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Dust control

Commonwealth of Pennsylvania
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DUST CONTROL

DOCUMENTS SECTION

FOREWORD

This short pamphlet on dust is designed primarily as a brief outline of the problems encountered in industry and some of the methods used in solving these problems. For the administrator or engineer, it will help him understand the problems and purposes of dust control. It is not intended as a text on the subject however, and if problems in dust control are encountered aid from the staff of the Pennsylvania Department of Health is available. Write to:

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF HEALTH
DIVISION OF INDUSTRIAL HYGIENE
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DUST CONTROL

INTRODUCTION

Dust is a very important regulating factor in the maintenance and preservation of life on earth. Without its presence as a nucleus upon which filtering moisture condenses, the burning rays of the sun would soon reduce our most densely covered vegetation areas to deserts. It is the dust of plants or pollens which perpetuates the species, and aesthetically, it is the complex mixture of dusts in the atmosphere which produces the brilliant colors of a sunrise or a sunset.

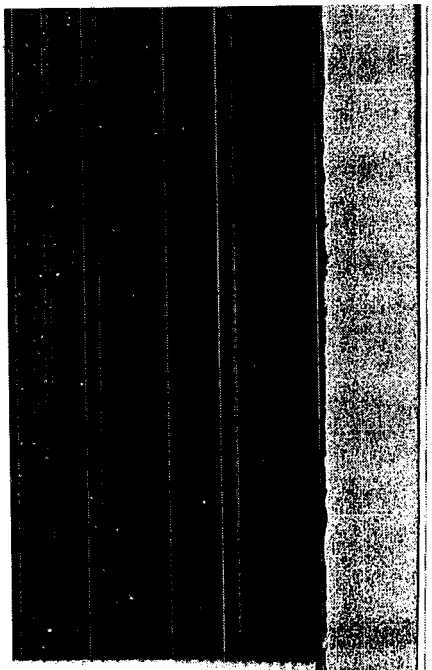
On the other hand, there is a saturation point for everything, and excessive quantities of dust can produce reactions in man from the mildest form of discomfort to the most severe form of disability.

The ENGINEERING Aspects of Dust Control

HAZARDS OF DUST

There are several factors which influence the hazardous effect of dusts. These include the composition of the dust, the particle size, the concentration, the length of exposure, and the susceptibility of the individual to a particular dust. If the dust is soluble in body fluids, the result of exposure is an absorptive which may or may not give rise systemic poisoning. If the dust is relatively non-soluble, the reaction may be either inert or fibrogenic.

Retention of a given particle in the lung is a function of the particle size. Recent studies of this characteristic have indicated that the lung does not receive all particles equally. Large particles are removed in the nasal passages and cannot enter the alveoli, the smallest recesses of the lung where gaseous exchange takes place. Smaller particles, on the other hand, are capable of entering the alveoli, but,



because of their small size, are not able to remain there and are forced out with exhalation. Particles of hygenic significance are therefore well defined, and research indicates the retention size to be within the range of slightly less than one to approximately five microns. Mathematically, retention increases sharply as the particle size approaches one micron and decreases gradually as the particle size exceeds one micron to a diameter of approximately five microns.

An exception to the particle size is that of asbestos, since particles as large as 180 microns are of physiological import, probably the result of mechanical irritation of pulmonary tissue rather than a physio-chemical reaction.

The concentration of the dust in air is another factor, and it may be coupled with the length of exposure. Interpretation of a dust stress upon exposed individuals follows the general rule of effect equals concentration times exposure length. It therefore follows that a condition may arise from a short exposure time if the concentration of material is very great, or conversely, the condition may arise from several years of exposure to smaller quantities of dust. The individual is quite often the limiting factor, however, because it has long been recognized that certain persons exhibit symptoms of exposure even after brief contact with a given substance, and these individual inadequacies should be thoroughly investigated prior to exposure.

AIR SAMPLING

In order to evaluate an employee's exposure to dust, air samples must be collected for subsequent analysis. These samples may be collected by several methods among which are impingement, electrostatic precipitation, thermal precipitation, or filtration.

