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THE BULLETIN OF THE AMERICAN CERAMIC SOCIETY

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PAPERS

INDEX TO CERAMIC HISTORY, ACTIVITIES, NOTES

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established in the majority of states, and these bureaus have initiated programs to study industrial conditions and, to formulate rules, regulations, and methods to eliminate occupational disease hazards. Industry should welcome the assistance that these bureaus afford, because prevention of occupational diseases is of primary interest to employees and saves employers the cost of compensation.

MULLIKIN, STOCKBRIDGE, AND WATERS
BALTIMORE, MARYLAND

HEALTH OF BRICK AND TILE PLANT WORKERS IN NORTH CAROLINA*

BY M. F. TRICE†

ABSTRACT

Data are reviewed which were obtained in an investigation of the North Carolina brick and tile industry to evaluate the siliceous dust exposure of the workers in terms of hazards to health. The distribution of the forty-eight plants is classified according to the raw material used, that is, alluvial clay or shale. The extent of the dust exposure of the workers by occupational classification is appraised in terms of millions of particles of dust per cu. ft. of air, based on particle-count analyses of 183 samples of air-borne dust collected in twenty-eight plants. An evaluation of the health status of the workers is based on medical data obtained in the clinical and X-ray examination of 1555 employees in plants, most of which were the same as those in which dust samples were obtained. The investigation disclosed that none of the employees had silicosis, a fact which apparently is explained by a low quartz content of the atmospheric dust, an absence of excessive concentrations of dust, and a high labor turnover.

I. Introduction

A potential hazard to health exists whenever workmen are exposed to dust that contains quartz, flint, or other forms of uncombined silica, as such particulate matter is definitely toxic.[1(a)] The role of combined silica, or silicates as causes of pulmonary diseases, however, cannot be so categorically assessed. Authorities differ with respect to the toxicity of silicates although most of them no doubt would agree "that the presence of other inorganic dusts in the silica-containing atmosphere may tend to influence the rate of progressive reaction . . . (to) . . . inhaled silica."[1(b)] Although there is some question as to the effect of silicates in general, several of them, notably asbestos,[2] steatite (talc[3]), and mica[4] are capable of producing a serious and sometimes disabling pathology. Any silicate dust therefore should be regarded as a probable menace to health until such time as it can be proved innocuous in the concentrations that are encountered in routine.

Because the raw material from which brick and tile are made is siliceous in character, an investigation of the North Carolina industry has been made to evaluate the dust exposure of the workers in terms of hazards to health, particularly with respect to silicosis. Most of the medical and engineering data were collected over a twelve-month period, beginning in the summer of 1938.

II. Evaluation of Working Environment

In a study of this character, it is desirable to appraise, in terms of an average dust concentration, the exposure of the workers in each occupational classification, as such values permit a comparison of occupations with respect to the extent of the dust hazard and are useful in correlating medical and engineering data. The Greenburg-Smith impinger[5] was used to the collect 183 samples of atmospheric dust for particle counts in twenty-eight plants. These dust samples were collected during each of the four seasons under a variety of weather conditions and so distributed as to yield a

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[1] (a) R. R. Sayers and R. R. Jones, "Silicosis and Similar Dust Diseases," *U. S. Pub. Health Repts.*, 53 [33] 1453–72 (1938); p. 1456; *Ceram. Abs.*, 18 [1] 40 (1939).

(b) L. U. Gardner, "Inhaled Silica and Its Effect on Normal and Tuberculous Lungs," *Jour. Amer. Med. Assn.*, 103 [9] 743–48 (1934).

[2] W. C. Dreesen, J. M. Dalla Valle, T. I. Edwards, J. W. Miller, R. R. Sayers, H. F. Easom, and M. F. Trice, "Study of Asbestosis in the Asbestos Textile Industry," *U. S. Pub. Health Bull.*, No. 241 (Washington, D. C., 1938).

[3] W. C. Dreesen and J. M. Dalla Valle, "Effects of Exposure to Dust in Two Georgia Talc Mills and Mines," *U. S. Public Health Repts.*, 50, 131–43 (1935); Reprint No. 1669.

[4] W. C. Dreesen, J. M. Dalla Valle, T. I. Edwards, R. R. Sayers, H. F. Easom, and M. F. Trice, "Pneumoconiosis Among Mica and Pegmatite Workers," *U. S. Pub. Health Bull.*, No. 250 (Washington, D. C., 1940).

