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ASSESSMENT OF AIR POLLUTANTS PRODUCED BY INDUSTRIAL ACTIVITY FROM AN ALUMINIUM ALLOYS FOUNDRY

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The industrial activity in non-ferrous alloys foundries leads to the elimination of the pollutants in the atmosphere that may have adverse effects on the environment and human health. This paper presents an evaluation of the pollutant emissions resulting from an aluminium foundry starting from data on concentrations and pollutant mass flow rates estimated for each phase of the technological process and on measured ambient levels for the area of influence of the objective to study.

Key words: foundry, aluminium alloys, air pollutants, emission, technological process

INTRODUCTION

Production of spare parts by foundry is a very laborious work of design and technological skills, which can be divided into the following stages: design of the model and of the core boxes with which to be able to execute the form, choosing the method of execution of the shape, shape design, so as to ensure the removal of the piece and the settlement cores without its demage, establishment of the shape technology execution, and its readiness for foundry, so the metal to solidify lently. In the technological process of foundering the sequences are the following: execution, after the projecting, of the model and of the core, nominated suit of model; the execution of the form, which requires first preparing the materials from which they are made; preparing the form for casting; metal casting in shape; removing the piece from the form after solidification (de-battement); cleaning and repair of small defects and heat treatment of the piece [1,2].

The stages of the technological process within a nonferrous foundries are generating pollutants such as: sulphur oxides, nitrogen oxides, carbon monoxide, hydrocarbons, aldehydes, dust, oxides of Al, Cu, Mg, Mn, Zn, Ti, Ni, and volatile organic compounds [3]. By the action on the human body, the specific investigated economic unit's pollutants fall into groups: pollutants irritants - SO_2, NO_2, dust suspension; stifling-toxic pollutants CO; toxic systemic pollutants - Ni, Mn, Cu, Zn, and its compounds. The effects of pollutants on the human body are immediate (acute) appearing shortly after exposure and is manifested by pathological changes and late effects (chronic) exposure occurring for a long time and which is manifested through the functional changes followed of morphological alterations [4,5].

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MATERIALS

In the study conducted have been identified and inventoried pollution sources and pollutants of interest generated by the technological process developed in a unit of obtaining of aluminium profiles. Pollutants resulted from technological process are shown in Table 1.

Table 1 **Pollutants resulted from technological process**

Stages of the technological process	Pollutants of interest
Heating furnaces melting	sulphur oxides, nitrogen oxides, carbon monoxide and hydrocarbons, aldehydes, powders
Smelting of aluminium waste	sulphur oxides, nitrogen oxides, carbon monoxide, dust, oxides of Al, Cu, Mn, Mg
Metal casting in the gutter	oxides of Al, Cu, Mn, Mg
Preheating bars	sulphur oxides, nitrogen oxides, carbon monoxide and hydrocarbons, aldehydes, powders
Hardening treatment	
Drying profiles	volatile organic compounds (xylene, toluene, butyl acetate, acetone)

In order to assess the level of emissions was used the methodology Emissions Factors & AP 42, Compilation of Air Pollutant Emission Factors. The emission levels assessed according to the above mentioned methodology have been reported to the limit values in accordance with the Order 462/93 for approving the technical conditions concerning the atmospheric protection and the methodological norms for the determination of emissions of air pollutants produced by stationary sources. The limit values in accordance with the normatives are shown in Table 2, 3.

Table 2 **Emission limit values for combus-tion plants for production of industrial heat**

Indicators	Units mass	Limit values
Dust in suspension	mg/m^3	50
Carbon monoxide	mg/m^3	170
SO_2	mg/m^3	1 700
NO_2	mg/m^3	450
Reference measure O_2	% vol.	3

RESULTS AND DISCUSIONS

The estimation of the level of emissions for the aluminium foundry was analysed for each phase of the production process, starting from the characteristics and parameters of specific pollution sources identified.

