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Harold O. Hayes, *Promotion Manager*

Representatives

New York City
E. Macdonald Bacon
17 West 45th—Room 909
Longacre 3-5260

Detroit
Parker & Tarbell
419 Curtis Bldg., 2842 W. Grand Blvd.
Madison 1540

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The Cement Mill Edition of CONCRETE is edited exclusively for those interested in the manufacture of portland cement and related products.

Its pages are devoted to discussions of plant design, management, operation, production efficiency, chemical research and control, quarry operation, progress and news of the industry.

The Cement Mill Edition also contains all the material published in the corresponding Regular Edition and so provides news of the uses and merchandising of the materials whose manufacture is discussed in the Mill Edition.

The Regular Section furnishes mill operating officials and mill executives valuable points of contact with the users of the materials they produce.

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J. C. WITT, *Consulting Editor*
A. C. BAMBERGER, *Assistant Editor*

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INHALATION OF DUST
and Control of Dust Hazards

By W. C. JAMES
Safety Engineer
Portland Cement Association



W. C. JAMES

CONFUSION still seems to be the dominant keynote outside the research laboratory in this question of occupational "dusty-lung" diseases. Terms such as pneumoconiosis, silicosis, siderosis, chalicosis and even silicatosis are bandied about indiscriminately and often without meaning. Usually, the mere mention of dust in a conversation inspires visions of high mortality, high sickness rates and a long trail of serious hazards.

Confusion of Terms

The term "pneumoconiosis" is often interpreted to mean a disease of the lungs, resulting from dust inhalation. Actually, it means simply "dusty lung." In the early history of lung disease it was thought that all dusts caused the same disease reaction, and this term was applied to that disease. Modern research has demonstrated that most dusts are harmless. The term "pneumoconiosis" therefore should assume its primary meaning, and when applied to an individual it can rightly be interpreted only as indicating that the person has inhaled dust. Dr Leroy U. Gardner, referring to non-specific pneumoconiosis says, "Such changes have no clinical significance and produce neither symptoms nor interference with working capacity. They are of no more importance than the callouses on the palms of the hands." Any person in any environment may develop this condition. Even office workers in large industrial communities may show X-ray evidence of having inhaled dust, but such evidence is meaningless as far as health is concerned.

Of the various strictly industrial dusts, coal and iron ore are perhaps the most spectacular in their appearance in the lung. Early investigators—and by this I mean investigators in the first 16 or 17 centuries of the Christian era—were so impressed by the lung pigmentation of workers in iron ore and coal that they credited these substances with a prominent part in the development of lung disease. Modern research has demonstrated that this coloring of the lung tissue is, in itself, of no significance. Only two substances are now known to cause a definite lung disease—namely, asbestos and uncombined silica.

Inhalation of free silicon dioxide (usually quartz) in excessive quantities over a long period of time causes the disease, silicosis. You will note particularly that three factors are necessary to the causation of this disease:

1. Free silicon dioxide (usually quartz), in particles less than 10 microns in greatest diameter.
2. Excessive concentrations.
3. Long period of exposure.

No Silicosis from Cement Dust

Particular emphasis should be given to these limiting factors. First, "free silicon dioxide, less than 10 microns in greatest diameter." This means exactly what it says—not calcium carbonates, not iron oxides, not silicates, not even silicon carbide (which is carborundum), but free silicon dioxide. It seems probable that no little confusion has arisen in the minds of plant superintendents and engineers because of the time-honored practice by industrial chemists of reporting an analysis in terms of the oxides of the components. For example, a typical reported analysis of portland cement will show a total silica content of about 20 per cent. Actually, all of this silica is combined in the forms of entirely harmless calcium silicates; and it has been conclusively demonstrated that it is utterly impossible to acquire silicosis from exposure to cement dust. It should be mentioned that quartz is not the only form of free silica, though it is apparently the most dangerous, and certainly the most common, form. The various amorphous forms of the compound, such as flint, tripoli and chert, may also produce the silicotic reaction in the lung, but they are known to be less severe in their effect.

The limiting size of ten microns is also of importance. Particles larger than this do not reach the lungs. Furthermore the percentage of quartz in a given material will vary greatly with the particle size. A petrographic examination of shale at Saranac Laboratory under Dr. L. U. Gardner's direction, recently revealed 20 per cent quartz. In a special fraction containing only large particles, 40 to 50 per cent quartz was found.

Dr. Gardner writes, "this is obviously due to the fact that quartz is so hard it does not fracture into fine particles." It must, therefore, be emphasized that conclusions as to the hazard existent in a dusty operation can not be based with confidence on an analysis of the parent rock. Only an analysis of the dust in the breathing zone of the operator will give an accurate picture of conditions.

Question of Concentration

The second limiting factor is concentration. The exact amount of air-borne quartz that constitutes a dangerous concentration in any particular industry is not easily determined, nor is there as yet any substantial agreement as to what limits of quartz content should be observed.

Dr. A. J. Lanza, assistant medical director of the Metropolitan Life Insurance Company, an outstanding authority on the silicosis problem, gave an excellent summary of what needs to be known about dust concentration in his paper presented before The American Institute

Paper read before the Quarry Section of the All Ohio Safety Congress, May 11, 1938.

of Mining and Metallurgical Engineers, in February, 1937. He said:

> "In the present state of our knowledge, it is not possible to establish permissible limits of dustiness for all dusty industries or processes, as the variation both in the dust content and in external modifying conditions is so extreme. In mining, however, working conditions are fairly constant and it would be extremely valuable to the industry if the various mining companies that face a silica hazard would establish, with the help of the proper governmental authorities, tentative standards practicable and applicable for their own mines. Some have done so and it is a long step in the right direction."