[5] Leonard Greenburg and J. J. Bloomfield, "Impinger Dust Sampling Apparatus as Used by U. S. Public Health Service," *U. S. Pub. Health Repts.*, 47, 654–75 (1932); Reprint No. 1528.

representative evaluation of the atmospheric dust conditions in the industry. The importance of an occupation, insofar as it concerns the distribution of dust samples, was based on the number of men involved and the apparent dustiness of the job. A proportionately greater number of samples was thus collected to evaluate the exposure of a screen attendant than that of a hacker because the screen attendants in most plants are exposed to much more dust than the hackers.

(1) Dust Exposure by Occupational Classification

Inasmuch as the manufacture of brick at some plants is performed under virtually outdoor conditions, all dust counts were classified according to the type of building in which they were collected, that is, "closed" or "open." Average values were computed, after this segregation, for each occupation for both types of buildings. Whenever the two results obtained checked closely, they were combined, and the one value was employed for the occupation in both types of plants. One dust-exposure value thus serves for all hackers. The dust counts for open- and closed-type plants were further classified according to raw material employed. As the values obtained for both the clay and the shale plants were almost identical, the results were discarded. The calculated average dust exposures of the workers by occupational classification (expressed in millions of particles of dust per cu. ft. of air) are shown in Table I.

(2) Character of Dust

Because free silica or quartz is a toxic mineral insofar as pulmonary pathology is concerned, it is desirable to know the amount contained in the atmospheric dust to which the workmen are exposed. Samples for petrographic analysis accordingly were obtained directly from the atmosphere with an electrically driven, hand vacuum cleaner suspended at the breathing level and operated intermittently for a period of several days. Inasmuch as only one such sampling device was available (and it was out of commission for a while), several samples of settled dust were collected from structural members. Four samples of atmospheric dust and three samples of settled dust were examined petrographically for quartz content, the results of which are presented in Table II. No two of these samples were collected in the same plant. Although both of the clay samples contain more quartz than the shale samples, they represent settled dust, which may account for their higher quartz content. An analysis of samples by particle-size fractions is frequently made to determine the quartz content of the respirable sizes. The brick plant dusts, however, were not so meticulously analyzed. West

TABLE I

AVERAGE DUST EXPOSURE OF WORKERS BY OCCUPATIONAL CLASSIFICATION

	No. samples considered	Dust exposures (millions/cu. ft.) Max.	Min.	Avg.
Hoistman (inclosed and preparation machinery)	11	26.0	9.4	19.0
" (open " " ")	10	6.0	1.0	3.0
Clay storage bin	4	5.0	1.0	3.0
" " " (inclosed)	1			71.0
Crusher (rolls and disintegrator attendant, root boy)				
Inclosed (no bats)	4	45.0	3.0	21.
" (bats)	*	227.0		33.0
Open (no bats)	5	14.0	2.0	7.0
" (bats)	*	227.0		19.0
Screen attendant, inclosed	11	166.0	14.0	69.0
" " inclosed, full bin	2	6.0	2.0	4.0
" " open	2	2.0	2.0	2.0
Dry pan operator, closed (material dry)	3*	162.0	3.0	44.0
" " " " (" damp)	3*	22.0	3.0	8.0
" " " salvage	2*	816.0	11.9	112.0
" " " open	2	11.0	8.0	10.0
Pug-mill operator				
Preparation-machinery exposure	10	88.0	21.0	51.0
Isolated from preparation machinery	5	18.0	9.0	10.0
Brick machine	3	10.0	7.0	9.0
Open mill discharge	2	184.0	89.0	137.0
Hackers	25	52.0	1.0	13.0
Transfer, upper	3	16.0	16.0	16.0
" lower	3	8.0	1.0	4.0
" " (car rackers)	2	6.0	4.0	3.0
Kiln workers, downdraft	41	57.0	4.0	17.0
" " updraft	5	17.0	9.0	12.0
Kiln cleaning	5	274.0†	69.0	138.0
Pipe manufacturing, pipe feeder (isolated)	1			14.0
" " pressman	3	39.0	5.0	25.0
" " special shapes	1			5.0
Pipe drying floor	4	92.0	8.0	33.0
Cleanup man	4	51.0	13.0	28.0

* Weighed average. † Cleaning kiln eyes.

NOTE: "Inclosed and preparation machinery" means a closed type of building in which workers are exposed to dust created by this machinery. Dried or fired bats when ground produce much dust; "no bats" and "bats" indicate, respectively, the absence or involvement of such material.

