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CHANGES OF EVALUATION RULES OF EXPOSURE TO DUST FACTORS IN THE ROCK MINING INDUSTRY. A CASE STUDY OF EVALUATION RULES IN POLAND

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Abstract: The paper presents changes in provisions of the regulation concerning the maximum permissible concentration and intensity of agents harmful to health in the work environment, in force in Poland from August 2018. A new qualification of dust factors regarding rock mineral dusts has been provided for, within the range referring. Consequences of regulations changes for the rock mining industry have been indicated, in particular those resulting from introduction of a new noxious agent-respirable crystalline silica.

***Keywords*:** *crystalline silica (CS), quartz, cristobalite, dust, rock mining, work environment*

1. INTRODUCTION

In Poland, on 12th of June 2018, a new regulation modifying the 6 June 2014 regulation of the Minister of Family, Labor and Social Policies on the maximum permissible concentration and intensity of agents harmful to health in the work environment (hereinafter, the "MPCaI" regulation) was entered into force (Journal of Laws of 2018, item 1286). An update of the national law regulations stemmed from the obligation to implement, on that date at the latest, provisions of the Directive of the Commission (EU) 2017/164 of 31 January 2017 (Journal of Laws of 2017, item 1348), establishing the fourth list of indicative occupational exposure limit values in accordance with the Euro-

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pean Union Occupational Safety and Health Agency (EU-OSHA) Directive 98/24/EC and amending the Directives 91/322/ECC and 2009/161/EU and Directive (EU) 2017/2398 of the European Parliament and of the Council of 12 December 2017 amending Directive 2004/37/EC on the protection of workers from the risks related to exposure to carcinogens or mutagens at work. The MPCaI regulation of 2018 also takes into account thirteen requests of the Interservice Commission on Maximum Permissible Concentration and Intensity of Agents Harmful to Health in the Work Environment, addressed to the minister in charge of labor over the period 2014–2017.

The new MPCaI Polish regulation for noxious agents in the work environment introduces a number of significant changes, namely (Journal of Laws of 2018, item 1286):

- in Annex 1 to the Regulation, division into part A "Chemical substances" and part B "Dusts" has been replaced with a combined "List of maximum values of permissible concentrations of chemical and dust factors harmful to health in the work environment";
- provisions for dust substances and their permissible values have been verified;
- changes to permissible concentrations for 32 chemical substances have been introduced;
- 15 new chemical substances and their permissible concentrations have been added to the list, including independent maximum permissible concentration (MPC) for crystalline silica (CS);
- the obligation to assay crystalline silica (CS) in other substances qualified in the regulation with notation 7) has been introduced;
- "skin" designation in the "Comments" column next to substances that may be absorbed through skin has been added
- provisions for cold microclimates according to PN-EN ISO 11079:2008 standard have been updated.

Changes concerning in Polish MPCaI, introduced in the regulations, will allow for a more comprehensive analysis of working conditions and a more reliable evaluation of occupational hazards resulting from occurrence of agents harmful to health.

In the previous Polish regulation, the name Free Crystalline Silica (FCS) was used as a harmful agent. This name raised many doubts and misinterpretations. However, FCS referred to all the crystalline forms of silica (quartz and cristobalite, CS) misleadingly called "free crystalline silica" (Maciejewska 2008; Ojima 2003).

2. CHANGES TO DUST FACTORS. THE CASE OF CRYSTALLINE SILICA

In other cases of dust factors, assayed using the gravimetric method, the name of the substance was used directly, e.g., hard coal, lignite, magnesium calcium carbonate

(dolomite), kaolin, talcum, crystalline silica, etc. A comparative list of dust factors, most frequently occurring in rock mineral mining and processing facilities, are presented in Table 1.

New Polish regulations fundamentally changed the approach to crystalline silica. Previously, the percentage of free crystalline silica content in dust (so-called FCS) (Maciejewska 2008; Omija 2003) served as a basis for calculation of the value of MPC for the inhalable and respirable fractions of dusts containing FCS in two broad ranges: from 2% to 50% and above 50%, and, separately, for dusts containing less than 2% of FCS. The MPC value of crystalline silica itself was not set, and the evaluation of occupational exposure to illnesses resulting from its presence was unreliable (Stefanicka 2012). The new MPC in Poland for crystalline silica, i.e. for the respirable fraction of quartz and cristobalite, was set to 0.1 mg/m^3, which corresponds to EU recommendations and normative values adopted in the majority of European countries.

Regulation of MPCaI, in force in Poland from 21 August 2018 (Journal of Laws of 2018, item 1286), in relation to the dust factors, not only introduces new substances and corrects values of permissible concentrations, but also changes nomenclature. Previously (in a separate Annex no. 1-B "Dusts"), 19 dust substances were classified. Currently, the term "dusts" refers only to four factors:

- dusts unclassified for toxicity,
- wood dusts,
- flour dusts (new factor), and
- organic dusts of animal or plant origin other than wood and flour dusts.

