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THE CONTROL OF DUST DISEASE IN THE BRITISH CERAMIC INDUSTRY

E. POSNER

Birmingham Regional Hospital Board, Mass Radiography and Routine Chest X-Ray Centre, Central Out-patients Department, Hartshill, Stoke-on-Trent, England

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The British ceramic industry has always been concentrated in a small area of Staffordshire. Because of the widespread use of flint (almost 100% free silicic acid) for kiln placing and as a component of most ceramic articles, silicosis has been a serious health problem for about 300 years. The paper deals with the trends of silicosis morbidity since the reconstruction of the industry which began at the end of the last war. In only a few processes hazardous materials have been substituted by harmless ones (for instance flint by alumina in the placing of bone china). Most efforts have been concentrated on the improvement of local dust control and general workshop hygiene. In recent years it was found that the traditional so-called protective clothing of ceramic workers constituted itself a definite hazard and has now been replaced by materials made of dust-repelling man-made fibres.

Modified routine mass radiography has proved a valuable tool for assessing the incidence of dust disease in ceramic workers and the analysis of its records suggests that only a small proportion of workers acquired pneumoconiosis during the past 15 years. Although manufacture of flint-containing articles must be considered the most hazardous risk, it is shown that pneumoconiosis occurs to a significant extent in the manufacture of fine china which does not contain any flint.

In recent years the most impressive facet of pneumoconiosis statistics has been the rapidly declining rate of progressive massive fibrosis.

In Great Britain category 1 simple pneumoconiosis (according to the I. L. O. classification) is generally and not considered to be a »disease process« but its importance as a biological index of undue dust exposure is stressed.

During the Industrial Revolution the abundance of coal and the cheapness of female labour made the English Midlands the seat of the British Ceramic Industry which has remained concentrated in a small area commonly called »The Potteries«. For more than 100 years this area was notorious for its high incidence of pthisis and for what used to be called non-specific chronic respiratory disease, in other words of pneumoconiosis and bronchitis. For the past 30 years or so the ceramic industry was been subject to a number of investigations and official reports

but it seems necessary to stress that – unlike the British Coalmining Industry – ceramic manufacture has not yet had the benefit of a planned longitudinal survey. This is now being prepared but the evidence which is shown in this paper is derived from a number of independent sources. It is therefore only circumstantial evidence which shows a large degree of concordance.

This paper brings up to date the information shown at two symposia concerned with pneumoconiosis in the ceramic industry. (Department of Scientific and Industrial Research 1963, British Ceramic Research Ass. 1961).

Table 1 underlines the important fact of continuous contraction of the industry caused by modernisation, mechanisation and amalgamation of factories.

Table 1

Number of workers employed in North Staffordshire pottery industry

1949	55,000
1956	48,000
1959	45,000
1961	44,000
1963	41,000
1967	38,000

Office workers not included.

Table 2 shows that although workers are still employed in small or medium sized factories, the hard facts of contemporary technology and economy affected mostly the smaller works.

Of the approximately 30,000 pottery workers at present employed in North Staffordshire only about 50% are exposed to mineral dusts. The population at risk is therefore about 19,000 of whom more than half are women.

For well known reasons so-called »certification« figures and rates, or in other words the number of persons who are annually awarded a disability pension by the State Pneumoconiosis Panels, are not a reliable index of true morbidity and even less of attack rates. They are, however, a useful although inaccurate yardstick, especially at times when the official connotation of pneumoconiosis remains unchanged as it did in Great Britain between 1951 and 1968.

Table 3 shows the number of cases allegedly caused by work in ceramic factories and awarded a disability pension between 1951 and 1966. The very steep decline is obvious. The »pottery figures« are compared with those of asbestosis, a striking example of the impact not only of the wider use of asbestos but of the newly awakened awareness of a comparatively new industrial disease. In 1966 four times as many cases of asbestosis were diagnosed by the Pneumoconiosis Panels than cases thought to be caused by work in ceramic factories.

