FILE NAME: Trade Publications (TR)

DATE: 1940 June

DOC#: TR044

DOCUMENT DESCRIPTION: Trade Journal Article - Making Progress in Control of Industrial Dusts

Charter Member

Associated Business Papers

CONCRETE, with which has been combined Cement Age, New York, and Concrete Engineering, Cleveland, is devoted to the Proper Use of Concrete and the Manufacture of Cement.

Published monthly by

CONCRETE PUBLISHING CORPORATION
400 West Madison Street
Chicago, Illinois
Telephone CENtral 8822

Louis Brookman, Jr., *Publisher*
L. Moeller, *Circulation Manager*
Donald T. Papineau, *Promotion Manager*

Representatives

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

San Francisco: Don Harway
155 Montgomery Street
Exbrook 6029

Los Angeles: Don Harway & Co.
318 West Ninth Street
Tucker 9706

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Charter Member

Audit Bureau of Circulations

CEMENT MILL SECTION of

Concrete

Established 1904

Volume 48 June, 1940 Number 6

NORMAN M. STINEMAN, *Editor*
J. C. WITT, *Consulting Editor*

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CONCRETE is indexed in INDUSTRIAL ARTS INDEX, which may be consulted in any Technical or Public Library.

Making Progress in Control of Industrial Dusts

IN 1938 the Air Hygiene Foundation established two fellowships at the Harvard School of Public Health. At present, these are held by two engineers working toward the Doctorate of Science Degree in Industrial Sanitation. The thesis work of these men is directed toward problems of direct interest to Foundation members.

What Sizes?

An important problem in silicosis prevention and in the appraisal of silicosis risks is, "What is the most potent size of silica particles?" It is recognized that the most dangerous sizes are certainly below 3 microns (a micron is 1/25,000 of an inch), but whether there are critical differences here between particles of 0.5, 1, and 2 microns has not been studied. Accordingly, ground flint (99.7 per cent free silica) was separated into four fractions, 3.30, 1.65, 1.04, and 0.62 microns, and the fractions cleared, as far as possible from particles other than the sizes stated. Sterile suspensions of these fractions were then injected into the ear veins of rabbits twice at three-month intervals, and the animals were killed and autopsied periodically.

Preliminary examination of liver sections indicate that the fine particles are more rapidly taken up by cells than are the larger ones. Later examinations showed no striking effects with the two larger sizes (3.30 and 1.65 microns), while it looks as if the third and fourth (1.04 and 0.62 microns) produced the greatest changes. The final report on this study will be ready in about eight months.

Why Engineers Want to Know

The reason engineers want the information which we hope this study will bring is that we are responsible for measuring degrees of dustiness in workplaces and for controlling conditions. Also, we must design dust respirators. We would like to know what, physiologically, are the most important sized particles; and then we can focus our efforts particularly against them.

An engineering corollary to this problem is "What is the most difficult size dust particle to wet when floating in air?" and "What can be done to make the modern air washer into a more efficient dust catcher?" These questions are important to the air-conditioning industry and to all plants where air is cleaned by wet methods. The graduate student who is working on the dust injections is studying commercial air washers with a particular view to the possible application of wetting agents (surface-active agents). An incentive to the study of this problem has been the remarkable progress recently in the separation of non-metallic dusts by flotation, a method considered inapplicable to industry only a few years ago.

Interest Increasing

As evidenced by the number of papers published in the last year, interest in the vapors from organic compounds has become widespread. Firms selling equipment or materials in which such solvents are in any way concerned are generally alert to the problem. Methods for detecting and for recording such substances are being reported from numerous laboratories. At least three large firms have arrangements for investigating the potential risks of one new compound after another and thus to determine under what conditions they can be marketed and used safely. As compared with the silicosis field, it is likely that the interest and activity in these directions will increase rather than diminish as new compounds continually are being developed.

The design of electro-plating tanks, baths, and vats using toxic solvents and liquids has not yet been placed on a rational basis. The purpose of the second Foundation research now in progress at Harvard is to investigate the characteristics of these solvent tanks and to provide a rational basis of design by studying their performance under various conditions.

Small tanks, with lateral exhaust on one or two sides, have been used. Taking several liquids with widely different physical properties, trichlorethylene, water, toluol, triethylene glycol, the minimum ventilation requirements at various temperatures and evaporative rates have been determined. This phase of the work is now nearing completion.

With reasonable surety it may be stated that the required ventilation in CFM (cubic ft. per minute) varies as the evaporative rate to an exponent. The use of a minimum quantity, rather than a minimum velocity, has been found necessary in the case of fumes, vapors, and mists, and it is believed that this work gives adequate basis to that fact.

The second phase of the work has been to ascertain the velocity characteristics of these tanks. The velocities at all four tank corners and at the sampling point are being determined to find which location will give the best and most satisfactory correlation with vapor concentration.

Dust-Counting Instruments

In addition to the above work, a new vapor-pressure instrument for determining organic solvents in air has been developed. Also, a new dust-counting instrument revision was made.

The development of instruments for recording continuously low concentrations of toxic vapors should interest the members of this Foundation. Many firms using toxic solvents must either continue to use them or else take up an entirely new line of manufacture—often they can not use harmless substitutes. Under such conditions, the plant management requires periodic sampling of the air to find out if ventilation is as it should be.

