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DANGEROUS EMISSIONS IN THE TECHNOLOGICAL PROCESSES OF THE FOUNDRY HOUSES

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ABSTRACT
This paper refers to the dangerous emissions that appear during some technological processes and in some of metallurgical installations in foundries.

1. INTRODUCTION

A great diversity of gas emissions appear in the industrial environment of a foundry, determined especially by the composition of the materials and the casting procedures that are used.
One of the most important gas emissions in a foundry is a great volume of microscopical dust. As an example, the following table contains data consisting of the volume of impure air and the characteristics of the dust emissions in the main sectors of a cast-iron foundry, with the capacity of 15000 tones a year.
The dust particles contain mainly oxides: SiO2, Fe2O3, AlO3, CaO, MgO of very small dimensions (under 60 µm). To exemplify, the following table contains the average values of oxides in a foundry atmosphere.

Table 1. – The Volume of Impure Air in a Cast-Iron Foundry with the Capacity of 1500 Tones a Year.

The sector in the foundry	The volume of impure air (m^3/h)	Characteristics of dust emissions	
		Concentration (mg/m^3)	Composition
Preparation of moulding mixture	52000	92-1200	Silicon (SiO2)
Moulding – core making	63000	210-1037	Silicon, Phenols etc.
Melting	66200	1540	Metallic oxides, soot
Knock-out and cleaning	161500	30-60	Metallic oxides, abrasive dust, silicon

Table 2. The Oxides Content and Their Dimensions in the Atmosphere Of Different Sectors of a Foundry

The sector and the intallation	The average oxides content (%)				The particles content (%)					
	SiO_2	Fe_2O_3 Al_2O_3	CaO MgO	Other oxides	0-5 µm	5-10 µm	10-20 µm	20-40 µm	40-60 µm	>60 µm
Processing, electric furnace with arc	3,0	96,0	1,0	-	60	20	15	5,0	-	-
Moulding, mould dryer	32	61,2	2,1	4,7	5,0	30	35	14,0	9,0	7,0
Knock-out, knock-out grate	34	58,5	3,0	4,5	10	8,0	43	12,5	4,5	22
Cleaning, cleaning tables	35	59,5	1,5	4,0	11	2,2	1,0	3,3	6,6	66,9
Cleaning, sand-blasting chambers	27	63,0	2,4	7,6	7,5	5,5	8,0	17,5	21	40,5

In the foundry houses the processing furnaces with cupola, the electric furnaces with arc and the induction furnaces are important sources of an impure atmosphere. The dust produced by the electric furnace with arc has the greatest capacity of dispersion, also having the largest proportion of soft particles.

During the processing in the cupola, due to coke combustion, there is a great quantity of gas emission. The composition of the gas emission is the following: carbon monoxide, sulfuric anhydride, azote, oxygen, carbonic anhydride. The smoke contains silicon oxides and metal oxides, depending on the composition of the materials used: Fe_2O_3, CaO, MgO, Al_2O_3, MnO, ZnO etc, in quantities up to 1-2% of the total mass of the elaborated cast iron.

In the case of induction furnaces of high capacity, the gas emissions contain different oxides such as Fe_2O_3, MgO, SiO_2, ZnO, Al_2O_3, CrO_3, MnO, TiO_2, NiO_2, PbO, CuO, CaO, BaO. In these emissions, Fe, Si, Mn, S, P are predominant. In a medium percentage there is Zn and Cu and also Mg, Pb, Ni, Ca, Ba in a small percentage of approximately 1. The sources of the emissions are the rust on the iron, the impurities on the surface of the charge, products of oil, paint or plastic combustion, adherent sand, coal dust, graphite dust, zinc-plated and non-ferrous metals scrap.

The chemical and thermal phenomena that take place on the surface of the melted metal in the burning process develop the “metallurgic smoke”. It is very important to avoid using lead scrap (for example, lead-based paint). During the elaboration process in the electric furnace with cupola, melting and refining powders come off. The quantity of such powders that result is of about 5 kg per tone of liquid steel. During the refining process, emissions of very small particles of powders take place (with dimensions of several microns), containing heavy metal oxides (Pb, Zn, Cd etc.) and addition metal oxides (Cr, Mn etc.).

During the processing of non-ferrous alloys, gas emissions containing fluorides, chlorides and highly dangerous organic combinations (chlorinates, hexafluoride sulphur etc.) appear. The powder emissions are represented by oxides (Al, Cu, Zn, Pb etc.). They also consist of ashes generated by the treatment of the metal. The most important quantity of dust appears in the knock-out and cleaning sectors. The dust concentration can reach 12,8-25,5 mg/m^3 during the knock-out process and 10-16 mg/m^3 during the buffing process, far above the limit of 6 mg/m^3 .

The gas and powder emissions can provoke serious professional injuries of the respiratory tract: asthma, cancer, rhinitis etc.

