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SILICA PRESENCE IN BUILDING MATERIALS AND TASK-BASED EXPOSURE ASSOCIATED WITH RESTRUCTURING OF RESIDENTIAL BUILDINGS IN ITALY

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Abstract

Among the different facets of construction industry, residential and commercial buildings are of particular interest because the lack of exposure data for workers employed in this sector. In Italy, no data virtually exists for construction industry in general, and even less for building activities. Depending on the nature of the building material being used this dust can contain a considerable amount of crystalline silica (CS). During building activities these materials may be a potential source of occupational exposure to respirable CS. In several countries (USA, Holland, UK) there has been growing recognition of the risk of silica exposure in the construction sectors. On the contrary, in Italy, this problem has been rarely recognized. The objectives of this study are to present the data on the presence of silica in some of the building materials commonly used in Italy and on the exposure levels associated with typical tasks performed during renovation of residential buildings. In order to obtain more information on the chemical composition of these commercial products and to identify among them those containing silica, a systematic consultation has started of the national data bank of dangerous materials. Several samples of materials, including different type of cements, plasters, adhesives and mortars, have been analysed by X - Ray Diffractometry (XRD) and in 10 out of 42 samples CS have been found, ranging from 2,8%- 9,4% (finishing plaster) to 16,2% (adhesive for tiles). Personal respirable samples, depending on specific task and work practices, showed exposure levels to CS generally less than 0.05 mg/m^3. In a limited number of inhalable samples no appreciable concentration of CS was detected.

This study suggests that the hazard facing construction workers, at least for specific tasks, may be potentially significative and requires further investigation, in particular more extended characterization of the various building materials, and a program of systematic measurements of the exposure levels to CS associated to the various building activities.

Keywords: construction; building materials; crystalline silica; task

Introduction

The crystalline silica (CS) has been classified as carcinogen for the man from the IARC (1) essentially in base to the results of the epidemiological studies. Despite the doubts and the uncertainties expressed by different experts (2,3), the results of very recent studies seem to support and to confirm a causal relationship among pulmonary tumor and exposure to CS (4).

Even if the European union has not yet considered the classification of carcinogenicity of the CS, some countries have already introduced it in the national list of the carcinogens (5), applying in such way to this substance the principles of the specific European Directive (6) and establishing a threshold limit value (TLV). In Italy TLV for the CS does not exist, but case by case, it is generally adopted the TLV developed by the American Conference of Industrial Hygienists (ACGIH). The classification of carcinogenicity of the IARC has been adopted by the National Toxicological Commission (CCTN), but such decision has not formally been published still.

In the sector of the constructions dust can generally be considered omnipresent and the exposure to it constitutes a remarkable part in the practice of every day. Depending on the nature of the construction materials used, this dust can contain a considerable quantity of CS (present essentially as crystalline phase of the quartz). In USA the recent relationship of the National Institute of Occupational Safety and Health (NIOSH) on the overseeing of the occupational respiratory pathologies has underlined for the sector of the constructions the overcoming of the legal limit in the 37% of the time, with a greater frequency of that found in every other industrial sector (7). Despite this situation, they are still few studies on the incidence or prevalence of correlated pathologies to CS (8), as well as those on the characterization of the exposure levels in the various working operations, especially in the compartment of the building activities (9). A greater quantity of data exists in general for the great jobs of construction, but very more limited are the information on the levels of exposure associated to building activities. In Italy the situation appears even more precarious, in how much the lack of data essentially results total in the whole sector of the constructions, and particularly, in the building compartment (10). The factors that influence the working exposure include: the type of working activity, its duration and frequency, the used materials, the location, the presence of dust control systems. The operations of cut, perforation, abrasion and dry cleaning, produce the levels of concentration to respirable CS more elevated (8). The availability of all these informations, together with the data on profession and task, are of vital importance to be able to realistically appraise the risks for the health, the models of exposure estimation, and for future epidemiological studies.

It appears clear the necessity of codifying such numerous activities for creating a database comparable, to be used for strategic planning and preventive actions. In the United States, already from 1990, the agency of Statistic (Bureau of Census) and particularly the Center for the Control and Prevention of the Illnesses, founded an alphabetical index of the tasks carried out during the various working practices (BOC code) (11). Besides a recent study reports that 41 European organizations possess database of measures of occupational exposure to chemical agents (12). In Italy systems of coding of the working practices does not exist in the building constructions, as for other working activities, on the contrary the professions are classified only. To community level, the code ISCO-88(COM) (International Standard Classification of Occupations) is used for the classification of the professions. In reality, without any obligation of law, the majority of the community countries use their own codes (13), that are not perfectly referable to the code ISCO-88 (COM). Therefore the statistic data on the professions are not comparable entirely. To try to resolve such problem, from the first years 90, the Statistic institute of the European Communities (Eurostat) started, together with various European countries, a project denominated ESAW (European Statistics on Accidents at Work), destined to the harmonization of the various codes adopted by the community countries (14).

