



AIRBORNE DUST IN WORKING ENVIRONMENT AND HEALTH EFFECTS

Katarína LUKÁČOVÁ¹, Miroslav BADIDA¹, Miriama PIŇOSOVÁ¹

¹ Technical university in Košice, Faculty of Mechanical engineering, Department of environmental engineering / Park Komenského 5, 042 00 Košice, Slovakia

Abstract:

Airborne dusts are of particular concern because they are well known to be associated with classical widespread occupational lung diseases such as the pneumoconiosis. Solid aerosol with high percentage of finer particles and silica content posing serious health problems to the people exposed for longer duration.

This paper presents results which were obtained in the working environment with a high concentration of solid aerosols. There were realized personal samplings at four selected positions. Personal samplers were employed to quantify the total dust and respirable particulate fraction in the work environment, which was found significantly high, when compared to the occupational standards. The measurements show that in all cases were standards exceeded which proves necessity to periodic monitoring and adherence the measure.

Keywords:

solid aerosol, working environment, exposure.

INTRODUCTION

Dusts are solid particles ranging in size from below 1 μm up to around 100 μm , which may be or become airborne, depending on their origin, physical characteristics and ambient conditions.

Examples of hazardous dusts in the workplace include:

- mineral dusts from the extraction and processing of minerals (these often contain silica, which is particularly dangerous);
- metallic dusts, such as lead and cadmium and their compounds;
- other chemical dusts, such as bulk chemicals and pesticides;
- vegetable dusts, such as wood, flour, cotton and tea, and pollens;
- moulds and spores.

This article deals specifically with aerosols mineral dusts from the extraction and processing of minerals.

In the first instance, almost any type of aerosol may be viewed as a hazard. The associated risk to human health is realised only when interaction between the hazard and humans occurs such that there is exposure (Figure 1). [2]

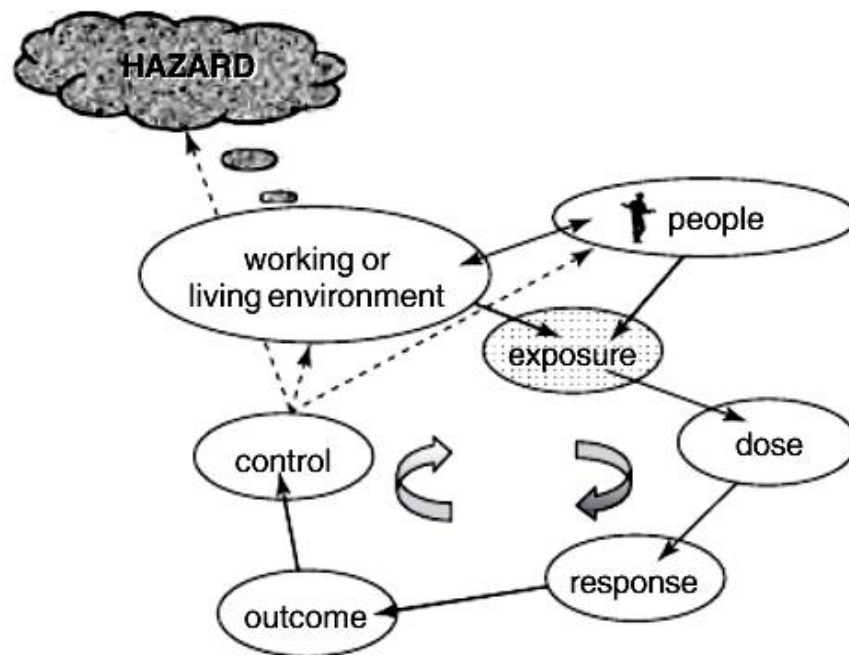


Figure 1: General overview to indicate the linkages between hazards in the environment, human exposure, dose, response, health outcome and control options

In general, exposure may be defined in the first instance as the instantaneous intensity of an agent that is relevant to a particular adverse health outcome at an appropriate interface between the environment and the exposed individual.

The health risk associated with a dusty job depends on the type of dust (physical, chemical and mineralogical characteristics), which will determine its toxicological properties, and hence the resulting health effect; and the exposure, which determines the dose. Exposure depends on the air (usually mass) concentration and particle aerodynamic diameter of the dust in question, and exposure time (duration). The dose actually received is further influenced by conditions that affect the uptake, for example, breathing rate and volume. [3]

METHOD OF MEASUREMENT

Measurement was realized in the stone-pit in eastern Slovakia. It provides basic material for road and building construction. The various unit operations involved in stone crushing, size reduction, size classification and transfer operations have the potential to emit process and fugitive dust. There is 43 employees and we chosen 4 of them for personal samplings.