In other cases of dust factors, assayed using the gravimetric method, the name of the substance was used directly, e.g., hard coal, lignite, magnesium calcium carbonate (dolomite), kaolin, talcum, crystalline silica, etc. A comparative list of dust factors, most frequently occurring in rock mineral mining and processing facilities, are presented in Table 1.

New Polish regulations fundamentally changed the approach to crystalline silica in Poland. Previously, the percentage of free crystalline silica content in dust (so-called FCS) (Maciejewska 2008; Omija 2003) served as a basis for comparisons of the value of MPC for the inhalable and respirable fractions of dusts containing FCS in two broad ranges: from 2% to 50% and above 50%, and, separately, for dusts containing less than 2% of FCS.

Due to the fact that crystalline silica may be present in other dust substances, in the new regulation, factors for which there is an obligation to additionally assay the content of crystalline silica in the respirable fraction, were identified with notation 7). This situation applies to substances mentioned in the regulation under the following names:

- Apatites and phosphorites,
- Portland cement [65997-15-1],

- Titanium dioxide [13463-67-7],
- Kaolin [1332-58-7],
- Dusts not classified for toxicity [–],
- Calcium sulphate (IV) (gypsum) [7778-18-9],
- Coal (hard coal, brown coal),
- Calcium magnesium carbonate (dolomite) [16389-88-1],
- Silicon carbide, non-fibrous [409-21-2].

Evaluation of exposure of workers should be conducted, in that case, simultaneously in relation to the MPC values for: specific dust particle fractions (chemical and dusty substances identified in the work environment in accordance with the classification provided for in the new MPCaI regulation in Poland), and subsequently, for respirable fraction of crystalline silica (quartz and cristobalite).

Crystalline silica, as a new noxious agent in the work environment, should be assayed using reference method, according to findings published by CIOP [Central Institute for Protection of Labor] in "Bases and methods of evaluation of work environment" (Maciejewska 2012).

In Poland the technically, methods of air sampling and interpretation of measurement results used to assess occupational exposure to chemicals, occurring in the form of vapors, gases, aerosols and industrial dusts sampling remain unchanged. Individual dosimetry according to PN-Z-04008-7:2002+Az1:2004 is considered as the basic method. This standard indicates that the number of workers examined per workstation should be as follows: all of the workers exposed in the case of employment of up to six persons, and, if the number of workers is higher than six, according to the following formula: $2\sqrt{n}$, where n – number of workers employed in the given work conditions. If there are people who are potentially more exposed to higher concentrations, they are the ones who should be selected for testing first (in a group of more than 6 people) "worst-case measurement" according to PN-EN 689:2002 (this standard is directly referred to in PN-Z-04008-7:2002. This rule shall probably be rigorously observed (by inspection and control authorities) due to the varying content of crystalline silica in the air of the work environment, even if nominally those workstations have the same names and working day timing systems.

In Poland the issue of crystalline silica as a noxious agent, in the case of which long-lasting exposure to respirable fraction may lead to development of many diseases, such as: silicosis and its complications, i.e., bacterial and fungal infections, lung cancer, chronic obstructive pulmonary disease, immune disorders, autoimmunological diseases, chronic kidney diseases, and systemic silicosis, was thus regulated. It should be noted that pneumoconiosis is the most frequently diagnosed occupational disease in the mining industry. Between 2013 and 2017, 1800 cases of that disease were diagnosed in the mining sector and a vast majority of them concerned hard coal mining in Poland (in accordance with the health and safety at work analysis for the mining sector – WUG, 2018).

3. CONSEQUENCES OF CHANGES OF DUST FACTORS OF MPCS FOR THE ROCK MINING INDUSTRY IN POLAND

Dust noxious agents in the work environment, related to presence of typical rock minerals according to the "old" and the "new" classification of provisions of the regulation on MPCaI in Poland, are presented in Table 1.

For rock mining facilities in Poland, before the legal framework was amended, to a majority of cases, MPCs regarding the content of free crystalline silica (FCS) (Maciejewska 2008; Omija 2003) ranging from 2 to 50%, had been applicable, namely: 4 mg/m^3 for the inhalable fraction and 1 mg/m^3 for the respirable fraction. That group comprised rock mineral dusts: granite, basalt, melaphyr, gabbro, amphibolite, syenite, porphyry, gneiss, etc. More rigorous MPCs were applicable with FCS (Maciejewska 2008; Omija 2003) content exceeding 50%; in those cases, the concentration of inhalable fraction was limited by the MPC normative of 2 mg/m^3, and respirable fraction – 0.3 mg/m^3. Quartzite and quartzite sandstone dusts were usually classified in that mineral group. For substances free of FCS in material quantities (i.e., less than 2%, e.g., limestone), the normative applied only to the inhalable fraction and it amounted to MPC 10 mg/m^3. The same harmful factor, affecting humans in the same way regardless of its percentage content, had different limit values, and this is what was standardized in the 2018 regulation. The situation in Poland changed with the introduction of the new MPCaI regulation, effective from August 21, 2018 (Journal of Laws of 2018, item 1286). Currently the MPC contents in the air of the work environment were assigned individually to every substance, including crystalline silica (even in cases of its cooccurrence, thanks due to the introduction of the notation 7). According to the new provisions, most frequently identified dust factors in the rock mining industry are "dusts unclassified for toxicity" with notation 7) (item 456, list no. 1). The MPC for those substances is: 10 mg/m^3 for inhalable fraction, and concentration of respirable fraction of crystalline silica – 0.1 mg/m^3. The same normative values apply to magnesium calcium carbonite (dolomites) [16389-88-1] (item 540), kaolin [1332-58-7] (item 305), and gypsum [7778-18-91] (item 466).

