

average eye is around 50 microns all air floated material of this kind is too small to identify without the aid of the microscope.

Mineral particles, such as grains of sand, bits of rock, volcanic ash, or fly-ash, can be transported long distances under unusual circumstances. Thus, the dust storms of 1935 in the Kansas district resulted in vast amounts of fine top soil being thrown high into the air. Solar illumination as far east as Boston was affected noticeably and particles as large as 40 to 50 microns were actually carried half way across the continent before they settled out. In similar manner volcanic ash has been carried even further. It is not surprising, therefore, that fly-ash from furnace gases, cement dust and the like, can be carried for considerable distances and occasionally the engineer is confronted with the problem of removing such material before the air in question is suitable for use in building ventilation.

The physical properties of the particulate impurities of air are summarized conveniently in the chart of Fig. 1.

In the case of gases the physical property which is probably of most importance is inflammability. The best data available at present on this subject are given in Table 1.

Dust Concentrations

It is customary to report dust concentrations as grains per 1000 cu ft or milligrams per cubic meter. Gas concentrations are commonly recorded as milligrams per cubic meter or as parts per million or as per cent by volume. Typical ranges in dust concentrations as now found in practical applications are given in Table 2.

TABLE 2. DUST CONCENTRATION RANGES IN PRACTICAL APPLICATIONS^a

APPLICATION	GRAINS PER 1000 CU FT	MGS PER CU M
Rural and suburban districts.....	0.2 to 0.4	0.4 to 0.8
Metropolitan districts.....	0.4 to 0.8	0.9 to 1.8
Industrial districts.....	0.8 to 1.5	1.8 to 3.5
Dusty factories or mines.....	4.0 to 80.0	10 to 200
Explosive concentrations (as of flour or soft coal).....	4000 to 8000	10,000 to 20,000

^a 1 grain per 1000 cu ft = 2.3 mgs per cubic meter; 1 oz per cubic foot = 1 gram per liter.

The engineer frequently desires information regarding the effects of various concentrations of gases or dusts upon man, as the success of a particular installation may depend upon the maintenance of air which is adequately clean. At the present time there are a number of organizations working on this problem all of them publishing literature of various kinds.¹ References to books covering the hygienic significance, determination and control of dust are listed at the end of this chapter.

¹National Institute for Health, U. S. Public Health Service; Division of Labor Standards, U. S. Department of Labor; University of Toronto Medical School, Canada; Saranac Laboratories, Saranac Lake, N. Y.; Air Hygiene Foundation, Inc., Pittsburgh, Pa.; Harvard School of Public Health, Boston, Mass.; Haskell Laboratory, Wilmington, Del.; and the Departments of Health and of Labor in the United States and in various provinces of Canada.

AIR POLLUTION AND HEALTH

The prevention of various diseases which result from exposure to atmospheric impurities is an engineering problem. It is important for the engineer to insure, by proper ventilation, suitable environments for working or for general living. If the equipment used is to be successful, it must operate automatically as in the modern air-conditioned theatre or railroad train.

In Table 3 are given data on permissible concentrations of various substances, gases and dusts, which occur in industry. The prudent

TABLE 3. TOXICITY OF GASES AND FUMES IN PARTS PER 10,000 PARTS OF AIR^a

VAPOR OR GAS	RAPIDLY FATAL	MAXIMUM CONCENTRATION FOR FROM ¼ TO 1 HOUR	MAXIMUM CONCENTRATION FOR 1 HOUR	MAXIMUM ALLOWABLE FOR PROLONGED EXPOSURE
Carbon monoxide.....	40	15-20	10	1
Carbon dioxide.....	800-1000	-----	-----	-----
Hydrocyanic acid.....	30	1½	½	⅓
Ammonia.....	50-100	25	3	1
Hydrochloric acid gas.....	10-20	½	-----	⅓
Chlorine.....	10	½	-----	⅓
Hydrofluoric acid gas.....	2	⅓	-----	⅓
Sulphur dioxide.....	4-5	½-1	-----	⅓
Hydrogen sulphide.....	10-30	5-7	2-3	1
Carbon bisulphide.....	-----	11	5	½
Phosphene.....	20	4-6	1-2	-----
Arsine.....	2½	½	½	-----
Phosgene.....	Over ¼	¼	-----	⅓
Nitrous fumes.....	2½-7½	1-1½	-----	⅓
Benzene.....	190	-----	31-47	1½-3
Toluene and xylene.....	190	-----	31-47	-----
Aniline.....	-----	-----	1-1½	⅓
Nitrobenzene.....	-----	-----	⅓	⅓
Carbon tetrachloride.....	480	240	40	1
Chloroform.....	250	140	50	2
Tetrachlorethane.....	73	-----	-----	⅓
Trichlorethylene.....	370	-----	-----	-----
Methyl chloride.....	1500-3000	200-400	70	5-10
Methyl bromide.....	200-400	20-40	10	2
Lead dust.....	-----	-----	-----	0.15 mg/cu m
Quartz dust.....	-----	-----	-----	1 mg/cu m

^aAdapted from Y. Henderson and H. Haggard. (See *Noxious Gases, 1927*, and *Lessons Learned from Industrial Gases and Fumes, Institute of Chemistry of Great Britain and Ireland, London, 1930.*)

engineer will design equipment using these bench marks as the upper limits of pollution. In general it is good practice to avoid recirculation of air which contains originally toxic substances. Obviously there may be exceptions to this rule, but it is one which is generally being followed in current practice.

Bronchitis is the chief condition associated with exposure to thick dust, and follows upon inhalation of practically any kind of insoluble and non-colloidal dust. Atmospheric dust in itself cannot be blamed for causing tuberculosis, but it may aggravate the disease once it has started.²

²Physiological Response of the Peritoneal Tissue to Dusts Introduced as Foreign Bodies, by Miller and Sayers (*U. S. Public Health Reports*, 49:80, 1934).