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through a narrow orifice toward a collecting plate. As the air velocity increases through the orifice, the particles gather momentum which forces them to continue in a straight path toward the collecting plate. Upon reaching the plate, the air is capable of changing its direction because of its fluidity, but the particles, with their greater kinetic energy, resist the change of direction and are deposited on the plate. The efficiency of collection may be increased by coating the plate or by submerging the orifice and collecting plate under a suitable liquid.

Electrostatic precipitation consists of an ionizing field of a high electrical potential. As dust-laden air is drawn through this field, the particles are ionized and are deposited on a plate. This method is of value when chemical methods or weight determinations are to be made on the dust, but is of questionable value for subsequent microscopic evaluation.

Thermal precipitation is similar to that of electrostatic, but the principle is somewhat different. It was observed that if a hot wire were placed in a dusty atmosphere, the area directly surrounding the wire would become dust free. This principle was incorporated into an apparatus which consists of a hot wire and glass plates. As dusty air is drawn through the apparatus, the dust particles are repelled by the hot wire and are deposited on cool plates, placed near the wire. This method is advantageous for analysis, because it deposits the particles in the same condition as they existed in the air without further shearing during deposition.

Filtration consists of passing dust-laden air through a membrane capable of filtering the very small particles. Recently a membrane has been developed which is soluble in in several organic solvents, so that the dust may be collected on the filter and determined directly, or may be counted by standard methods after the filter has been dissolved.

DUST ANALYSIS

Analysis of the dust depends upon the composition of the dust. In the case of soluble dusts, the analysis depends on a straight weight basis, or the dust may be dissolved in a suitable solvent and analysed by chemical or electronic methods. When the dust is regarded as non-soluble anatomically, it is generally microscopically analyzed.

The present standard microscopic method for dust counting is by a lightfield method. For liquid collected samples, the solution is diluted to any convenient volume; one cubic centimeter of the solution is placed in a counting cell of one millimeter depth; and the number of particles, visible in an eyepiece grid by passing a light through the microscope, are counted. The grid must be calibrated, and by mathematical computation, the number of dust particles present per cubic foot of air is determined. In the case of filtration methods, the membrane is placed on a standard microscope slide and is counted using the calibrated disk under oil immersion, and the amount of dust present is determined.

Particle size determinations are made by means of a calibrated eye-piece micrometer in conjunction with a microscope, and the diameters are recorded in groupings of any suitable dimension. In general, it is well to use high objective magnification, so that the size may be measured more accurately.

MAXIMUM ALLOWABLE CONCENTRATION

As was cited above, the physiological response is the determining criteria as to whether a dust is harmful or not. In order to determine levels of toxicity, the American Conference of Governmental Industrial Hygienists established a list containing maximum allowable concentrations. This

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threshold level may be defined as the maximum average atmospheric concentration of a contaminant to which workers may be exposed for an eight-hour work day without impairment to health. These values are obtained from epidemiological studies in plant atmospheres and their effect on persons exposed, from experimental studies of laboratory animals, or from a combination of the two. The values are reviewed annually and are altered as additional data becomes available. A list of some of these maximum allowable concentrations can be found on page 8.

CONTROL MEASURES

Control of dust exposure includes industrial hygiene engineering principles and good housekeeping. Basically, a dust-generating operation should be isolated from the main shop, and if possible it should be enclosed. In the case of falling masses of dust, such as hopper loaders, care should be exercised in the design of the conveyer so that the height of drop be minimized. A falling mass entrains air, and when it compresses again, this air is dispelled, carrying with it mass quantities of dust. When materials flow designs have reduced the quantity of airborne dust as much as practicable, and if the dust concentrations remain excessive, local exhaust ventilation together with adequate collector controls for reducing air pollution should be installed. It should be pointed out that there are many dust producing operations which do not lend themselves well to engineering controls in that the expense of installation and maintenance is excessive. These operations are, however, generally completely automatic and isolated. There are times, however, when a worker must enter these areas, and since his exposure time is brief, he should be supplied with a respirator, approved for the type of dust to which he is exposed. A respirator, therefore, has its place in the control of dust ex-

posure, but it should never be a substitute for adequate ventilation or design control. In addition, in order to prevent the redispersal of dust from rafters and light fixtures, a system of good housekeeping should be instituted and periodically maintained.

