ASSESSING THE EXPOSURE TO INORGANIC LEAD AND CADMIUM WITHIN A FACTORY OF NONFERROUS METALLURGY

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Abstract: *Evaluating the exposure to heavy metals by personal and workplace monitoring, within a nonferrous metallurgy factory has shown a higher level of lead and cadmium pollution in the departments: agglomeration, furnace, electrolysis, and refinery. There has also been shown the presence of other heavy metals with values that exceed the accepted limits. The presence of several heavy metals at the same workplace raises for discussion the possibility of their interaction, the cumulative effect, as well as the side effects upon the health of employees.*

Keywords: *Exposure evaluation, working place and personal monitoring, heavy metals*

Rezumat: *Evaluarea expunerii la metale grele, prin monitorizare la locul de muncă şi monitorizare personală, într-o întreprindere de metalurgie neferoasă a evidenţiat un nivel de poluare cu plumb şi cadmiu mai ridicat în secţiile aglomerare, furnal, electroliză şi rafinare. S-a constatat şi prezenţa altor metale grele cu valori care depăşesc cu mult limitele admise. Prezenţa mai multor metale grele în acelaşi loc de muncă, pune în discuţie posibilitatea interacţiunii lor, efectul cumulativ şi efectele secundare, asupra stării de sănătate a angajaţilor.*

Cuvinte cheie: *Evaluarea expunerii, monitorizare la locul de muncă şi personală, metale grele*

INTRODUCTION

Exposure assessing represents one of the main stages for risk evaluation and the process of measuring or estimating qualitatively or quantitatively the intensity, frequency, length or the human exposure way to a pollutant.

Exposure approaching methods were grouped by the National Academy of Sciences of the USA in direct and indirect methods. At their turn, the indirect methods were classified in four main categories:

- Workplaces pollution monitoring
- Computed-assisted models of concentration, contact between pollution and human body, or of the dose
- Questionnaires
- Individual journals

The direct methods are also of two types:

- personal monitoring used especially for the occupational exposure
- biomarkers of exposure, effect and of susceptibility (1)

In this study, we used the majority of these methods, both direct and indirect ones.

PURPOSE OF THE RESEARCH

The paper aims at assessing the heavy metals exposure, by fixed points and personal monitoring, within a nonferrous metallurgy factory.

MATERIAL AND METHOD

The main activities and departments within the factory taken into our study are: agglomeration, furnace, lead electrolysis, zinc refinery, facilities for recycling and recovery of zinc and lead containing wastes.

Establishing the levels of pollutants in the workplaces air was made by taking samples of powders from the air for 30 minutes, by observing the taking samples methodology and the literature observations (2,3).

Lead and cadmium concentrations were established in the workplaces air, as well as those of other heavy metals: arsenic, mercury, copper, chromium, zinc, and the concentrations of sulphur dioxide, nitrogen dioxide, breathable powders (PM 10). We have also made determinations of the workplace microclimate: relative humidity, dry and wet temperature and the speed of the air currents and noise determinations.

58 determinations were made for each metal in different workplaces from almost all departments of the factory. The results were related to the limit values for the occupational exposure established by the legislation in force and were compared with literature data (4,5,6,7).

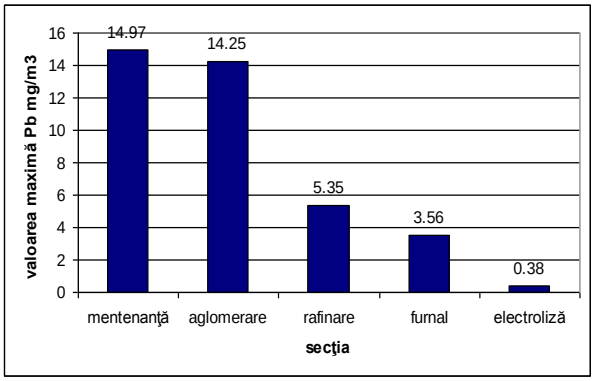
RESULTS AND DISCUSSIONS

Lead concentrations were included in the interval 0-14.79mg/m3, with an average value of 1.788mg/m3± 3.412. Skewness and Kurtossis indexes indicated a curve of the distribution which was sharp and moved to the right.

Exceedings of the maximum values of lead were registered in almost all departments of the factory where determinations were made. The highest levels were registered in the agglomeration and maintenance

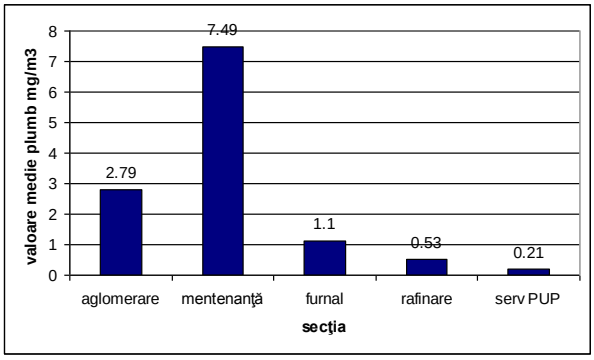
departments. These values exceeded the accepted limit 147.9 and 142.5 times. Values over the accepted limit were also registered in the departments of refinery, furnace and electrolysis (Fig 1).

