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American Standard

[redacted] Acceptable Concentration of Benzene

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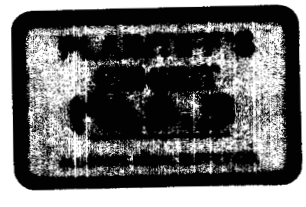

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Foreword

(This Foreword is not a part of American Standard Maximal Acceptable Concentration of Benzene, Z37.4-1960.)

American Standard Maximal Acceptable Concentration of Benzene, Z37.4-1960, has been developed by a committee, national in scope, functioning under the procedure of the American Standards Association.

This committee was organized to co-ordinate all available information on the various air contaminants and to establish acceptable concentrations which could be used in the development of means for controlling such contamination. This standard on the acceptable concentration of benzene is one of a series of standards which have been prepared by the committee and approved by the American Standards Association.

The initial draft of this standard was prepared co-operatively with the United States Public Health Service. The first standard on this subject was approved January 15, 1941. The subcommittee which developed the present revision of this standard was under the chairmanship of Hervey B. Elkins.

For many years the need for standard acceptable concentrations of toxic dusts, gases, mists, vapors, and fumes in the air of work places has been recognized. A great deal of information on such concentrations has been published, but it frequently differs, due largely to the varying conditions under which observations and tests were made.

While research on the toxic effects of many dusts, fumes, mists, vapors, and gases is continuing in industry, governmental institutions, universities, and elsewhere, the concentration set forth in this standard reflects information obtained from all authoritative published data and the experience of the members of the committee.

The ASA Sectional Committee on Acceptable Concentration of Toxic Dusts and Gases, Z37, which developed this standard, had the following personnel at the time of approval:

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Contents

Tlic Meaning of Maximal Acceptable Concentration

It is generally recognized that there arc levels of concentration of atmospheric contaminants to which a person may Le exposed without known ill effects or discomfort. Since it is not practical to maintain completely uncontaminated air in most industrial situations, it is necessary to establish maximal acceptable concentrations of atmospheric contaminants encountered in industrial operations. These concentrations in themselves do not represent a scale of relative toxicity; they represent the concentrations of contaminants below which ill effects are unlikely to be experienced by any but hypersusceptible individuals.

These concentrations are usually based upon data obtained by one or more of the following procedures:

(1) Laboratory tests on animals

(2) Laboratory tests using human subjects

(3) Environmental and medical investigations in plants

A common feature of these procedures is that the experimental exposure shall correspond to the normal work pattern. This should bc taken into consitlcrotion also in the application of maximal acceptable concentration values.

Three criteria have governed the establishment of these conccntrntions:

(1) Organic or other tissue changes

(2) Functional reactions that hnvc no discernible untoward effects on health but cause impairmcnts, such as in-co-ordinations and incrcoscd proneness to accidents

(3) Discomfort or adverse sensory effects

In those cases in which the concentrations have been cstnblishcd on the bneis of organic changes, it is logical to assume that repeated exposure to concentrations significantly in cxccss of tlic acceptable concentration probably would produce injury. When the level has been established on the basis of a functional change or discomfort, it is logical to assume that cxposure to concentrations not greatly cxcccding the acceptable concentration would not produce materially injurious effects. Hence it is important to understand the criteria upon which any such maximal acceptable concentration has been established.

Though tlic purpose of tlic acceptable concentration is to minimize health hazards, its immediate use is for guidance in establishing cnginccring procedures to prevent objectionable concentrations of toxic or noxious materials from being prcscnt in the air of work places. Comparison of tlic results of air analyses with maximal acceptable concentrations indicate acceptable conditions or otherwise tlic need, extent, and urgency of control measures. Sampling and analysis should be performed by competent personnel using an acceptable method that will provide a reliable measure of actual exposure.

Air analyses in conjunction with acceptable concentrations of such atmospheric contaminants as arc encountered in industrial operations serve as a measure of exposure, but riot as a means of diagnosis of occupational disease. Diagnoses should bc based on a consitlcrntion of all factors, including results from clinical and physical csnminntion, as well as from air analyses, from means of assessing amounts of materials in the body, and a knowledge of toxicological effects of the materials under consideration.

In the application of tlic standards, it should be kept in mind that:

(1) Tlic acccptablc concentrations scrvc as standards for good industrial hygiene practice.

(2) They serve as engineering guides. Design and operation should aim at maintaining all concentrations below the acceptable masimum.

(3) Tlicy should bc applied and interpreted by competent individuals with a full understanding of tlic basis and limitations of the information from which the standard has been devclopcd.

(4) It is-advised that these standards are considcrcd to bc guides toward good industrial hygiene and are not intended as legal rcquircmcnts.

(5) The levels are applicable only for cxposure to a single substance. In the case of cxposure to mixtures, the effect may bc increased or decreased, and controls should be based on the specific situation.