Virginia authorities[6] report that the finer fractions of air-borne dust in brick and tile plants contain less quartz than the raw materials from which the dust originates. They estimate that the quartz content of air-borne dusts varies from 3 to 10%.

Table II

Quartz Content of Samples of Atmospheric and Settled Dust Obtained in N. C. Brick and Tile Plants

Identification	Quartz content (%)
Settled dust (clay)	25
Atmospheric dust (shale)	10
" " "	10
" " "	15
" " "	15
Settled dust (clay and shale)	13
" " (clay)	20

Greaves-Walker and his co-workers[7] report that quartz is abundant in all samples of clay and shale deposits of North Carolina.

III. Cumulative Dust Exposure of Workers

In an evaluation of an occupational disease hazard, the medical data are usually correlated with the total dust exposure of the workers as well as with their total lengths of service. As the amount of dust to which the men are exposed varies with the occupation, the total dust exposures of the workmen are of more value than their lengths of service in years. Some jobs expose the men to little dust; others to appreciable amounts of dust, as shown in Table I. To compare workmen on the basis of their total dust exposure, a million-particle year dust index[8] is used, which is obtained by multiplying the average yearly dust exposure of an occupation by the total number of years spent therein. A man exposed to an average of ten million particles of dust per cu. ft. of air in ten years would therefore build up a cumulative exposure of 100 million particle years of dust. When more than one occupation is involved, the cumulative exposure for each is calculated and a total exposure computed by adding together the individual occupational exposures.

A distribution of the workers according to arbitrarily selected cumulative dust-exposure classifications is presented in Table III.

Virtually 80% of the routine workers have accumulated less than 150 million particle years of dust, which is not an excessive exposure. This conclusion may be examined on the basis of the free silica (or quartz) content of the dust. It is generally accepted that five million particles of quartz (of respirable size) per cu. ft. of air is the maximum concentration that may be tolerated with safety. The brick plant workers are exposed to dusts, the quartz (or free silica) content of which varies from 10 to 25% (Table II). If the maximum concentration of 25% of free silica is employed for illustration, then a concentration of twenty million particles of such dust per cu. ft. of air would contain five million particles of quartz, which is the maximum amount that may be tolerated with safety. Assuming that forty years constitute a normal lifetime, a person could theoretically build up a cumulative exposure of 800 million particle years of such dust without incurring a serious risk to health. Thus 800 million particle years become a kind of yardstick by which the cumulative dust exposures of the workers may be gauged. Only twenty routine workers (see Table III) have built up a cumulative exposure of more than 500 million particle years of dust, which is only a little more than one half of the 800 million-particle-year yardstick at which some evidence of dust pathology might be expected. This hypothetical "threshold" limit is based on the dust sample with the maximum quartz content, which is undoubtedly much higher than that of the average atmospheric dusts to which the workers are exposed. Thus, instead of the total "threshold" dust exposure being 800 million particle years of dust, it is probably at least double that figure, as the quartz content of the air-borne dust samples (Table II) averages only 12.5%, or one half of the figure used. One worker only has built up a cumulative exposure of more than 1600 million particle years. The length of exposure, in years, of the employees reveals that almost one half of the routine workers examined have been in the industry more than ten years. After so long a period of service, however, their cumulative dust exposures are only a fraction of the theoretical "threshold" computed as a yardstick by which to examine the total dust exposure of the workmen. These assumptions and computations, therefore, indicate that the siliceous dust hazard is not acute in the North Carolina brick and tile industry.

IV. Medical Examinations

Medical examinations, including an X-ray film of the chest, were given to 1755 employees and prospective employees in twenty-eight plants, which were not identical in every instance with those in which dust samples were collected. The clinical and X-ray examinations were made on the premises of the respective companies in the cruising X-ray trailer of the North Carolina Division of Industrial Hygiene.[9] The medical examination given to the workers was thorough, especial emphasis being placed on the heart and lungs. Blood specimens for the Wassermann and Kline tests for syphilis were obtained from a large number of the persons examined. A complete medical and occupational history was also obtained in every instance.[10]

[6] "Preliminary Report of Study in Brick and Tile Industry in W. Va.," Bureau of Industrial Hygiene, W. Va. State Health Dept., Charleston, W. Va., 1939.

[7] A. F. Greaves-Walker, N. H. Stolte, and W. L. Fabianic, "Occurrence, Properties, and Uses of Commercial Clays and Shales of N. C.," *N. C. State Coll. Agr. & Eng. Expt. Sta. Bull.*, No. 6, 74 pp. (1934); *Ceram. Abs.*, 15 [3] 105 (1936).