Picture no. 1 Maximum values of inorganic lead per departments, established as a result of the fixed points monitoring. (occupational exposure limit value =v0.10mg/m3)



The average values per departments show that the highest average value that exceeded the accepted limit 74.95 times was recorded in the maintenance department, 7.495 mg/m3 ±10.316, followed by the agglomeration department, where the average value was of 2.793mg/m3 ±4.137, then the furnace and refinery departments (Fig.2)

Picture no. 2 Inorganic lead average values per departments established as a result of the point fixed monitoring (occupational exposure limit value=0.10mg/m3)



For cadmium, 58 determinations were registered and its presence was recorded only in one department, of fine mill, with a value of 0.31mg/m^3.

The arsenic determinations showed values in the interval 0-0.26mg/m3, with an average of 0.011mg/m3 ±0.049. Regarding three departments: agglomeration, furnace and refinery, the values exceeded the accepted limit, the highest value being recorded in the agglomeration department, 2.6 times over the accepted limit.

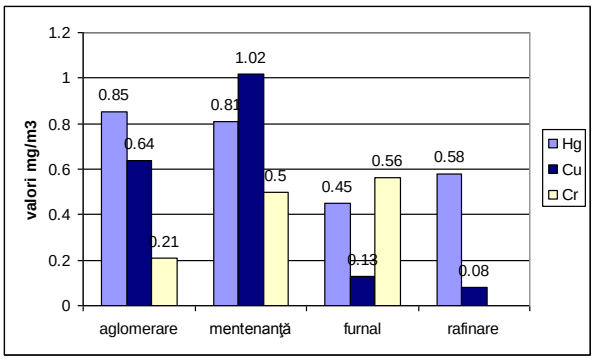
The mercury determinations registered values between 0 and 2.63mg/m3, with an average value of 639mg/m3±0.541. The maximum highest value was recorded in the agglomeration department and exceeded the accepted limit 17.5 times.

The highest value was registered in the agglomeration department 0.859mg/m3±0.668, which means an exceeding of the accepted limit of 5.72 times, followed by the refinery department.

Regarding copper, the maximum value was registered in the agglomeration department where it exceeded the accepted limit 2.38 times. The values were between 0-3.58mg/m3, with an average of 0.367mg/m3 ±0.630. The highest average value was registered in the maintenance department, followed by the agglomeration department (Fig. 3).

Chromium and zinc highest concentrations, as well as the highest average values of these metals were also recorded in the agglomeration and maintenance departments.

Picture no. 3 Maximum values of certain heavy metals per departments, established as a result of the fixed points monitoring.



Although the legislation in force does not provide a maximum accepted limit for chromium and zinc in the workplaces air, studies have shown that negative effects might occur in the health state of the employees, regarding certain levels of exposure to these metals (8).

Sulphur dioxide and nitrogen oxide concentrations did not exceed the accepted limit in the workplaces air. Breathable fraction powders (PM10) exceeded the accepted limits in only two departments: furnace and refinery.

Noise determinations showed values around the accepted ones, slightly exceeding them, but the average value was registered in the normal limits and the standard deviation was small. The highest average values per departments were registered in the agglomeration and refinery departments but without exceeding the accepted limits.

Within the personal monitoring, concentrations of different pollutants were registered in the workplace air, regarding a group of employees from different workplaces. The taking of samples process lasted for two working hours.

Lead concentrations established in the breathing air of the employees registered the highest values in the departments of furnace and agglomeration, which exceeded the accepted limit 16.8 times, respectively 11.8 times.

Mercury concentrations had the highest value in the breathing air of the employees working in the

agglomeration department, which exceeded the accepted limit 17.5 times. Out of 18 determinations, 11 exceeded the accepted limit.

For zinc, the highest values were recorded in the furnace department - 30.84mg/m3, followed by the departments of agglomeration and maintenance.

Within the personal monitoring, determinations for other heavy metals were also made, such as for: arsenic, cadmium, chromium, copper, nickel, but no significant values were recorded.

Sulphur dioxide had values two times over the accepted limit only in the agglomeration department, while the nitrogen dioxide did not register exceeding values.

The average values of the powders in suspension (PM10) is of 4.00mg/m3, value that does not exceed the limit, but the standard deviation is very high, of 10mg/m3

CONCLUSIONS

The highest values of the pollutants' concentration in the workplaces air were recorded both within the fixed points monitoring and within the personal monitoring in the agglomeration department, where the most risky operations were developed regarding the employees' health, from the point of view of the exposure to heavy metals and associated noxious substances (powders, noise, warm microclimate). Values that exceeded the accepted limit were also registered in the departments of maintenance, furnace and refinery.

It is to be noticed that the highest exceeding of the accepted limit was registered by lead values (of 149.7 times), regarding the determinations made in the workplaces air.

As far as the personal monitoring is concerned, the presence of lead, mercury and zinc in the work place breathing air of the employees was noticed.

The presence of more heavy metals in the same workplace raises for discussion the possibility of their interaction, the cumulative effect and the side effects upon the employees' health state (9).

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