warszawa 1982.
9. E. Błasiak, Wł. Bobrownicki, *Nitrogen compounds technology*, PWT Warszawa 1956.
10. S. F. Zakrzewski, *Basis of environment toxicology*, 1995.
11. J. Namieśnik, Z. Jamrógiewicz, *Physical-chemical methods of environment pollutions control*, Warszawa 1998.
12. M. Siemiński, *Physics of environment hazard*, PWN 1994.
13. *Order of Minister of Health and Social Welfare,* from 22 day of March 1993, regarding of principle and frequency of execution investigation and noxious for health agents in work environment measurement, Dz. U. No 26.
14. *Order of Minister of Environment Protection and Natural Resources,* from 17 day of April 1987, regarding of permissible to introducing to ambient air of sort and quantity of polluting substances, producing by combustion engine, Dz. U. No 14.
15. J. Ignac-Nowicka, T. Pustelny, *Monitoring Methods of Nitrogen Dioxide,* (M&QA, vol 22, 2001).