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# Dusts, Fumes, Gases and Vapors

## WEDNESDAY MORNING SESSION

### October 12, 1938

Assembling in the Grand Ballroom of The Stevens Hotel, this meeting was called to order by Chairman Walter S. Paine, Manager, Engineering and Inspection Department, Aetna Casualty & Surety Company, Hartford, Conn., and Vice-President for Engineering, National Safety Council. Chairman Paine briefly outlined the session objectives, and then introduced the speakers.

## Recent Developments in Detecting Hazardous Dusts, Fumes, Gases and Vapors

By WARREN A. COOK

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In discussing the determination of injurious dusts, fumes, gases and vapors, I am very sure that you are not interested so much in a meticulous dissertation on such phases of the subject as whether the logarithm of the reciprocal of the hydrogen ion should be 9.5 or 9.0 for the determination of lead by the dithizone method, but rather in a discussion of this matter along broad lines, pointing out what types of potentially injurious materials should be looked for, whether determination of them is in order, a brief discussion on some of the more important and common methods of determination, and interpretation of the results obtained.

### Foolhardy to "Work in the Dark"

Working in the dark without any means of illumination where there may be hazardous conditions serious enough to cause loss of life or severe injury would be considered most foolhardy; yet every day men conduct their operations in atmospheres containing dusts, gases, and vapors which may cause death or severe injury to health without being able to see or otherwise perceive the potentially hazardous condition.

Most gases and vapors can no more be seen than the well-known black cat in the coal cellar. Some of them cannot even be detected by odor, though odor is itself no reliable criterion as is evidenced by the gas, hydrogen sulfide, which has a most obnoxious odor but has caused many a case of poisoning.

How, then, are we to know whether the atmosphere in which we work is safe or injurious? Are we to wait until we see the effects of unhealthful or irrespirable atmospheres on our men or is it not more intelligent to determine, within the limitations of modern methods and practical applications, just what sort of atmosphere we are subjected to?

The importance of having facts before us is well illustrated by an atmospheric condition where a life could be snuffed out in a few minutes, even though the more common situation is where excessive exposures may require weeks, months or years to cause their injurious effects.

Thirteen years ago this month a powder crew was walking down the tunnel of a new water supply system of a Connecticut city. Their duty was to inspect the roof and the face, to see that all the shots were fired. On approaching the tunnel heading immediately after the blast, they found that flying rock had broken the compressed air line, which had been left turned on in order to blow the smoke and gas away from the face of the tunnel. The crew, consequently, ran into a heavy blanket of smoke, but they were hardened workers, used to smoke and gas, and a little smoke, even though they knew it contained carbon monoxide, did not hold them back.

They found the roof intact. But four of the holes had not fired. Caps with 3-foot fuses were inserted in sticks of dynamite, one for each of the holes. The gas condition by the time this work had been accomplished was beginning to make these men feel a bit groggy. Following the usual practice, the powder foreman sent the rest of the men back down the tunnel before he lighted the fuses.

The men walked back through the smoke to the car, about a quarter of a mile down the tunnel. There they waited for the foreman. Seconds passed. The time stretched to a minute. Down the tunnel came the boom of the blast—but no foreman. The men rushed to the heading and found the foreman stretched on the tunnel floor, nearly covered with rock from the blast, where he had collapsed from the effects of the carbon monoxide.

This is a true story up to a certain point, but I have omitted a part of the story, and the ending, I am glad to say, is pure fiction. The part of the story which I omitted was that carbon monoxide determinations were being taken when those men got up to the heading, and a concentration of .3 per cent carbon monoxide was shown to be present by means of the Hoolamite carbon monoxide detector. With such a high concentration, it was realized by the man making the determinations that it would not take long for exposed persons to collapse. He informed the crew of the condition and hurried them back to the car to wait until the smoke and gas had cleared enough to permit them to work safely and fire the blast.

The difference between fact and fiction in this case, between a brief delay and a fatal case of carbon monoxide poisoning, was the ready availability of a simple means of determining the carbon monoxide concentration on the job.

The present tendency in development of methods of determination of injurious materials in air is toward such simple, quick-acting devices. As many of you know, the Hoolamite carbon monoxide detector operates merely by pressing a rubber bulb ten times and comparing a purple color which develops in presence of carbon monoxide with a standard color scale mounted on the instrument—an operation which requires about a minute. Instruments of this type are especially important for gases which may cause acute poisoning such as carbon monoxide, hydrogen cyanide, and hydrogen sulphide.

