BASIC CONCEPTS FOR MAXIMUM ALLOWABLE CONCENTRATIONS OF TOXIC SUBSTANCES

A. A. LETAVET

Institute Gigieny Truda i Profzabolevanii, Moskva, S.S.S.R.

Exact definition of basic concepts and terms is of paramount importance to the question of maximal allowable concentrations of toxic substances in industrial atmospheres. The differences existing in various countries are often due to differences in the interpretation of basic concepts. Mutual agreement on the question of basic concepts will facilitate a *rapprochement* of points of view, and, perhaps, even an agreement on specific problems and individual standards.

The term maximal allowable concentration, (M.A.C.), should be used to denote such concentrations of various harmful chemical substances in the form of gases, vapours and dusts in industrial atmospheres, which, by their constant effect on workers during normal daily work over an indefinite period of time, can produce no pathological change or disease detectable by current methods of examination. M.A.C.'s, therefore, can produce neither acute, nor chronic occupational poisoning.

The establishment of M.A.C.'s of toxic substances and the design of preventive measures against occupational poisoning under actual conditions must have regard to the possibility of penetration of toxic substances not only through the respiratory tract, but also through the skin and through the digestive organs. However, the respiratory tract is most important. Therefore the main preventive measure against occupational disease will be the avoidance of contamination of atmospheres with toxic substances, and the effort to preserve the highest possible cleanness of air in industrial plants is fully justified.

The establishment of M.A.C.'s as a fundamental element in legal provisions concerning occupational hygiene (which provisions are obligatory for all industrial institutions) pursues the humane aim of complete protection of the health of labourers working for many years in industrial plants.

The establishment of M.A.C.'s is intended for:

(a) organizations and persons designing technological processes and production facilities, in order that these facilities may secure minimal escape of toxic substances into factory atmospheres;

(b) calculating air exchange when designing ventilating systems for plants where toxic gases and vapours arise;

(c) the medical inspection of the condition of the atmosphere in workrooms.

In our opinion, the M.A.C.'s of toxic substances should not serve only for the narrow purpose of medical inspection of factory atmospheres, but should also become a primary governing factor in the design of technological

processes and factory equipment. As regards highly toxic substances with low M.A.C. values, it is necessary to choose continuous mechanized processes with air-tight equipment. In the case of manual work with large exposed surfaces of toxic substances, no ventilating devices can secure a clean atmosphere within the limits of maximal allowable concentrations.

Tables listing M.A.C.'s cannot always be used for exact technical calculations on production equipment and ventilating facilities, for the design of new kinds of production, or for the reconstruction of the existing equipment. However, the knowledge of even the kind of danger existing may be of considerable help.

Naturally, air in which toxic substances are controlled at the level of M.A.C.'s cannot be regarded as an " optimal " atmosphere; all modern technical facilities which are available should be utilized to achieve lower concentrations than those allowed, and zero values where possible.

The establishment of M.A.C.'s applies to all places of work where workers are constantly or periodically present to control or carry out production processes. When production operations are carried out at various places of a workroom, then the whole workroom must be considered to be the working place.

The question of the time factor in the M.A.C. field is a particularly difficult problem. Unfortunately, the maximum allowable " dose " of toxic substances, in the sense in which " dose " is understood in connection, for example, with ionizing radiations, cannot be determined in practice because of the complexity of the metabolic processes undergone by the toxic substances in the body, their deposition and excretion, especially in the case of organic compounds.

Special, much higher, values of concentrations may be established for various types of work which involve exposure to toxic gases for short periods only (for instance, work in the presence of exhaust gases in a garage). These values are only acceptable when the rest of the work during the day is not done in the presence of toxic substances.

M.A.C.'s for those types of work which are done under changing conditions of time and space (and this is the case for most types of work) should be related to the highest values found in the atmosphere of the place of work. Such an arrangement secures the highest margin of safety for the workers.

Because of the existence of gas diffusion, convection currents and motion of air due to artificial ventilation, transient local increases in the concentration of toxic substances (" peaks ") to values much higher than those in the surrounding atmosphere cannot be taken into account, and the concentrations of toxic substances determined with the present methods of air sampling are always to a certain extent average concentrations.

To base a maximum allowable concentration on " hypothetical " average concentrations at different places in a working area at various periods of an eight-hour workday corresponding to various phases of the production process would be very indefinite and hardly practicable at all. Such an " average concentration " would be dependent on the place where it was determined. If workers had to be at various places in working area, it would be necessary to calculate a weighted mean based on the time spent by

a worker at each place. This would involve the introduction of exact time-keeping.

The problem of combined action of various toxic substances is a very complex one and difficult to solve. In this field we still do not have enough data. Therefore it is difficult to evaluate atmospheres containing various vapours and gases. In practice it is best to use the sum of the concentrations of the individual substances. There are insufficient data to prove a synergistic action of the substances at the given concentrations, and still less an antagonistic action.

The question of a combined action of various toxic substances is being extensively studied and further investigations are required; the same applies to the question of maximum allowable concentrations of several toxic substances existing simultaneously in the atmosphere.

It is beyond all doubt that the state of intense fatigue considerably increases sensitiveness towards toxic substances. Increased temperature of the environment and physical strain, which intensifies respiratory exchange, are also important. But no sort of coefficients to the values of M.A.C.'s can be determined for these factors.

Neither can the increased sensitiveness to various substances, found occasionally with some persons, be taken into account. When such persons are found upon periodic medical examinations, they should be withdrawn from the work in question.

Tables listing the M.A.C.'s of toxic substances should be regularly checked on the basis of newly obtained experimental and clinical information. This applies especially to those substances which have been brought into production only recently, and have not been subject to long study.

Data obtained from regular examinations of workers handling toxic substances are of great importance for the further improvement of the values of M.A.C.'s established experimentally. The data from these examinations, gathered over a number of years, may serve as material for a substantial modification of the concentrations which had originally been established from experiments on animals.

In addition, a comparison of the established M.A.C.'s with the concentrations determined in the atmosphere of a given plant can help the public health service considerably in solving the question of the occupationa etiology of a given illness.

Sufficiently sensitive and precise analytical chemical and physicochemical methods for determining toxic substances must be developed for the check of M.A.C.'s in air. Without such methods, the establishment of M.A.C.'s loses its practical value. Recording instruments are of particular importance for controlling M.A.C.'s. Standardization of the methods of research is very important for obtaining results from the inspection of atmospheres which are sufficiently comparable.

International co-operation, based on the widest mutual exchange of scientific information, is of great significance for the further successful development of the scientific investigation of the problem of the maximum allowable concentrations of toxic substances.