Table 2

Size and structure of North Staffordshire ceramic industry

Branh of industry	1957 Size group										1967 Size group									
	< 100		101–500		501–1,000		> 1,000		Total		< 100		101–500		501–1,000		> 1,000		Total	
	F.	W.	F.	W.	F.	W.	F.	W.	F.	W.	F.	W.	F.	W.	F.	W.	F.	W.	F.	W.
Mills	30	656	1	163	—	—	—	—	31	819	34	809	1	130	—	—	—	—	35	939
General earthenware	42	1,739	61	15,227	8	5,211	—	—	111	22,177	27	620	51	12,607	9	5,209	—	—	87	18,436
China	17	668	26	5,402	1	693	—	—	44	6,763	12	426	18	3,649	2	1,212	—	—	32	5,287
Tiles	18	874	19	3,557	3	2,145	—	—	40	6,576	7	282	10	2,120	1	502	1	1,113	19	4,017
Electrical porcelain	1	61	9	2,441	2	1,612	—	—	12	4,114	3	213	7	1,466	1	874	—	—	11	2,553
Sanit. earthenware	3	236	5	1,520	—	—	—	—	8	1,756	1	76	4	987	—	—	—	—	5	1,063
Sanitary fireclay	—	—	3	625	—	—	—	—	3	625	—	—	4	653	—	—	—	—	4	653
Mixed production	—	—	3	754	1	817	2	2954	6	4,525	1	24	—	—	1	683	2	3,202	4	3,909
Decorating & kiln furniture	42	659	1	170	—	—	—	—	43	829	32	498	4	730	—	—	—	—	36	1,228
Total:	153	4,893	128	29,859	15	10,478	2	2954	298	48,184	117	2,948	99	22,342	14	8,480	3	4,315	233	38,085

F: Number of factories
W: Number of workers

The qualifying words »thought to be« are important because a rigorous analysis of the occupational histories of the pottery workers shown in the reports of the Ministry of Social Security (1952–1966) revealed that not less than one third of the men may well have acquired pneumoconiosis during preceding or interpolated employment in coal mines or foundries. (Ministry of Labour, 1963, Reports of Joint Standing Committee for the Pottery Industry, 1962–1966). Taking this into account the rapid decline of pensionable cases since 1956 is very impressive and is unlikely to be due only to the statistical inaccuracies and fallacies of »certification figures«.

Furthermore the concentration of the ceramic industry in such a small area made it an ideal target for comprehensive and repeated mass radiography surveys, four of which have now been held and analysed since

Table 3

Industrial injuries act.
Cases of pneumoconiosis in »pottery workers« and cases of asbestosis diagnosed by pneumoconiosis panels of Great Britain 1951–1966

	Pottery industry	Asbestosis
1951–1953	638	55
1954–1956	1,025	110
1957–1959	579	110
1960–1962	217	124
1963–1965	203	214
1966	27	114
Total:	2,689	827

1953. It is generally agreed that the very steep rise of pensionable cases between 1954 and 1956 was largely due to these surveys which brought to light a vast number of previously undiagnosed or misdiagnosed cases of pneumoconiosis.

Table 3 shows the situation in the industry as a whole but we are dealing with a highly diversified industry in which the number of various products are matched by a variety of risks. A statistical breakdown into specific sections and occupations is therefore of paramount importance to establish a system of priority with regard to prevention. Before doing this it will be useful to note the chemical composition of the main products manufactured in North Staffordshire. This is shown on Table 4.

All earthenware products contain a high proportion of flint or quarts – consisting almost entirely of free silica – and only in the local speciality, English Bone China these minerals are replaced by finely ground animal bones. It should be noted however that the so-called »Cornish Stone« a

felsparic mineral contains 30–35% free silica and small amounts of silicic acids are also found in Ball and China Clays. (Ministry of Labour, 1959).

Table 4

Composition of earthenware, bone china and vitreous china

I. General earthenware, Sanitary earthenware, Earthenware tiles.	II. Vitreous china	III. Bone china
Ball clays 22–28% China clay 22–28% Flint 32–40% Cornish stone 13–18%	Ball clays 20–28% China clays 20–28% Flint or quartz 30–35% Felspar or Nepheline Syenite, 18–24%	Bone 45–52% Cornish stone 24–32% China clay 17–26%

Table 5 gives the aggregate figures over a period of 16 years of those workers who had a straightforward occupational history. The large majority of these cases came to light before 1959.

Table 5

Industrial injuries act.
»New« cases diagnosed by pneumoconiosis panel, Stoke-o-Trent, 1950–1965.
Biscuit placing and clay shops

		Men	Women	Total
Biscuit placing	Earthenware	41	1	42
	China	38	1	39
	Others	41	1	42
Clay shops	Earthenware	219	365	584
	China	66	21	87
	Sanitary earthenware	121	—	121
	Sanitary fireclay	11	—	11
	Tile pressers	13	112	125
	Electrical porcelan	13	14	27

With regard to kiln firing and placing, the analysis shows that the hazard from placing existed not only in the china section where until the 1930's finely powdered flint was used as a placing medium, but also in the earthenware industries where quartz sand has been used for the same purpose.

The large number of female cases originating in the clay shops reflects the large female Labour Force in the tile-making and potters shops. Tile making and fettling because of the very dry state of the materials used, was a particularly hazardous occupation in pre-war years. It is therefore noteworthy that of the 125 cases shown on Table 5 only 17 were diagnosed during the past 6 years. The corresponding figure for earthenware clay worker was 113 out of 584.