[8] J. M. Dalla Valle, "Significance of Dust Counts," *U. S. Pub. Health Repts.*, 54, 1095–1104 (1939); Reprint No. 2083.

[9] C. R. Matheson and M. F. Trice, "North Carolina's Mobile X-Ray Laboratory," *Jour. Ind. Med.*, 7, 327–30 (1938).

[10] M. F. Trice, "Pre-Employment Examinations and Related Activities of N. C. Div. of Industrial Hygiene," *ibid.*, 9, 188–93 (April, 1940); *Ceram. Abs.*, 19 [11] 272 (1940).

TABLE III

DISTRIBUTION OF WORKMEN BY ARBITRARY TOTAL DUST-EXPOSURE CLASSIFICATIONS

Total exposure (m.p.y.)*	Total employees	Pre-employment (No.)	Pre-employment (%)	Routine (No.)	Routine (%)	Rejected (No.)
Negative	374	301	60.7	71	6.7	2
Less than 25	356	166	33.5	189	17.9	1
25– 50	236	23	4.6	213	20.2	
50–100	229	5	1.0	224	21.3	
100–150	140			140	13.3	
150–200	85			83	7.9	2
200–300	79			77	7.3	2
300–400	22			21	2.1	1
400–500	13			13	1.3	
500 and over	21	1	0.2	20	2.0	
TOTAL	1555	496	100.0	1051	100.0	8

* Million particle years.

TABLE IV

PERCENTAGE OF BRICK AND TILE WORKERS EXAMINED HAVING TUBERCULOSIS CONTACTS, PAST RESPIRATORY ILLNESSES, AND OTHER MEDICAL FINDINGS IN EACH GROUP SPECIFIED

Past medical finding	Men examined (%) Pre-employment	Routine
Family history of tuberculosis	1.6	1.9
Exposure to tuberculosis	1.2	1.1
Pleurisy	2.8	4.3
Hemoptysis (blood-streaked sputum)	1.4	0.9
Pneumonia	8.3	9.2
Influenza	20.8	15.8
Colds (few reported)	87.5	80.0
Colds (more in recent years)	2.6	3.1
Other respiratory diseases	29.4	27.0
Clubbed or bowed extremities	8.9	12.0
Diaphragm (normal)	92.0	89.0
Diaphragm (angles shallow)	4.4	5.2
Childhood tuberculosis	6.7	7.5
Childhood and adult tuberculosis	0.2	0.2
Pulmonary tuberculosis (activity (?) or arrested)	1.0	1.0

The examination of the workers in brick and tile plants was expected to reveal the existence of pulmonary pathology that could be attributed to the inhalation of dust. When the complete absence of such pathology was reported, it was decided to analyze all of the medical data carefully to determine whether some effect of dust inhalation might be revealed by higher incidences of the more commonplace respiratory disorders. All data therefore were coded on punch cards and analyzed on International Business Machines tabulating equipment. The more important results of this analysis, except the heart findings, are presented in Table IV. There is no appreciable difference in the incidence of the various findings for the pre-employment and routine workers, indicating that exposure to brick plant dust has produced no demonstrable effect on the health of the workers. Inasmuch as all pre-employment and routine workers alike are from the same economic level, the former serve as a satisfactory control group with which to compare the latter. The group of men examined were in an unusually excellent state of health, except eight men who were rejected for employment, one of whom had tuberculosis questionable, four questionably active, and three definitely active tuberculosis. Seven of the persons rejected were routine workers; the other was a pre-employment case.

TABLE V

NUMBER AND PERCENTAGE OF PRE-EMPLOYMENT AND ROUTINE WORKERS, CLASSIFIED BY RACE, REACTING POSITIVELY TO WASSERMANN AND KLINE TESTS FOR SYPHILIS

	Pre-employment				Routine			
	White		Colored		White		Colored	
	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)
Wassermann								
Negative	62	91.0	69	52.2	53	93.0	161	43.6
Doubtful	1	1.5	11	8.4	1	1.8	31	8.4
Positive	3	4.5	52	39.4	3	5.2	177	48.0
Not done	115*		182*		227*		398*	
TOTAL	181		314		284		767	
Kline								
Negative	94	91.3	157	71.0	221	93.5	382	58.5
Doubtful	6	5.8	15	6.7	8	3.5	72	11.0
Positive	3	2.9	49	22.3	7	3.0	200	30.5
Not done	78*		93*		48*		113*	
TOTAL	181		314		284		767	

* Not considered in calculating percentages.