American Standard

Maximal Acceptable Concentration of Benzene

1. Scope and Purpose

1.1 The maximal acceptable concentration of benzene applies to all places of employment.

1.2 The purpose of this standard is to prescribe the maximal acceptable concentration of benzene in the atmosphere of work places for guidance in design and operation, so as to protect the health of the workers.

2. Properties of Benzene [1] *

2.1 General Properties. Benzene (benzol) is the lowest homologue of the aromatic hydrocarbons. It should not be confused with benzine (benzin), a mixture mainly of aliphatic hydrocarbons. Benzene is a colorless liquid. Commercial benzene is seldom pure and may be contaminated with xylene, toluene, phenol, thiophene, carbon disulfide, acetonitrile, and also by pyridine and other substances.

2.2 Physical-Chemical Properties

Chemical formula:	C_6H_6	
Molecular weight:	78.11	[2]
Specific gravity:	0.879 at $\frac{20}{4}$ C	
Vapor density (air = 1.00):	2.7	
Boiling point:	80.1 C	
Melting point:	5.5 C	
Vapor pressure at 26.1 C:	100 mm Hg (millimeters of mercury)	
Flash point (closed cup):	—11 C (12 F)	
Explosive limits (percent by volume in air):	1.4-7.1	[3]
Autoignition temperature:	562 C (1044 F)	

2.3 Toxic Properties. Benzene absorption occurs mainly through inhalation of the vapor. Upon acute exposure, benzene acts predominantly as a narcotic, causing depression of the central nervous system.

With chronic exposure, benzene may cause bone-marrow damage, resulting in a change in the circulating white blood cells, platelets, and red blood cells. Individual susceptibility varies greatly.

Absorbed benzene is excreted partly as phenol conjugated with sulfate in the urine. Determination of the ratio of inorganic to total sulfates in the urine is a useful method of estimating benzene exposure [4].

Medical control procedures should emphasize periodic blood examinations.

3. Maximal Acceptable Concentration

3.1 The maximal acceptable concentration of benzene (benzol) shall be 25 parts per 1,000,000 parts of air by volume, corresponding to 0.08 mg (milligram) per liter at 25 C and 760 mm pressure, for exposures not exceeding a total of 8 hours per day, with the understanding that variations in concentration should fluctuate below this level.

3.2 The maximal acceptable concentration of benzene is based on field studies in plants where benzene poisoning has occurred. Serious cases of benzene poisoning have been reported where concentrations averaged 150 ppm (parts per million) [5], 105 ppm [6], 100 ppm (3 cases) [7], and 60 ppm [8]. Blood changes were found in workers exposed to average concentrations of 100 ppm and 90 ppm [9], 80 ppm [5], 105 ppm [6], and 60 ppm [8].

The concentration of 25 ppm is intended to provide the average individual with a considerable margin of safety against serious benzene poisoning. A medical control program is recommended whenever workers are exposed to concentrations of benzene vapor approaching the maximal acceptable concentration.

4. Sampling Procedure and Analytical Methods

4.1 Sampling Procedure

4.1.1 The sampling procedure shall be in accordance with what experience shows is necessary to secure a sample which is *truly representative of the actual working conditions at the location tested and for the period of the employees' daily exposure.* This implies that the volume of the sample and the rate at which it is drawn into the sampling apparatus shall

* Numbers in brackets throughout the text refer to corresponding numbers in References on page 9.

be such that the taking of the sample does not itself change appreciably the atmospheric conditions at the location tested. The volume of the sample shall be consistent with the sensitivity of the analytical method employed.

4.1.2 Samples of air should be taken wherever exposure to benzene in the atmosphere is known or suspected to be of hygienic significance.

4.1.3 Samples should be taken at the breathing level, close to the mouth or nose of the worker, with special attention to the locations near the source of the benzene and in the path of air currents carrying it towards the worker, if such condition exists.

4.1.4 Samples should be taken in sufficient numbers to indicate whatever differences in concentration of benzene exist during the working period.

4.2 Analytical Methods. The analytical methods recommended for use are based on the formation of dinitrobenzene by the action of fuming nitric acid and concentrated sulfuric acid. The sample may be taken originally by passing the air through such a nitrating niixturc, in a suitable bubbler, at a rate of 0.02 to 0.25 liters per minute [10]; or grab samples may be taken in suitable receptacles and then shaken with nitrating acid [11]; or tlic air may he passed over silica gel, and the latter heated in tlic laboratory to drive o.f the benzene, which is passed through nitrating acid.

The dinitrobenzene may he determined by the color produced by methyl ethyl ketone and alkali.

Any other analytical method may be used, provided it is equivalent in applicability and reliability to those cited.

NOTE: It is understood that the sampling and analysis of contaminated air as specified above, and the interpretation of the data in relation to the stated permissible concentration shall be done only by technically qualified and competent persons.

References to the Text

[1] Physical constants, unless otherwise referenced, are taken from or calculated from *International Critical Tables of Numerical Data, Physics, Chemistry, and Technology*. Published under the direction of National Research Council—National Academy of Sciences. New York: McGraw-Hill Book Company, Inc. 1926-1929.

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