The silicon dust and powders can be easily removed from the foundry atmosphere through an adequate process of exhausting and cyclone collecting. But, unfortunately, a great number of toxic substances that are present in the foundry atmosphere and that are highly aggressive are difficult to neutralize.
The problem of the dangerous foundry climates that provoke serious professional injuries is today a subject of international debate. Specialists are trying to find technological solutions in order to reduce or eliminate the dangerous effects on human health. The efforts that are being made in this direction, especially by the intensively industrialized countries, are concentrated in up to 15% of the cost of the manufactured products.
In the recent years, the improvement of molding – core making technologies was based on the chemization process, by using on a large scale binders, catalysts, synthetic hardeners, which under the conditions of high temperatures release a diversity of pollutants and toxic substances, such as: vapors of phosphoric acid, nitrogen oxides, carbon oxides, furfurilic alcohol, acetone, aromatic polycyclic hydrocarbons, diisocianates etc. All these products influence to a certain extent the health condition of foundry workers.
In the 3rd Table you shall find a few data related to the noxious potential of some binders and auxiliary additives used to prepare the mixtures for molding – core making in Romanian foundries.

Table 3. The Noxious Potential of Some Binders and Auxiliary Additives Used to Prepare the Molding-Core Making Mixtures

Binder Auxiliary additive	**Noxious potential**
Linseed oil	While drying the cores, temperature reaches 250^0 – 300^0 C, when the oil decomposes and there are aldehyde emissions among which the acrylic aldehyde has a high degree of toxicity. It may cause irritations of the respiratory tract. This substance has also a high carcinogen and lung neoplasm potential
Phenolic resin	Used as fast setting binder in the presence of bezenosulphonic acid causes, in direct contact with the skin, orthoergic or allergic dermatitis. Upon setting, it releases phenol, phormaldehyde and monomers. These may cause digestive disorders and bronchial asthma. Phenol has a high capacity of being absorbed by skin and mucosa, being thus a potential carcinogen
Furanica resin	At high temperatures, the resin decomposes and emanates: furfurilic alcohol, formic aldehyde, methanol – pollutants causing skin and mucosa irritation and toxic for the digestive and respiratory system. Furfurol presence in the atmosphere in quantities of 0, 05 – 0, 5 mg / m^3 causes skin disorders, chronic rhinitis, disorders in the nervous system, stomach disease. Exposure to acetone and benzol can produce leukemia while the vapors of formaldehyde cause chronic bronchitis, eye problems.
Carbonic Materials – Coal dust, coal tar, coal tar pitch	In contact with coal dust the risk of mechanical irritation may occur. Upon molding, as a result of heating the coal dust in the mixture at 1000 1200-0- C in the metal contact area, partial combustion compounds and destructive distillation may occur. The so-called high temperature tar is released. At 400^0 C – 600^0 C form the coal dust: oxygenated aromatic derivatives, parafinic hydrocarbons, alcohols, cetones, Under the influence of increasing temperatures, the primary tars undergo pyrolise reactions as a result of which we have: - hydrocarbons: parafins, olefins, diolefins, aromatic etc. - Nitrogen compounds : pyridine, aniline, pyrrole, quindine

	- Sulphide compounds: carbon dusulphide, tyotoluene - Oxygenated compounds: phenol, xylenoles, acrydine Cola tar pitch contains: anthracene, fluoratene, pyrene. While heating the pitch at 50 – 200^0 C the following are released: naphthalene, dyphenile, acenaphtene, anyline.

Some of the products listed in Table 3 are part of the II^{nd} group of occupational carcinogen agents which can induce carcinogen alterations, permanently and rapidly.

Among the substances with a particular rapid noxious action, some of them have a settled carcinogen effect such as: polycyclic aromatic hydrocarbons, which are released upon the pyrolysis of coal dust, coal tar, coal tar pitch, synthetic resins etc.

The substances inducing mutations and carcinogenic processes after long exposures are as follows: phenols, cresols, formaldehyde.

In occupational carcinogenesis, the additive, inert, industrial environment factors must be given a particular attention. These are as follows: organics solvents, moisturizing agents, acid vapors, fog by means of water aerosols or oils, irritating dusts, etc. These factors may intensify the activation of carcinogen substances, turning into real co-carcinogen factors.

Considering those mentioned above, the specialists, who perform their activities in foundries, and the design engines are called to take some measures of which we would like to mention the following:

- Security system design for the metallurgical installations meant to prevent the dispersal of pollutant substances in the microenvironment in the foundry as well as outside it.
- Thinking, conceiving, designing and putting into practice of some neutralizations solutions of noxious pollutant substances in foundries
- Choosing with great precaution of binders and additives to be used to prepare the mixtures of molding – core making
- Development of technologies which use safe, non-harmful binders and additives
- Periodical analysis of pollution level in foundries.

2. REFERENCES

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