Table 3 **Emission limit values for inorganic substances**

Substance	Masic debit / g/h	Concen-tration / mg/m^3
Copper and its compounds	25	5,0
Manganese and its compounds	25	5,0
Aluminium and its compounds	The limit values are not set	
Total dusts (organic and inorganic)	If the flowrate is greater than 0,5 kg/h, the level of concentration must not exceed the concentration of 50 mg/m^3	

For the heating of melting furnaces (Fase1), the characteristics of the source of pollution posed by oven basket (two pieces) are as follows: height chimney (17 m) diameter chimney (0,7 m), temperature of the effluent (200 ^{0}C), flue gas flow rate (1 400 Nm^3/h), nominal flow rate (15 000 Nm^3/h), liquid fuel. The maximum level of emissions for pollutants of interest generated in this phase of the technological flow is presented in Table 4.

Table 4 **The maximum level of emissions on the stove, in the phase of heating of melting furnaces (Fase 1)**

Substance	Concentration / mg/m^3	Mass flow / g/h
SO_2	339,3	475
NO_2	371,4	520
CO	50,7	71
Aldehydes	8,57	12
Hydrocarbons	202,86	284
Dust in suspension	20	28

From the analysis of estimated values is observed that the emission of SO_2, NO_2, CO, total dust in suspension fall into the limit values stipulated by Order of the 462/93. For aldehyde emissions and hydrocarbons limit values are not set for burning stove. At the stage of melting aluminium wastes (Fase 2), the source of pollution is the metallic chimney (two pieces) which shows the following characteristics: high of chimney (17 m), diameter (0,7 m), temperature of the effluent (120 ^{o}C), flue gas flow rate (15 000 Nm^3/h), total flow discharged effluent (25 000 Nm^3/h), liquid fuel. The maximum estimated emission phase of melting aluminium wastes is shown in Table 5. The level of the emissions of SO_2, NO_2, CO, Cu, Ni, Mn fit emission limit values (LV) provided by Order 462/93. For Al, Zn, Mg, Ti and their compounds have not been laid down emission limit values but have been taken into account in total suspension and fits into limit values. In the preheating phase of the bars or extrusion (Fase 3), the source of pollution is the metal chimney (12 m), flue gas flow of 140 Nm^3/h, fuel used liquid-type. The maximum level of estimated emissions for the preheating phase is presented in Table 6 through the values of the mass flows and concentration of pollutants.

Table 5 **The maximum emission level in the stage of melting aluminium waste (Fase 2)**

Substance	Concen-tration / mg/m^3	Mass flow / kg/h	/ g/h
SO_2	340,0	-	500
NO_2	375,0	-	551
CO	51,0	-	75
Al oxides	7,12	0,178	178
Cu oxides	0,368	0,0092	9,2
Zn oxides	0,076	0,0019	1,9
Mn oxides	0,063	0,0016	1,6
Mg oxides	0,014	0,0034	3,4
Ni oxides	0,160	0,004	4,0
Ti oxides	0,0160	0,0004	0,4
Total dusts in suspension	9,92	0,248	-

The data presented in Table 6, show that the emissions of SO_2, NO_2, CO, total dust in suspension fits in limit values with the difference that for hydrocarbons and aldehydes are not set limit values for burning stove. The treatment of hardening profile (extrusion) – Fase 4 presents itself as source of pollution the metal chimney with the following characteristics: height of 12 m, the flue gas flow of 2 800 Nm^3/h, fuel oil.

Table 6 **The maximum level of emissions for the preheating phase of bares (Fase 3)**

Substance	Concen-tration / mg/m^3	Mass flow / g/h
SO_2	339,3	47,5
NO_2	371,4	52
CO	50,7	7,1
Aldehydes	8,57	1,2
Hydrocarbons	203	28,4
Dust in suspension	20	2,8

Table 7 shows the estimated emission level for this stage of the technological process. The data indicate the level of emissions of SO_2, NO_2, CO and dusts in suspension that fit limit values of the standard in force.