In this paper are presented the results obtained as a part of a wider project aimed to the characterization of the exposure to CS and to the evaluation of the risk in the compartment of the building activities. The results reported concern the initial phases of the project, in which the available information on the chemical characteristics and on dangerousness of over 40 different materials commonly used in this sector, have been collected and examined, and their content of CS has been determined by X-ray diffractometry (XRD). Besides a first series of results on the levels of exposure to respirable and inhalable fractions of dust and CS are reported, concerning in particular specific working activities habitually carried out during jobs of building restructuring.

Materials and methods

For the information search related to the bulk samples of building materials used more commonly in the sector of the restructurings of residential and commercial buildings, in a first phase, several associations of category have been contacted. The scarce information obtained have however induced to individualize other sources, in fact we have directly been retrieved on the market the samples of building materials necessary to the search.

The normative in force foresees that all the chemical substances and all the dangerous compounds commercialized in Italy, and those for which exposure limits do exist, must be accompanied by a safety sheet, compiled to care and responsibility of whom introduces such products on the market (manufacturer, importing, distributor).

The safety informative sheet has to bring, among other compulsory informations, the composition and the ingredients of the product (15-17).

Naturally in the list of dangerous substances the crystalline silica does not appear because it is not classified as such from the European Community. Nevertheless the existing regulation foresees packing and provisional labeling on the basis of the existing pertinent and accessible data. In the specific case of the silica the data on the health effects are well known and easily available.

To get information related to the presence of quartz in the materials considered and to verify the compliance to the existing regulations, it has been retrieved both the technical and safety documents.

Besides, for information search on the chemical composition of these commercial products and to be able to eventually identify those that contain silica, a systematic consultation of the national database on dangerous materials, activated at Istituto Superiore di Sanità (ISS), Rome is initiated. Since currently the crystalline silica is not included in the list of the dangerous substances the consultation of the aforesaid file cannot be considered exhaustive, in how much in the database they are present exclusively the compounds that are classified as dangerous, e.g. if they contain dangerous substances in concentration greater than the limits percentages of classification. For the substances classified very toxic, toxic, carcinogenic of category 1 and 2, the concentration in weight does not have to overcome 0,1%, while for the corrosive, harmful and irritating substances it does not have to overcome 1%. At the same time it has been started the search in the Chemical Abstract Service (CAS) of the code

No 14808-60-7 correspondent to CS (quartz), with the objective to retrieve all the compounds containing CS (or synonymous), and used in the building sector.

The sampling strategy was established on the basis of the following considerations:

for many tasks the duration was less than 30 minutes, but most of these were often repeated during the whole working day; in some cases the potentially dusty activities were carried out only for few minutes at the beginning of a workshift, during which dust production was negligible; very low levels of dust was often associated to many activities of long and short duration. In order to take into consideration this situation, we decided to use two sampling approachs: one based on full shift (7-8 h) and one on specific task.

For sampling respirable dust, according the new ACGIH/ISO/CEN convention, both the SKC aluminum, at flow-rate of 2,5 l/min, and 10 mm cyclone, at 1.4 l/min, were used. In four cases inhalable dust samples were also collected simultaneously, using IOM samplers at 2 l/m, in order to check the presence of CS in this fraction. The bulk samples and those of inhalable and respirable dust were analyzed by mean of XRD method using the silver membrane filter (18).

Results and conclusions

The technical data sheets of the materials have been obtained entering the manufacturers websites. These sheets do not have a common scheme (outline), the information reported are generally relative to composition, physical and technical characteristics, advantages, preparation and application, the consumption, coverage, and packing.

Material Safety Data Sheets (MSDSs) have been directly requested to the manufacturers, because they resulted unavailable in the websites. The samples of materials analyzed are not classified dangerous according to the European Directives 1999/45 (19) and 2001/60/CE (20), but, since they contain some substance dangerous to health and environment, the MSDS is required. For instance, cements become irritating, because the resulting strong alkaline solution when mixed with water. The same occurs for other materials containing calcium hydroxide or cement in their composition. From the consultation of the ISS database, 104 dangerous compounds have emerged. They were: 53 containing quartz, 39 containing ventilated quartz, 4 containing spheroidal silica, 8 containing oxide of silicon, with a content resulting very variable (from 1% to 75%), but none declared specifically if these components were CS. In fact for most of these compounds the information available from this system was insufficient for a correct identification of the product and of its use.