As already mentioned, flint is not part of the materials used for making china and the considerable number of cases originating in china potters' shops is therefore of considerable interest. This type of work was always considered to be »safe« and even today china potters are exempt from the statutory periodical examinations by members of the Pneumoconiosis Panels. It was thought that cases of pneumoconiosis in china potters shops were due to contamination by flint brought in from the placing departments.

The first comprehensive mass radiography survey of the china industry showed however that certain workers, such as throwers and turners had a much higher prevalence of pneumoconiosis than other workers in the china clay shops, a sure sign that this was due to process – rather than to background dust. (Posner 1961, 1963). Similarly cases of pneumoconiosis have always been found in the preparing departments or sliphouses of the china industry where large amounts of felspar are handled in the dry stage. (Ministry of Labour 1963).

The real magnitude of the pneumoconiosis problem in the British ceramic industry became known only after the inception of routine mass radiography in Stoke-on-Trent in 1953. Although based on voluntary attendance, they reached a far larger proportion of the working population than any previous surveys (Table 6), especially in their early stages. The gradual decline in the attendance since 1959 was clearly due to the reluctance of many workers who had been diagnosed on earlier occasions and were now attending clinics and the Pneumoconiosis Panel, to attend for yet another chest X-ray. An early analysis also showed that the response varied little with age and occupation. (Posner, 1955). By insisting on precise occupational histories at the time of X-ray we were able to exclude from our statistics those men who had clearly acquired pneumoconiosis in other industries.

On the other hand it cannot be said that routine mass radiography as practised in the United Kingdom is the ideal way of finding early pneumoconiosis. The 35 mm film, which was originally used is most certainly unsuitable for identifying category 1, according to the International Classification. (International Labour Office, 1959). This should be remembered when looking at the righthand side of Table 6 with the surprisingly slight decline in newly found cases between the 2nd and 3rd survey which was almost certainly due to a change in radiographic technique.

In 1959 we replaced the 35 mm film by 70 and 100 mm films as the basic medium from which recalls for full sized films were selected. As a result of this the proportion of cases with X-rays classified as category 1 simple pneumoconiosis rose from 18% to 51% of the total.

Table 6

Respense at four successive mass radiography surveys and number of cases of pneumoconiosis detected (previously known cases excluded)

	Employed	X-rayed	Response	Pneumoconiosis (All categories)
1952–1954	55,000	40,900	74%	872
1955–1958	48,000	38,000	79%	492
1959–1962	44,000	31,200	71%	430
1963–1966	39,000	26,600	68%	261

At this point it may be asked whether the identification of category 1 simple pneumoconiosis, which is rightly or wrongly usually not regarded as a disabling disease process is really important. This is of course so: these early stages are an important epidemiological index as is the proportion of unvaccinated tuberculin-positive children in communities with a low incidence of active tuberculosis.

Table 7

Pneumoconiosis first identified at four successive mass radiography surveys in North Staffordshire pottery industry, according to branches of industry

Branch	1952–1958			1959–1966		
	Simple pn.	P. M. F.	Total	Simple pn.	P. M. F.	Total
Mills & colour works	43	13	56	16	4	20
General earthenware & mixed factories	632	141	773	449	28	477
China	180	40	220	66	4	70
Tiles	96	20	116	37	1	38
Electrical porcelain	79	27	106	59	3	62
Sanitary ware	77	16	93	18	6	24
Total:	1,107	257	1,364	645	46	691

Table 7 shows the marked decline of newly detected cases during the later surveys according to main branches of the industry. It will be seen that the proportional fall in cases of Progressive Massive Fibrosis was

much greater than that of simple pneumoconiosis, especially in the china, tile and electrical porcelain sections. This *prima facie* most encouraging fact, will of course, meet with the valid objection that workers with P. M. F. – the more disabling form of pneumoconiosis – are more likely to have left the industry or have died than those with simple pneumoconiosis only. On the other hand we also found that the proportion of P. M. F. in ex potters, many of whom attended for X-ray during the periods of our factory surveys, fell from 33% during the years 1952–1958 to only 14% between 1959 and 1966.

The very marked fall of newly detected cases in the china section was almost entirely due to the diminishing return of new cases amongst china placers and women who brush the bedding material from the ware after first or »biscuit« firing. In prewar days these workers suffered from the highest incidence of silicosis in pottery operatives because of the use of finely powdered flint as a placing medium, a material which at the high firing temperatures converted to the even more fibrogenic isomers of Crystobalite and Trydimite. In the 1930's alumina was substituted for flint in these processes and a number of radiological follow-up examinations showed a complete absence of radiologically manifest pneumoconiosis in those workers who had been exposed to alumina only. (Meiklejohn and Posner 1957, Posner & Kennedy 1967). Furthermore no impairment of respiratory function was found in workers who had been exposed to alumina dust, compared with a control series. If anything the evidence pointed the other way. (Posner & Kennedy 1967).