For drying profiles phase (Fase 5), the characteristics of the source of pollution, metal chimney (one piece) are as follows: height (12 m), flue gas flow rate (70 Nm^3/h), debit chimney (2 500 m^3/h) and the fuel used is liquid. The emission levels of toluene, xylene, butyl acetate and acetone (Table 8) fit into the limit val-

Table 7 **The maximum level of emissions for the treatment of hardening profile (Fase 4)**

Substance	Concen-tration / mg/m³	Mass flow / g/h
SO_2	339,3	950
NO_2	371,4	1 040
CO	50,7	142
Aldehydes	8,57	24
Hydrocarbons	203	568
Dust in suspension	20	56

ues. The level of emissions of volatile organic compounds, combined classes: toluene - xylene, butyl acetate - acetone fit limit values from Order 462/93. The level of emissions of SO_2, NO_2, CO, total dust in suspension fits in limit values and for aldehydes and hydrocarbons are not set limit values for burning stove. Assessment the level of emissions of atmospheric pollutants SO_2, NO_2 (Figure 1), CO and total dust in suspension (Figure 2), for stages of the technological process of the aluminium foundry analysed indicate the framing of these estimated parameters in the range of the values indicated in Order 462/93.

Table 8 **The maximum level of emissions for the drying profiles stage (Fase 5)**

Substance	Concentration / mg/m³	Mass flow / g/h	/ kg/h
Toluene	34,2	-	0,085
Xylene	28,7	-	0,072
Acetone	39,5	-	0,100
Butyl acetate	41,2	-	0,103
SO_2	339,3	23,75	-
NO_2	371,4	26,0	-
CO	50,7	3,55	-
Powders	20	1,40	-
Aldehydes	8,57	0,60	-
Hydrocarbons	203	14,21	-

The imissions of CO_2, NO_2, CO and dusts in suspension are specified to the area investigated and results from the industrial activity such as from the cars' traffic. The level of imissions measured for different control

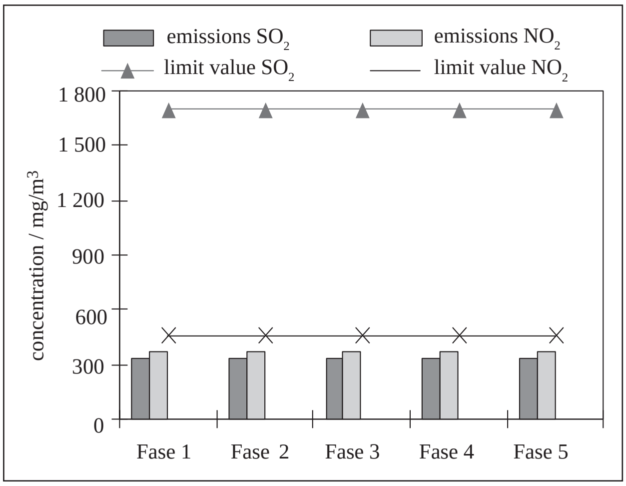

Figure 1 Assessment of the SO_2 and NO_2 levels

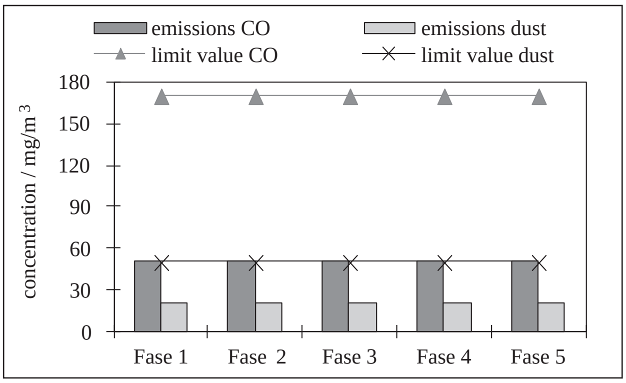

Figure 2 Assessment of the CO and dusts levels

points from the area of influence of the objective to be monitored is presented in Table 9. Measurements of SO_2, NO_2, CO have been made using a portable gas analyser Model Multilyzer N. G. The measured values have been reported to the values provided by STAS 12574/87 – Air of the protected areas. Conditions of quality and Order of the Minister 756/1997 concerning evaluation of environmental.