During sampling were used four personal measurements. Personal samples were collected in the workers' breathing zone using IOM sampling heads with glass fiber depth filters (GF/A, liquid nominal pore size of 1.0 μm). The flow rate was calibrated to 2 l.min⁻¹. There were used also cyclone with the same type of filter (GF/A). [1]



Figure 2: Sampling heads used during sampling

Assessment of the measurement was realized using gravimetric analysis. For most practical purposes, the aerosol collected at a filter or a substrate in a sampling instrument must be converted into an aerosol concentration. Usually this is expressed in terms of particulate mass per unit volume of air sampled, in which case the mass concentration is given by:

$$c = \frac{M}{Q \cdot t} \quad (1)$$

where M is the mass of particulate matter collected, Q is the sampling flow rate and t the sampling time. In this expression, Q and t are known from the sampling conditions, and M is the subject of interest for analysis. It is here where analytical methods are needed. In many practical situations, M is measured in terms of the overall mass that has been collected, including all species of particulate material. In that case, it may be obtained gravimetrically by using an appropriate analytical balance, where it is usual to weigh the filter or substrate before and after sampling, with the difference providing M and in turn c from Equation (1).

Measurement of exposure intensity strictly according to the definition might be achieved by assessing the instantaneous aerosol concentration in real-time using an appropriate direct-reading sampling instrument. However, in practice it is usually more appropriate to measure it in terms of a value that is averaged over an appropriate time interval. This might range from a few minutes to as much as many hours. In occupational aerosol exposures, for example, time-averaging typically takes place over a working shift of up to 8 h. [2, 3]

RESULTS

In the next table there are presented the results of personal samplings which were realized in working environment. Each employee had two types of sampling head – for inhalable and respirable fraction.

Table 1: Results of personal samplings

P	Profession / position	Fraction	Measured value [mg.m ⁻³]	Assessed value [mg.m ⁻³]
1	Primary operator	inhal.	63,1	55,2
		respir.	1,7	1,5

P	Profession / position	Fraction	Measured value [mg.m ⁻³]	Assessed value [mg.m ⁻³]
2	<i>Tertiary operator</i>	inhal.	311,94	272,9
		respir.	2,5	2,2
3	<i>Mechanist</i>	inhal.	5,0	4,4
		respir.	12,2	10,7
4	<i>Maintainer</i>	inhal.	54,7	47,9
		respir.	14,4	12,3

The limit value for this kind of solid aerosol – other silicates (asbestos-free) – for respirable fraction is 2 mg.m⁻³ and for inhalable is 10 mg.m⁻³.

Personal samplers were employed to quantify the total dust and respirable particulate fraction in the work environment, which was found significantly high, when compared to the occupational safety and health standards. [1]

CONCLUSIONS

Dust exposures during hard rock mining (e.g. metal ores) have long been of concern due to the potential for workers' exposures to crystalline silica – or quartz – leading to the very serious lung disease of silicosis.

Most of the people working in this field of industry are having respiratory problems. The measurements show that good housekeeping practice is essential for effective control of dust.

ACKNOWLEDGEMENTS

The author would like to thank to ministry of education of Slovak Republic for their financial contribution on the grant project VEGA 1/1216/12 a ESF-ITMS 26220120060.

References

- [1] Lukáčová, K.: *NÁVRH A OVERENIE METODÍK KVANTITATÍVNEHO A KVALITATÍVNEHO HODNOTENIA PEVNÝCH AEROSOLOV V PRACOVNOM PROSTREDÍ*. Košice, 2011. 139 s.
- [2] Vincent, J. H.: *AEROSOL SAMPLING*. USA, John Wiley and Sons, 2007. 616 s. ISBN 978-0-470-02725-7 (HB).
- [3] World Health Organization: *HAZARD PREVENTION AND CONTROL IN THE WORK ENVIRONMENT: AIRBORNE DUST*. 1999.

Corresponding author:

Dipl. Ing. Katarína LUKÁČOVÁ, Ph.D.

Faculty of mechanical engineering, Departement of environmental engineering

Technical university in Košice

Park Komenského 5

042 00, Košice

Slovakia

Phone: +421 55 602 2643

e-mail: katarina.lukacova@tuke.sk