An instrument for determination of hydrogen cyanide, similar to the Hoolamite carbon monoxide detector, has recently been developed by the United States Bureau of Mine workers, and, together with a number of other of these simple detectors, is now available commercially. Determination of such materials can accordingly be made much more widely than formerly when laborious chemical laboratory methods were necessary.

## Potentially Hazardous Materials

The first step in an organized endeavor to avoid environmental conditions which may cause injury to health is a listing of all materials, used or produced, which may under certain conditions be deleterious. It was found in a study by the United States Public Health Service of potential hazards in a typical industrial area (1) that a considerable percentage, nearly 20 per cent, of the workers were exposed potentially to carbon monoxide. The report by no means intimated that this percentage of workers were being poisoned by carbon monoxide, but rather that if things went wrong and a concentration of the gas built up to injurious proportions these men might become poisoned.

So I suggest that you go through your plants and see what operations involve potentially injurious materials. Of the dusts, those which may produce silicosis occur not only in the well-known industries where major studies of conditions have been conducted but in other industries as well, though usually to a lesser extent. In silver-

ware manufacturing, for example, one man may be exposed day after day to tripoli dust in making up a polishing compound for use within the plant. A list of industries in which such dust exposures may exist is given in the report of the National Silicosis Conference.[2]

The toxic dusts and fumes are more readily spotted. We recognize and guard against lead exposure in storage battery plants, but often overlook such an operation as where red lead is being mixed with a vehicle by a worker in one corner of the top floor of the plant to color lettering on a steel part. It is not so much whether a pound of lead or a ton is used in a day, but the extent to which it contaminates the air breathed by the worker.

Carbon monoxide, hydrogen sulphide, hydrogen cyanide have been mentioned as examples of gases. The first of these occurs where producer gas or water gas is used. The last named should be looked for where fumigating may be done from time to time. Where dry ice is used in quantity or fermentation processes are conducted, carbon dioxide is liberated and has caused deaths usually at the bottom of confined areas such as ships' holds and fermentation tanks.

Vapors are present wherever organic solvents are used. Death may result quickly where high concentrations exist as has occurred when a drum of solvent was dropped on a basement storage room floor and split open, and again where carbon tetrachloride was being used for fumigating a flour mill and the fumigator sprinkled the liquid in the basement as his last operation. It was his last.

Injury from continued exposure to solvent vapor at concentrations which cause their effect after weeks of exposure is the more common condition. The various solvents differ widely in the concentration of vapor necessary to cause injury. These are divided into groups in accordance with their toxicity in a paper delivered before the Northwestern University Symposium on Occupational Diseases a year ago.[3]

## Where Should Determinations Be Made?

After going over your plants and learning where potentially hazardous materials are present, it is my suggestion that, before making actual determinations of concentrations in air or instituting control measures, you make a thorough survey of the conditions and divide the various operations where these materials are present into groups: (1) those which are obviously safe; (2) those which are admittedly causing injury to health or are worse than good industrial practice dictates; (3) those conditions where it is not readily discernible by general observation whether the exposure is within safe limits.

Certain conditions we know definitely and can say definitely will not cause injury to health. I would not say that those are to be forgotten, but at least they need not be the subject of initial action. If, for example, a gas containing 30 or 40 per cent carbon monoxide is used for hot plates, and those hot plates are connected with rigid conduit rather than with rubber tubing, you can feel reasonably safe that the carbon monoxide exposure is within safe limits, and I would not recommend that determinations be made. Where spray painting is being done in a well ventilated booth in such a manner that there is no excessive rebound into the face of the sprayer, determinations of vapor or pigment need not be made even though the odor of the solvent is detectable. From time to time it may be well for state authorities to check some of these lesser exposures, but there is a considerable number of such exposures which can be accepted as safe.

The second group of exposures—that where conditions are admittedly severe—is another where determinations are not essential. Institute control measures immediately. If there are clouds of dust containing free silica in your plant, go to work on them. If excessive lead absorption is shown by development of symptoms or by high basophilic aggregation percentages, reduce the lead exposure. It may be desirable to make determinations even in these cases either to provide a before-and-after picture of exposures to show what improvement is effected or to obtain a clear picture of just what part of an operation is responsible for the excessive exposure to the end that control measures can be more specifically applied. This latter use of air analysis data is of especial value where the materials are invisible as is the case with gases, vapors and even some of the more toxic dusts such as quartz and lead.

The principal use for determination of