As shown on Table I, bulk sample analysis by XRD of the building materials showed the presence of quartz, ranging from 2.8% to 26.1%, only in 10 out of 42 products.

The MSDS of these 10 samples was examined for seeing if in their composition it was present the voice quartz and to verify the compliance with existing regulation. The results showed that the presence of quartz could only be inferred from the words “silica sand”, no sentences on potential risk associated with exposure to CS were reported in the safety sheets, and none of these materials resulted provisionally labeled.

The data on exposure levels are reported in Table II. Respirable dust concentrations resulted very variable, ranging from 0.01 to 8.97 mg/m^3, depending on the dust generated by the specific task. Hand held instruments, as expected, were less dusty than electric tools (drilling recesses and demolition with percussion). Smoothing was also associated with high level of respirable dust. In all cases, however, levels of CS resulted lower than TLV-TWA of 0.05 mg/m^3, because CS on filter was less than the limit of detection of the method (less than 10 μg). In that cases in which inhalable and respirable fraction have been collected simultaneously, the respirable fraction resulted only a small percentage of the inhalable, indicating that most of the dust produced was coarse. In only 2, out of 4 inhalable samples, CS was detected at concentration $\leq$ 0.003 mg/m^3. This low concentration of CS could only be interpreted as a residual presence of quartz in the coarsest fraction.

Even if the results of this study should be considered preliminary, they suggest the need to extend the characterization of the different materials used in this industrial compartment, including the compounds designed as dangerous, retrieved in the ISS database. Besides, awaiting the correct classification from the European Community, it would be desirable that the producers of materials containing CS include specific indications in the MSDS and appropriate label containing informations to the workers on the specific risks potentially associated to the use of such compounds. In the prosecution of the national program on CS in the construction compartment exposure levels to respirable end other fractions of crystalline silica for the workers involved in the various building activities will be systematically characterized, considering specifically the way to improve the performance of the sampling instruments, particularly in order to obtain significant increase in the collection of respirable dust. This task could be accomplished by the use the cyclone GK 2.69, operating at a flow-rate of 4,2 l/m, and recommended by the National Institute for Occupational Safety and Health in a recent review (21).

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TABLE I: SILICA IN 10 BULDING MATERIALS

BUILDING MATERIAL	% QUARTZ
Adhesive for tiles	13,4
Adhesive for tiles	16,2
Adhesive mortar for blocks of cement	3,5
Mortar	22,9
Mortar	26,1
Finishing plaster	2,8
finishing plaster	9,4
Sealants for tile	7,2
Cement waterproofer	8,1
Polymer waterproofing coating	14,1

TABLE II: EXPOSURE LEVEL TO DUST AND CS DURING VARIOUS TASKS.

Task performed	Task duration min.	Sample time min. (Range)	Sample volume litres (Range)	Inhal. Dust mg/m^3	Resp. dust mg/m^3 (Range)	Quartz mg/m^3
Milling recessess with handheld grinder	20	20	50 RD	-	8.97	ND
Milling recessess with chisel and hammer	50-420	50-420	125-1050 RD	-	0.14-1.99	ND
Applying floor rough to prepare flat floor	240	240	600 RD	-	0.38	ND
Mixing sand/cement and applying floor rough to prepare flat floor	480	480	960 ID	0.35		ND
			1200 RD		0.06	ND
Opening, mouving and mixing sand/cement sacks	40	40	100 RD	-	0.01	ND
Removing tiles and floor rough with percussion drill and mortar with pick	370	370	740 ID	4.97		ND
			925 RD		0.04	ND
Cutting tiles with handheld grinder and laying tiles	420-480	420-480	960 ID	4.01		0.003
			1050-1125 RD		0.08-0.31	ND
Laying tiles	390	390	975 RD	-	0.59	ND
Cutting and laying majolica bathroom	330	330	660 ID	2.83		0.0003
			825 RD		0.23	ND
Applying plaster	450	450	1125 RD	-	0.03-0.06	ND
Smoothing surface	480	198-362	277-507 RD	-	0,89-1,01	ND
Demolition with percussion drill	420	317-336	444-470 RD	-	1,85-3,40	ND
Applying plaster and smoothing surface	180	64-156	90-218 RD	-	0,03-5,90	ND

ID inhalable dust
RD respirable dust
ND not detected: corresponds to the presence of ≤10μg of Quartz on the filter.