A system of adequate control of dust reduces machinery wear and its subsequent breakdown, creates a more pleasing surrounding for employees thus reducing labor turnover, and most important reduces the likelihood of illness among employees thus increasing their productive capacities for themselves and their employer.

The MEDICAL Aspects of Dust Control

DEFINITION

Dust may be defined as solid particles ranging in size from the less than 1 to more than 150 microns. One micron is equivalent to approximately one twenty-five thousandth of an inch. In industry, dusts are produced by reducing solid materials to small sizes by such operations as crushing, grinding, drilling, and blasting. When this phenomenon occurs, several differences between the appearance of the parent material and the dust take place. Most important is that the surface area is increased, and on the basis of reducing a one centimeter cube to particles one cubic micron in size, the surface area will be increased 10,000 times. In addition, the smaller the approaching molecular size, the more they tend to act as a gas, expanding in volume, several times greater than the volume occupied by the original mass. This gas-like behavior thus increases the material's rate of solubility, evaporation, oxidation, absorption, and electrical activity.

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CLASSIFICATION

In general, dusts may be classified as animal, vegetable, or mineral. Animal dusts include feathers, hair, leather, and bone. Vegetable dusts are pollens, grain, straw, flour, hemp, paper, wood, coal, tobacco, etc., or organic dusts such as dyestuffs and intermediates. Mineral or inorganic dusts may be metals, such as lead or zinc, or non-metallic dusts such as asbestos, gypsum, quartz, and carborundum.

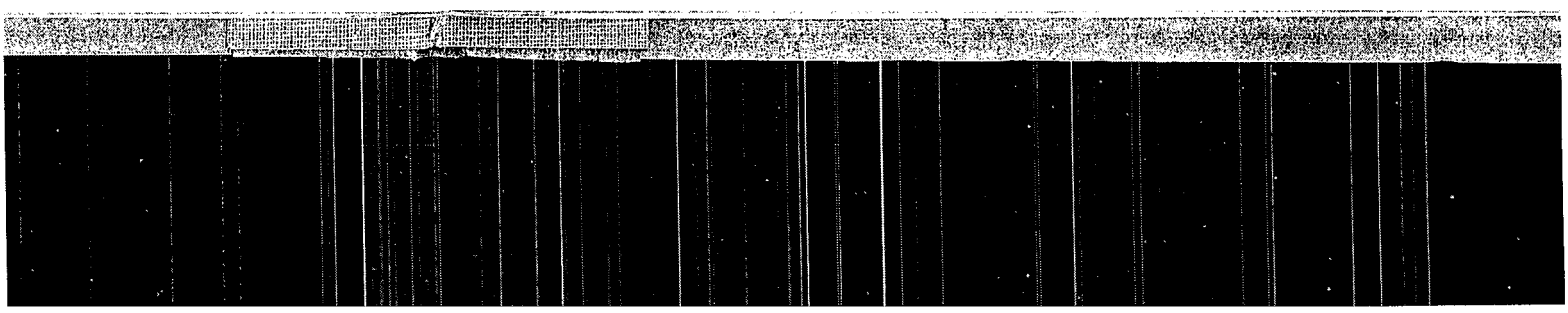
In the field of industrial hygiene, however, these broad classifications are not practical, and since the scope of this discipline lies in the field of public health, it is better to classify dusts according to the physiological response they create in man. Under this concept dust may cause an allergic reaction, such as exposure to pollens or most organic-type dusts; skin reactions, such as contact of lime or chromates with the skin; systemic poisoning, such as brought about by breathing lead or manganese dusts; or respiratory difficulty either by a simple overloading of the lung with non-reactive dusts, which reduces the exchange of gas rates, or by a proliferative reaction with the lung itself, such as silicosis.

TYPES OF DUST DISEASE

It has long been recognized that dust inhalation is capable of producing lung difficulty or disease. Conditions brought about by excessive exposure to dusts, which do not in themselves cause systemic poisoning, are classed under the general title, pneumoconioses, a broad term which includes all pulmonary manifestations, whether the dust is injurious or harmless.