Recorders are available today for carbon monoxide, sulfur dioxide, hydrogen sulfide, carbon disulfide, mercury vapor, and carbon dioxide, while continuous alarms or detectors for inflammable gas mixtures are in fairly general use. It is well within the realm of practical matters to develop instruments which will furnish reliable records, 24 hours a day, of air pollution from low concentrations of substances, such as benzol or carbon tetrachloride. We have every intention of pursuing the problem further in our work for the Foundation at Harvard.

New Idea in Silicosis Control

As the result of Dr. L. U. Gardner's medical research, backed by many field studies by others, notably the United States Public Health Service, it is now possible to outline and carry out, with reasonable assurance, a reasonable dust-

Report of Preventive Engineering Committee of the Air Hygiene Foundation, Pittsburgh, Penna., prepared by Prof. Philip Drinker, of Harvard, chairman of the committee.

control program. Industry neither demands nor expects from experimental medicine great precision in these matters, such as toxic limits in air. In the field of silicosis they have very nearly got what they need, and certainly they now know very clearly how many missing gaps can be filled out.

It is of some interest that the use of aluminum dust in the treatment of men who have had exposures to silicotic dust has definitely been suggested at least twice; once, to an important mining group, and again to the granite cutters' union. Furthermore, patents on the use of aluminum dust, both for the prevention and for the treatment of silicosis, have been granted.

What place, if any, the use of aluminum or other protector dusts may eventually have in silicosis control remains to be seen. In the meantime, we see no reason to reduce either engineering or medical control in any way whatever.

Design Problems Involved in Burning Pulverized Midwest Coals

By MARTIN FRISCH
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PULVERIZED Midwestern coals may be successfully used if four important characteristics of these fuels are adequately provided for. These are:

1. Low ash softening and fusion temperatures.
2. Small coking tendency.
3. Generally high total moisture content.
4. Low to moderate grindability.

The two last characteristics primarily influence the choice of coal preparation and pulverizing equipment. The other two determine the design of the firing equipment, extent and disposition of heat-absorbing surfaces, arrangement of gas passages and provisions for controlling superheat.

Easy to Burn

Most Midwestern coals are extremely easy to burn in pulverized form, even when quite coarsely pulverized, because their tendency to coke is small. Hence they are naturally free-burning. However, the ash in most of the coals slags easily, and for this reason alone these coals are more troublesome than most other native coals.

Whether or not it is possible to reduce the furnace-exit temperature as much as desired, the slagging tendency may be minimized by fine pulverization. Fine particles burn faster than coarse particles and may be expected to contain less unburned fuel residues when they pass out of the flame into the clear gas space between the flame and the furnace exit. Such particles can then give up heat by radiation to cold surrounding wall surfaces. If the particle path with respect to the furnace cooling surfaces and the flame is correct, the rate of heat dissipated by radiation from the particle will exceed the rate of heat reception by the particle by radiation from the flame and by convection from the surrounding gases.

Additional Cost Offset

The additional cost of grinding fine will be partially offset by fuel savings due to reduced carbon loss, and more than offset by the reduced cost of cleaning.

For example, experience indicates that in the average installation burning Illinois coal one may expect the relationship between fineness, fuel loss due to incomplete combustion in terms of the fuel fired, power consumption and maintenance, to be approximately as follows for a ball-mill job.

Fineness—per cent through 200-mesh	65	70	80	90
Fuel loss due to incomplete combustion—per cent of fuel fired ..	1.5	1.3	1.0	0.7
Fuel loss, lb. per ton burned . . .	30	26	20	14
Power consumption —KWH ton ..	13	15	21	30
Coal equivalent of power, 1.5 lb./KWH	19.5	22.5	31.5	45
Maintenance costs —cents per ton	0.9	1.0	1.4	2.0
Coal equivalent of maintenance cost for coal at $5.00 a ton	3.6	4.0	5.6	8.0
Net coal equivalent of carbon loss—power consumption —maintenance	53.1	52.5	57.1	67.0
Per cent of coal fired .	2.66	2.63	2.86	3.35

Economical Fineness

Under these conditions the minimum coal consumption occurs at a fineness of about 70 per cent through 200-mesh. If the power consumption or its coal equivalent is lower, or the carbon loss higher, the economical fineness is higher. Actually, one may safely conclude that considerable increases in fineness may be made without materially increasing the overall fuel cost.

Conclusion

The chief problem in the utilization of Midwestern coals with low ash fusion temperature is slag control. High fineness minimizes slag troubles and is justifiable for Midwestern coals even though not entirely justifiable on the basis of effect on efficiency.

Presented at Third Annual Midwest Power Conference, Chicago, Illinois, April 9 and 10, 1940.

QUARRY DRILLING

(Continued from page 189)

churn drills of intermediate size, but less than large drills.

4. Cut less volume of hole per hour of shift time than churn drills.
5. Break more rock per hour of drilling time and shift time than churn drills of intermediate size, but less than large churn drills.

Individual tests scatter widely and may reverse any of the preceding five points.

Churn drills in the group near 6 inches in diameter—

1. Operate at slightly lower time efficiency than larger churn drills. (This difference may be due entirely to small sample.)
2. Operate at higher time efficiency than hammer drills as a group.
3. Occupy a position intermediate between hammer drills and larger churn drills, in rock broken per volume of hole drilled.
4. Drill greater volume of hole than hammer drills during shift time, and less than larger churn drills.
5. Produce less rock per hour than hammer drills or larger churn drills.

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