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AIR POLLUTION WITH VOLATILE ORGANIC COMPOUNDS FROM HEAT TREATMENT OF METALS

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Introduction

This paper presents the results of volatile organic compound (VOC) pollution from a bearing factory. In the bearing manufacturing industry, the parts (rings and rollers) are subjected - in stages - to several thermal scaling processes, in order to change the microstructure of the parts in order to improve their physical-mechanical properties. The secondary heat treatment process responsible for VOC emissions are hardening and tempering. Tempering is achieved by rapidly cooling the carburized parts by immersion in mineral oil baths at a temperature of 40°C.

High return - is achieved by heat treatment of hardened parts in ovens at temperatures of 500°C or 230°C

From the hardening and tempering process, a series of air pollutants specific to the oil burning processes are emitted, among which VOC.

Materials and methods

An automatic analyzer of volatile organic compounds expressed as total organic carbon was used to measure VOC emissions from the hardening process. For a more accurate characterization, individual VOC measurements (benzene, toluene, m+p-xylene, o-xylene, hexane) were performed.

The applied methods were according with the following standards: Volatile Organic Compounds in the form of Total Organic Carbon (VOCs expressed in total organic carbon): SR EN 12619: 2013 - Emissions from fixed sources. Determination of the mass concentration of gaseous organic carbon. Method with continuous flame ionization detector. The method of measurement consists in determining the ionization current resulting from the combustion of organic compounds in a hydrogen flame. The current depends on the number of carbon atoms burning in the fuel gas flame, the type of bonds (straight or branched chain) and the constituents of the bonds. Equipment used - Thermo-Fid PT automatic analyzer for the determination of total organic carbon, in mgC/Nmc and SR EN 13649: 2002 - Fixed source emissions. Determination of the mass concentration of volatile organic compounds. Method by adsorption on activated carbon and desorption in solvents.

The results of the emission measurements were introduced in the Aermod View pollutant dispersion program. This program uses an atmospheric dispersion model based on the turbulent structure of the atmosphere layers and scaling concepts,

including the treatment of multiple point sources at ground level or at altitude. It can be used for flat or complex land, rural or urban and includes algorithms for the effects due to buildings.

Results and conclusions

For total volatile organic compounds, the values of the measured concentrations were between 6-67 mgC/m³. The values were below the emission limit values in accordance with Order 462/1992 of 150 mgC/m³. In terms of individual VOCs, the results of the measurements were presented in Table no. 1:

Table 1. Results of emission measurements

Emission sources	Pollutant, Concentrations				
	Benzene µg/m ³	Toluene µg/m ³	m+p-xylene µg/m ³	o-xylene µg/m ³	Hexane µg/m ³
Heat treatment - heating	0.61	0.15	0.12	2.82	0.09
Carburizing/ hardening	1.23	0.10	0.06	3.11	0.17
hardening	2.31	0.35	0.44	4.02	0.27

The concentrations of all pollutants were below the emission limit values, primarily due to the efficient combustion process of the heat treatment installations, as well as due to the waste gas treatment systems.

In order to see the contribution of the sources that emit VOCs in the vicinity of the site, the values from the emissions were introduced in the mathematical modeling. Table no. 2 presented the maximum values for VOCs at immissions.

Table 2. Pollutants dispersion results

Pollutant	Benzene µg/m ³	Toluene µg/m ³	m+p-xylene µg/m ³	o-xylene µg/m ³	Hexane µg/m ³
Mediation time	30 min	1h	1h	1h	1h
Concentrations	0.72	0.11	0.10	0.83	0.15
STAS 12574-87	1500	-	-	-	-

Overall, the modeling results emphasized that for all the limited indicators and for all the mediation periods the maximum concentrations obtained in both types of simulation are below the Limit Values / Maximum Allowed Concentrations provided in the environmental legislation. The areas where these values can be reached are located, for all indicators, on the site in a restricted area in the southern part of the premises.

In conclusion, VOC pollution caused by bearing manufacturing was not significant, the values found for emissions and immissions were below the appropriate limits, according to environmental legislation.