V. Medical Findings

The X-ray films of the 1555 workers were read separately and apart by two physicians, both of whom reported that there was no evidence in any of them of silicosis or any other pulmonary condition that could be attributed to dust.

VI. Venereal Disease

In view of the nation-wide campaign to eradicate venereal diseases, the medical findings relating to this scourge are presented in Table V. The incidence of syphilis is much higher among the colored workers. Among those whose blood was subjected to the Wassermann test, 48% of the routine colored workers reacted positively as against 5.2% of the routine white workers. Results of reactions to the Kline test were 30.5% against 3.0%; about the same ratio holds for the pre-employment cases.

VII. Conclusions

The total absence of silicosis and other serious pulmonary pathology and the low incidence of other respiratory diseases among 1555 brick and tile plant workers indicate that exposure to dust in the North Carolina industry does not constitute a serious menace to health.

Division of Industrial Hygiene
North Carolina State Board of Health
Raleigh, North Carolina

CERAMIC HISTORY

WALTER JODOK KOHLER*

Let me die, working.
Still tackling plans unfinished, tasks undone!
Clear to its end, swift may my race be run.
No laggard steps, no faltering, no shirking;
Let me die, working.

Walter J. Kohler, Chairman of the Board of Directors of Kohler Company, spent a busy day at his office, Saturday, April 20, 1940, working until near seven o'clock in the evening with the vigor and zest which always characterized him. Much of the morning was given to correspondence, study of operating reports, and presiding toward noon at a meeting of the executive committee. Afternoon brought a long conference with company engineers regarding a projected new factory building and its equipment.

On Sunday, the members of the organization, the people of the village, and thousands of friends were inexpressibly shocked to learn that he had been stricken that morning with a fatal attack of coronary embolism.

The verses above, by S. Hall Young, dated 1933, which he clipped and saved, had been prophetic.

Boyhood and Early Responsibilities

Walter Jodok Kohler was born March 3, 1875, in Sheboygan, Wisconsin, the son of John Michael and Lillie Vollrath Kohler. His mother died on March 2, 1883, the day before his eighth birthday. On November 3, 1887, his father married Minnie Vollrath, his mother's sister. Walter was devoted to her through the years, and her photograph was on his office desk at the time of his passing.

He was the third of a family of four sons and three daughters.

Family ties and traditions were ever a dominating interest and influence in his life, and his middle name Jodok, long in the Kohler family, is reminiscent of the Bregenzerwald (Forest of Bregenz), near Lake Constance in Austria, where the Kohlers had dwelt, according to church records, since 1624.

Thence John Michael Kohler came as a boy of ten with his father and the immediate family to America, where they settled on a farm near St. Paul, Minnesota. Reaching manhood, he worked for a time in Chicago. After the great fire, he went to Sheboygan, Wisconsin, where he married. There, in 1873, he established a manufacturing business which the family has continued ever since.

Walter Kohler was baptized into the Episcopal church, with which he continued affiliation throughout his life. He also belonged to the Blue Lodge of the Masonic Order.

His formal education was obtained in the Sheboygan public schools. At fifteen, he decided that he wanted to go into his father's business. He followed a natural urge. In the factory, he put in long hours at man's labor before the enameling furnaces and in the foundry, receiving a wage of about $1.25 a day. He became a foreman at eighteen and factory superintendent at twenty-five.

In 1899, the factory was removed by his father, John Michael Kohler, to its present site, which was then in the open country.

The death of his father, one month after its removal and two days after Walter's wedding day in the fall of 1900, left three young brothers, Robert, Walter, and Carl, to cope with difficulties which, a few months later, became more formidable with the total destruction of the new plant by fire.

They returned to the old plant in Sheboygan and continued business. Triumphing over the problems of financing, planning, construction, and equipment, they rebuilt the plant, reopening it one year later on the anniversary of the fire.

By the untimely passing of the two brothers who had been associated with him, Walter Kohler was left in 1905 the responsible head of the business. A series of calamitous events had precipitated him, at the early age of thirty, into the presidency of the company, a position which he held until 1937 when, becoming Chairman of the Board, he was succeeded as President by his youngest brother, Herbert V. Kohler.

Among Mr. Kohler's many civic activities, his keenest

* From *Kohler News*, 24 [5] (May, 1940).