Silicosis and asbestosis are pneumoconioses which cause permanent, irreversible damage and are defined as:

Silicosis - a disease resulting from breathing excessive



quantities of dust containing free silica, SiO_2. It is characterized by generalized fibrotic changes and miliary nodulation in both lungs.

Asbestosis - a disease caused by excessive exposure to quantities of asbestos dust and resulting in permanent damage to the lungs by unalterable tissue changes.

Other dusts give rise to lung conditions which may not cause permanent damage. In general, these are classified as pneumoconioses, but each is generally specifically titled by the name of the offending substance. There are probably as many of these conditions as there are substances, and only a partial list follows:

Anthracosis - a condition caused by inhalation of coal dust and characterized by a deposit of this dust throughout the lungs.

Aluminosis - a dust condition resulting from breathing aluminum dusts.

Byssinosis - a pneumoconiosis resulting from inhalation of cotton dust.

Siderosis - a condition resulting in the deposition of iron and iron oxide dusts in the lung.

MAXIMUM ALLOWABLE CONCENTRATIONS

The following is a partial list of dust maximum allowable concentrations as adopted for 1956:

TOXIC DUSTS

Substance	Maximum Allowable Concentration *(milligrams per cubic meter of air)*
Antimony	0.5
Arsenic	0.5

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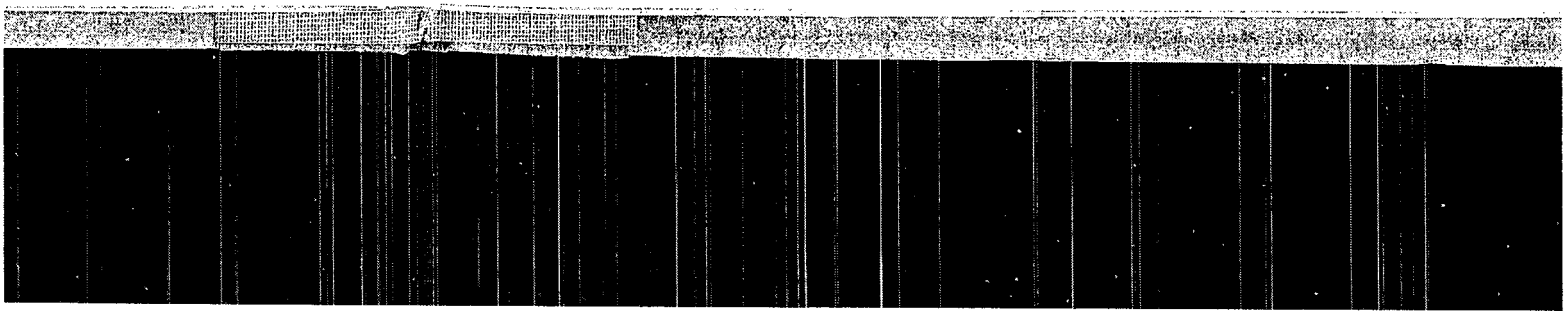
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TOXIC DUSTS (continued)

Barium (soluble compounds)	0.5
Cadmium	0.1
Calcium arsenate	0.3
Chromic acid (as CrO_3)	0.1
Lead	0.15
Lead arsenate	0.2
Molybdenum (soluble compounds)	5.
Molybdenum (insoluble compounds)	15.
Titanium dioxide	15.
Uranium (soluble compounds)	0.05
Uranium (insoluble compounds)	0.25

MINERAL DUSTS

Substance	Maximum Allowable Concentration *(millions of particles per cubic foot of air)*
Aluminum oxide	50
Asbestos	5
Dust (Nuisance, no free silica)	50
Mica (below 5% free silica)	20
Portland Cement	50
Talc	20
Silica	
High (above 50% free SiO_2)	5
Medium (5 to 50% free SiO_2)	20
Low (below 5% free SiO_2)	50
Silicon carbide	50
Slate (below 5% free SiO_2)	50
Soapstone (below 5% free SiO_2)	20
Total dust (below 5% free SiO_2)	50



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