PROCEDURE FOR USING RESPIRATORY PROTECTIVE EQUIPMENT

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Abstract. *The article deals with the problems that arise when determining the effectiveness of respirators in production and laboratory conditions. Since the current level of science does not allow to accurately determine the concentration of harmful substances in the inhaled air, an accurate assessment of effectiveness in a particular situation is impossible.*

Keywords: *personal protective equipment, respirator, protection factor, occupational diseases, biomonitoring.*

INTRODUCTION

The imperfection of technological processes and equipment, their wear and tear lead to air pollution of the working area with harmful substances. To protect against them, personal respiratory protective equipment (PRPE) - respirators are widely used. To ensure PRPE workers, “Model norms for the free issue of special clothing, special footwear and other personal protective equipment to workers ...” have been developed.

MATERIALS AND METHODS

To determine the effectiveness of respirators in real production conditions, more than 70 special studies in production conditions have been conducted since 1972 [3]. As an indicator of effectiveness, in most cases, such a value as the short circuit protection factor (the ratio of the average measured concentration of harmful substances outside the mask to the average measured concentration under the mask with simultaneous air sampling) was used. The measurement results showed that:

• with the right choice of filter, the overall effectiveness of PRPE is determined by the leakage of unfiltered air through the gaps between the face of the mask (respirator) and the face, which was the main route of contamination of the inhaled air;

• formation of gaps depends on many factors; the gaps are not constant and can be of different shapes and sizes, as a result, the short circuit can change dozens of times in a matter of minutes - this is a non-constant, random and unpredictable value;

• Under production conditions, leakage can be much greater than under laboratory conditions (for example, during certification), there is no direct relationship between them. Therefore, the direct use of laboratory results to evaluate the effectiveness of a respirator in real use is unacceptable.

RESULTS AND DISCUSSION

On fig. Figure 1 shows a photograph of unfiltered air leaking under a mask in a laboratory [4]. A trickle of polluted air (light in color) moves towards the suction port of the dummy. It can be seen that it does not mix with the filtered air, and the measurement of the average submask concentration during inspiration is, in essence, an attempt to determine the value of a quantity that does not physically exist. If the sampling probe enters a prickle of unfiltered air, the measured concentration will be too high (position 2) and the short circuit will be too low. If it doesn't hit (this happens much more often), then vice versa (position 1).

During inhalation, part of the gas/aerosol is absorbed in the respiratory organs, their concentration during exhalation is lower than during inhalation. Therefore, at first, when testing, they tried to take air samples only during inhalation. The revealed lack of mixing forced measurements to be taken continuously, since the exhaled air is mixed, and the absorption of gas/aerosol during inspiration is incomplete.

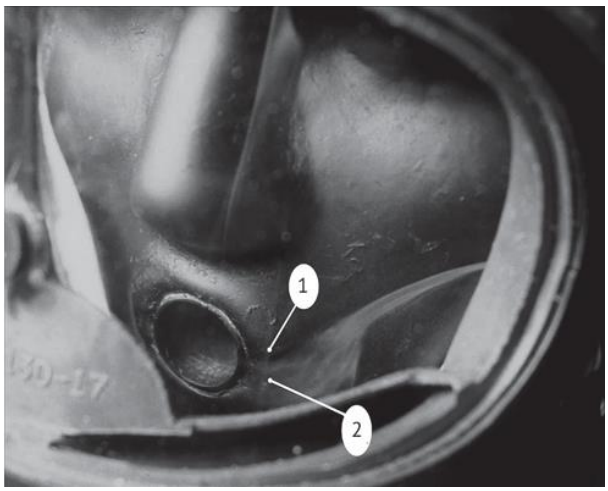

Fig 1. Leakage of a trickle of unfiltered air under a full-face mask

Putting on and wearing a mask by people introduces additional variability in the effectiveness of PRPE, since the mask can be put on inaccurately, can slip during movement, which affects the formation and change of gaps. The additional inconsistency makes the percolation itself a random variable. Statistical methods are widely used to work with random variables.

According to the head of the PRPE certification department ([1] pp. 25–26), in order to accurately determine the average protection factor for a particular person in laboratory conditions, about 18–25 repeated measurements are required in order to reduce the random error sufficiently due to the statistical static processing. But this referred to the case of performing the same movements (during certification). In practice, the movements can be different, and this affects the formation and size of the gaps.

With stable infiltration of unfiltered air (solid line), the measured under mask aerosol concentrations are unstable and often significantly underestimated (dotted line).

Statistical processing of a large number of measurements was used in the development of restrictions (mandatory for the employer) on the scope of acceptable use of PRPE of all structures in the UK and the USA. In [3], the limitations for all types of PRPE were established based on the processing of 1863 measurements (when 31 studies were carried out under production rather than laboratory conditions), and in [4], on the basis of more than 926 short circuit measurements [5].

The results of a comparative analysis of the methodology for reducing the classes of working conditions

1. Comparison of the methodology for reducing hazard classes and foreign publications in this area shows that it does not correspond to the modern level of science and technology.

2. The developed methodology does not prevent the selection and use of potentially insufficiently effective PRPEs, as well as the selection of respirator masks that do not match the faces of specific workers.

CONCLUSION

The analysis of the known methods for evaluating the effectiveness of PRPE showed the presence of significant shortcomings in the methodology for reducing the classes of working conditions, which creates a potential danger of excessive exposure to air pollution for workers using respirators, and, accordingly, acute poisoning and occupational diseases. For reliable prevention of the development of occupational diseases, it is necessary, first of all, to economically and politically stimulate the employer to improve working conditions, as well as to develop requirements for biomonitoring and the choice of PRPE based on the current level of science.

Reduction of hazard classes due to the issuance of personal respiratory protection equipment is not scientifically substantiated and unacceptable.

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