

a tube containing granulated sugar, which filters out the suspended dust. At the laboratory, the sugar is dissolved in water and the number of dust particles are determined by counting those in a small volume of the sugar solution under a microscope. This method of dust sampling had certain disadvantages, the chief of which was the fact that the purest commercial sugar contained a certain quantity of dust, which introduced considerable errors, especially in those samples containing a low dust concentration. To overcome the limitations of the sugar tube method various other devices were developed, one of which was the Palmer apparatus. This apparatus consisted essentially of a pear-shaped glass bulb, the lower end of which terminated in a U-tube or trap. Suction was applied to the glass bulb by means of an electric exhaust fan and the volume of air measured by means of a Petot tube. Dust-free distilled water was put into the U-tube. The air drawn through the water in the trap broke it up into a spray within the larger portion of the sampling bulb, which washed out and retained the dust. The dust so obtained was analyzed by the usual methods. The Palmer apparatus also had certain disadvantages, the chief of which was that its efficiency as a dust catcher was low. In the search for a more portable type of instrument, which at the same time would yield rapid results, the South African investigators introduced in 1916 a new instrument known as the Kratz konimeter. The konimeter samples dust by impinging a small volume of air against the surface of a vaseline-coated glass plate, the vaseline serving to catch the dust particles. The dust retained on the glass plate was then counted under the microscope at a suitable magnification. The chief disadvantages of the konimeter are that in atmospheres containing a high concentration of dust, the spots are too dense to allow counting the individual particles and the method can, therefore, not be used in such cases, also many samples had to be taken to secure a correct average determination in places where the dust concentration was variable.

As a result of the different methods of dust determination being used by the different governmental bureaus and others, it was soon found that the various dust-sampling methods did not yield absolute results, consequently some confusion arose in interpreting the various dust studies. In order to arrive at some basis of comparison the U. S. Bureau of Mines conducted a laboratory study of dust-sampling instruments. The results of this study were published in Public Health Bulletin No. 144 entitled "Comparative Tests of Instruments for Determining Atmospheric Dusts." (1925) During the course of this study two of the investigators, Dr. L. Greenburg and G. W. Smith, devised a new apparatus called the impinger. In the comparative study the dust collecting efficiency of the impinger was found to be high, and in addition the method offered several advantages over previous methods. After several modifications to meet special requirements, this instrument was adopted by the Federal Public Health Service and Bureau of Mines as the standard technique for the sampling of dust in air. The instrument has been used in the study of a number of dust trades, and is the commonly accepted method in use today.

Size of Dust Particles Taken into the Lungs

It has been observed from a study of silicotic lungs that most of the dust particles that have penetrated into the air sacs are less than 10 microns in longest dimension (1 micron is 1/1000th of a millimeter, or 1/2500th of an inch). It is generally agreed, therefore, that we need not bother with particles larger than 10 microns in measuring the concentration of a dangerous dust.

So that you may visualize the size of these small particles consider a 280 mesh

screen in which the screen openings are 50 microns. In the absence of a beam of light, an atmosphere containing these tiny particles will appear clear to the naked eye, and therefore is extremely deceptive. Only a powerful microscope can make such particles directly visible.

It is necessary, therefore, to make a microscopical examination of the atmosphere to learn how badly polluted it may be. Larger particles such as are visible to the naked eye are essentially harmless in the causation of silicosis, as these are caught by the membranes provided by nature in the nasal and other respiratory passages and are eventually coughed up or eliminated before any damage is done.

When small dust particles are dispersed in air, they are carried about like smoke and settle out very slowly. How long such particles will remain suspended in quiet air can be roughly determined from Stoke's law. Assuming a round particle to be one micron in diameter, it can be calculated by means of this law that such a particle will fall only 20.3 feet in 24 hours. It can be seen, therefore, that any fine dust dispersed into the air is not only a momentary hazard but remains in the air for an indefinite period. This fact is often overlooked by workmen, as it is usually assumed that as soon as the dust cloud is no longer visible all dust has settled out.

The term "dusty working place" is only a relative one. Most air, both inside and outside of factories, contains some dust. It is, therefore, necessary to adopt a standard content for the dividing line between slightly dusty and dusty working places. The Wisconsin dust code prescribes a "tentative figure of 15 million countable dust particles under 10 microns in longest dimension with free silica content of 35 per cent in a cubic foot of air as determined by Public Health Service technique. Variations in free silica content will make proportional inverse changes in this standard." In accordance with this standard the permissible count for practically pure silica would be 5,250,000 particles.

How Dust Samples are Collected

As mentioned previously, the instrument used in collecting the dust samples is that known as the "Impinger." With this instrument the air to be sampled is drawn through a glass tube and impinged at a high velocity on a glass plate which is immersed beneath a suitable liquid contained in the collecting flask.

The impinger, therefore, combines the principle of collecting dust by impingement with a water-washing or bubbling method and so possesses the advantages of both principles. The dust is thus trapped and remains in the collecting liquid. Suction is applied to the impinger by means of a steam ejector operated by compressed air. Where compressed air is not available, a small electrically-operated vacuum pump may be used. The rate of air flow is measured either by means of a small vacuum cage or an orifice-type flow meter.

The entire apparatus is calibrated before use against a standard gas meter, so that a known volume of air may be sampled. The rate of sampling is approximately one cubic foot of air per minute. The dust-collecting device is placed in close proximity to the breathing level of the workmen involved while performing their respective duties, so that air samples representing actual working conditions may be obtained. After a sufficient volume of dust-laden air has been sampled, the collecting liquid is placed in a suitable container and removed to the laboratory for the necessary analysis.

When the dust sample reaches the laboratory, the entire sample is filtered into a clean graduated flask through a 280-mesh screen so that only particles smaller than 50 microns are permitted to pass; particles larger than 50 microns are not considered