This recommendation might well be extended to other industries.

More Knowledge Is Needed

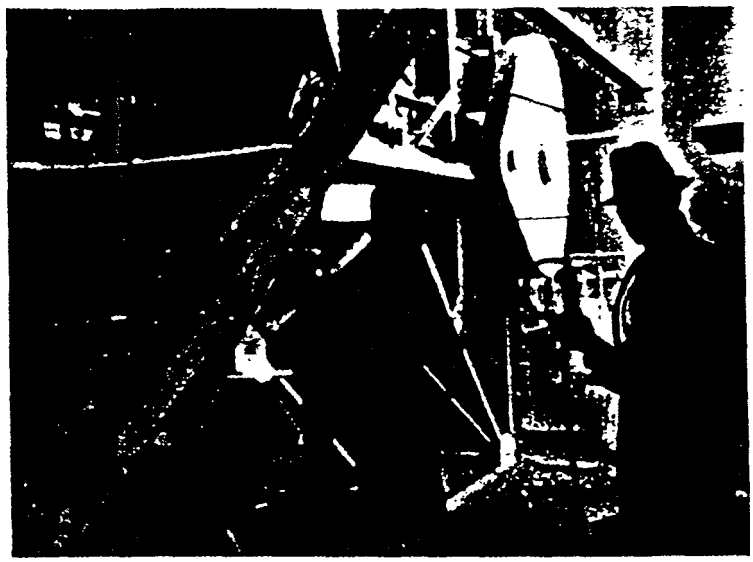
The National Silicosis Conference tentatively established a maximum of five million particles per cubic foot as a safe quartz concentration in the case of highly siliceous dusts. This standard is subject to modification as more data are developed by different industries. The National Silicosis Conference report also says, "It is recommended that clinical and engineering studies be carried out as rapidly as possible to establish the necessary scientific data upon which we may base practical and effective regulatory standards." The report then states that knowledge of three factors is necessary for establishing safe concentrations of atmospheric dust:

1. The relative number and size of the free silica and the other particles suspended at breathing levels in the different parts of the industrial atmosphere.

2. The proportion of the workmen's time actually spent in the various dust concentrations.

3. The effects of exposure to environment, as revealed by the occupational and medical histories of old employees, by physical examination and by the roentgenological appearance of their lungs.

Through a knowledge of these three factors, any industry can discover what, if any, hazard it has and what preventive measures are needed. For the past two years, under the direction of Dr. Leroy U. Gardner of the Saranac Laboratory for the Study of Tuberculosis, the cement industry has been making a careful estimate of the health of its workers, according to the plan just outlined. Many of the statements in this paper regarding the effect of mixed or non-siliceous dusts have been based on the findings of these studies.



Dust sampling at hammer mills—raw end

One of the outstanding conclusions a student of these researches in the cement industry will reach is that concentrations of free silica appreciably higher than the maximum specified by the Silicosis Conference are safe if the silica constitutes a moderate proportion of the total dust. Apparently a mixture of silica with other minerals, if the other minerals are predominant, tends to inhibit the effect of the silica in the lung. It is not yet possible to recommend, without reservation, the dilution of silica with other dusts as a protective measure. It is far better to remove the dust from the atmosphere. Nevertheless, it is significant that in the portland cement industry, where a high concentration of raw material dust containing up to 10 per cent of free silica is sometimes found, the X-rays and physical examinations reveal no pathological lung condition attributable to dust.

The Practical Limit

Although no agreement has been reached as to the maximum safe concentration of free silica in the presence of harmless dusts, agreement as to good housekeeping limits is practically unanimous. Industries with a dusty process, even though dusts are harmless, should endeavor to reach a concentration in the neighborhood of 100 million particles per cubic foot of air in the breathing zone of the workers, in the interests of comfort and increased efficiency.

The third factor in the development of silicosis is duration of exposure. The problem of exposure resolves itself into two parts. First, what proportion of the workers' time is actually spent in the dusty atmosphere? It is evident that a hazardous dust will not affect a man unless he is actually exposed to it and will not have as great an effect on a man who is exposed to it one hour a day as on a man continuously exposed.

[*The remaining part of this paper will discuss the effect of duration of exposure, followed by a discussion of preventive measures.—Editor.*]

Plan New Cement Plant for Turkey

ACCORDING to a report to the U. S. Bureau of Foreign and Domestic Commerce from the office of the American Commercial Attache at Istanbul, the Turkish Government has awarded a contract to a European equipment manufacturer for cement mill machinery to be installed in a new plant at Sivas.

Installation of the machinery is expected to start in October of this year, and the plant should enter into operation in July, 1939, with a daily production capacity of 300 tons, or 90,000 tons per year. In view of the abundance of raw material in the surrounding district, it is hoped that the factory will soon be able to double its production. The quarries will be connected with the plant by an aerial line of 3,100 meters. It is anticipated that when this factory enters into production the Eastern Vilayets and Central Anatolia will be supplied with cement at considerably lower prices.