Table 9 **Imission levels in the area of influence**

Control points	Measured concentrations / mg/m³/24 hours			
	SO_2	NO_2	CO	Dust in suspension
P1	0,0042	0,0137	2,845	0,166
P2	0,0072	0,0133	1,640	0,124
P3	0,0063	0,0196	1,745	0,205
P4	0,0071	0,0121	1,284	0,138
Max.allowable conc. (MAC)	0,25	0,1	2	0,15
Threshold alert	0,175	0,07	1,4	0,105

From the data obtained from measurements is seen as SO_2 and NO_2 is 100 % within the limits permitted in all control points. CO measured in the control point (P1) is situated over the alert threshold of 2,03 times, indicating a potential impact on air; in the protected area (P2, P3) CO level is above the alert threshold, indicating a potential impact on air; in point control (P4), CO is situated in the admitted limits. The evolution of the carbon monoxide concentration in the area of influence of the aluminium alloys foundry analysed is shown in Figure 3.

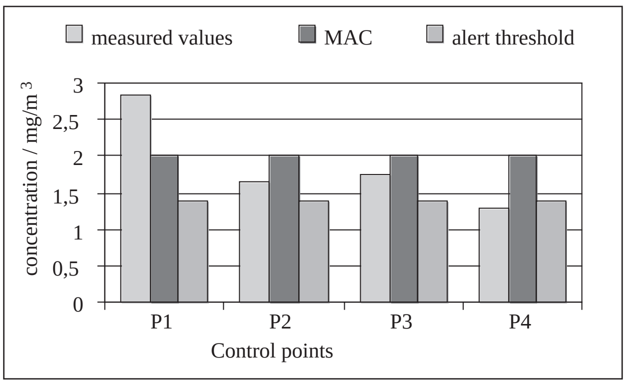

Figure 3 The evolution of the CO concentration

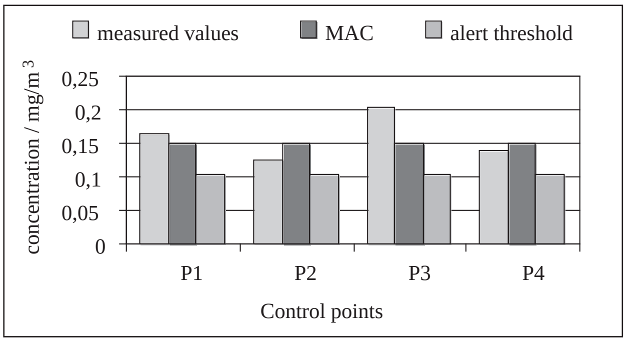

Figure 4 The evolution of dust in suspension concentration

Particulates in suspension measured in the control point (P1) is over the alert threshold of 1,58 times, indicating air impact; in the checkpoint (P3) is over the alert threshold of 1,95 times, indicating air impact; in other points is over the alert and below the intervention threshold, indicating a potential impact on air. The evolution of dust concentration in suspension in the area of influence of the aluminium alloys foundry analysed is shown in Figure 4.

CONCLUSIONS

The pollutants released into the atmosphere by industrial activities carried out in an aluminium alloys foundry were evaluated for each phase of the production process. Taking into account the specific characteristics and parameters of pollution sources identified in the activity of aluminium alloys foundry, were estimated concentrations and mass flow rates of the air pollutants. Assessing the level of emissions of atmospheric pollutants for stages of the technological process indicate these parameters in framing the norms in force. The emissions in the location of the objective are characterized by high concentrations of SO_2, NO_2, CO and volatile powders, influenced also by cars traffic. Carbon monoxide and particulates in suspension measured is situated in some points of the area surveyed over the threshold of intervention or alert, indicating a potential impact on air.

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