In comparison to previous Polish normative values in Poland, the concentration of inhalable fraction of dusts will be less strictly evaluated. Concentrations of respirable fractions of dust particles, in general, will not be evaluated for dusts unclassified for toxicity; however, actual concentration of respirable crystalline silica (quartz and cristobalite, CS) will be relevant. The MPC value established for the respirable CS is decidedly more rigorous for dusts of most rock group. for which the content of FCS, theoretically, exceeded 10%.

Mathematical comparison of "old" and "new" Polish MPCs, however, cannot be treated as a basis for evaluation of exposure to noxious rock mineral dust agents according to the new regulation on MPCaI due to a number of reasons, most significant of them being changes to the assaying method for crystalline silica and inconsistent

sampling procedures for FCS (Maciejewska, 2008; Omija, 2003) assay pertaining to individual sampling of crystalline silica.

Table 1. Comparison of classifications and maximum permissible concentrations as well as intensities of harmful factors in the work environment for selected types of rock material dust in accordance with changes to Polish regulations effective from June 12, 2018 in Poland

Dust factors and crystalline silica in Polish law regulations on MPCaI							
Before 2018-08-21 in acc. with J.o.L. of 2017, item 1348				From 2018-08-21 in acc. with J.o.L. of 2018, item 1286			
Pos.	Factor name	MPC [mg/m^3]		Pos.	New factor name	MPC [mg/m^3]	
		I.F.	R.F.			I.F.	R.F.
1	Dusts containing free (crystalline) silica above 50%, [14808-60-7], [14464-46-1], [15468-32-3]	2	0.3	456	Dusts unclassified for toxicity [–] 7)	10	n.a. (CS 0.1)
2	Dusts containing free (crystalline) silica from 2% to 50%, [14808-60-7], [14464-46-1], [15468-32-3]	4	1				
5	Other non-toxic industrial dust – including those containing free (crystalline) silica below 2% [–]	10	–				
–	–	–	–	315	Crystalline silica, quartz [14808-60-7]; cristobalite [14464-46-1]	-	0.1
17	Dolomite dusts containing free crystalline silica below 2% and not containing asbestos [–]	10	–	539	Magnesium calcium carbonate (dolomite) [16389-88-1] 7)	10	n.a. (CS 0.1)
18	Kaolin dusts containing free crystalline silica below 2% and not containing asbestos [1332-58-7]	10	–	305	Kaolin [1332-58-7] 7)	10	n.a. (CS 0.1)
16	Gypsum dusts containing free crystalline silica below 2% and not containing asbestos [7778-18-91]	10	–	466	Calcium sulfate(VI) (gypsum) [7778-18-91] 7)	10	n.a. (CS 0.1)

Symbols: I.F. – inhalable fraction, R.F. – respirable fraction, CS – crystalline silica.
Notation 7) – simultaneous assay of respirable fraction of crystalline silica applicable.

4. CONCLUSIONS

The new regulation in Poland on MPCaI, in force since June 12th, 2018 (Journal of Laws of 2018, item 1286), implies the obligation for employers to reassess and update lists of dust noxious agents in their work environments. They should take into account the verification of nomenclature previously used and introduction of new factors, including crystalline silica.

In the case of most mineral groups, evaluation of exposure to for the inhalable fraction, the new limit values are less stringent, and for the respirable fraction of dust we currently have no comparison (it has been replaced by crystalline silica, which is not dust but is associated with it).

Individual assay of crystalline silica for specific workstations may entail significant changes in levels of exposure to dusts of minerals containing quartz (and/or cristobalite).

Introduction of normative values for respirable crystalline silica will lead to a differentiated evaluation of occupational exposure to dusts of specific minerals, previously classified in Poland in large mineral groups with the same MPC values. This is a relevant development related to the change in current legislation in Poland on exposure to dust from raw materials containing quartz (or cristobalite).

It will be necessary to launch individual action programs aimed at limiting exposure to chemical agents noxious agents in various rock mineral mining and processing facilities.

Changes of regulations on establishing maximum concentration limits in the work environment in Poland, will positively influence scenarios for the development of on the occupational health sector, because the new MPC in Poland for crystalline silica, i.e., for the respirable fraction of quartz and cristobalite, was set to 0.1 mg/m^3, which corresponds to EU recommendations and normative values adopted in the majority of European countries.

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