As already mentioned the mass radiography data does not lend itself for the calculation of attack rates. However it is possible to produce

Table 8

Mass radiography.
Persons with X-ray evidence of pneumoconiosis below the age of 40 years.
Detected 1959–1966.

	Cases below age of 40 years	Cat. 1		Cat. 2 & 3.		P. M. F.		Total	
		Started work before 1945	Started work after 1945	Before 1945	After 1945	Before 1945	After 1945	Before 1945	After 1945
Earthenware clay shops	35	17	9	6	3	—	—	23	12
China clay shops	7	1	2	2	2	—	—	3	4
Tile pressers	8	1	3	2	1	—	1	4	4
Sanitary casters	2	—	—	1	1	—	—	1	1
Total:	52	19	14	11	7	—	1	31	21

Ex-potters included.

some information about workers who during the later stages of these surveys were younger than 40 years, in other words about those who had spent the larger part, or in many cases the whole of their working life under post-war industrial conditions. The results on Table 8 suggest that the majority of these relatively young workers who contracted pneumoconiosis were subject to conditions prevailing before and during the last war.

The most striking result during the early stages of mass radiography surveys was the very high prevalence of pneumoconiosis and of active tuberculosis in female fettlers of dry unglazed earthenware (Fig. 1),

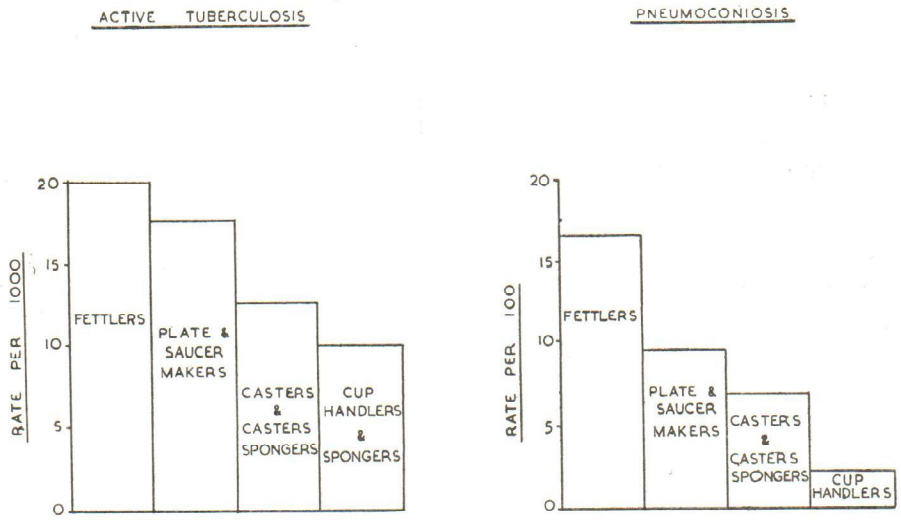

Fig. 1. *Active tuberculosis and pneumoconiosis in female earthenware fettlers, (towers) and other female pottery workers with more than 10 years occupational exposure.*

especially in so-called »towers« who use strings of tow, small knives and abrasive rags.

Table 9 suggests a very marked improvement of the situation, for reasons which will be discussed later.

Summarizing the radiological evidence shown in this paper it is perhaps permissible to say that the dreaded »Potters Rot« in the British Ceramic Industry is gradually being brought under control and has been eliminated from some working places. Only in one single instance has this been brought about by the substitution of a harmless for a hazardous raw material. Otherwise most of the credit must be given to the painstaking work of the scientists and technologists of the Factory Inspectorate and of the British Ceramic Research Association. A comprehensive review of these efforts and of methods of dust counts was given at this years »International Symposium on Health Conditions in the Ceramic

Industry« in Stoke-on-Trent (Bloor, 1968, Dinsdale 1968, Palmer 1968). Generally their work is based on a simple and pragmatic philosophy, namely that rather than relying on arbitrary »Maximum Allowable Con-

Table 9

Pneumoconiosis in 60 towers & ex-towers detected by mass radiography between 1959–1966. According to X-ray cotegory. All ages.

X-ray category	Started to work before 1952	Started to work after 1952	Total
1	36	2	38
2	18	2	20
3	5	—	5
PMF	3	—	3
Total	62	4	66

centration Values« the success or otherwise of dust control should be measured by these criteria:

1. The dust concentrations in the breathing zone of the operator should not be higher than those in the general atmosphere around him.
2. The concentrations should be as low as they could be expected by using the best available techniques.

I am not qualified to elaborate the technical and practical details which can be found in a number of recent publications (Ministry of Labour 1963, British Ceramic Research Association 1961, Dept. of Scientif., and Industrial Research 1963, Transactions of International Symposium, 1968) but the main principles are these:

1. The air flow must be so directed that the dust can be conveyed to the outside atmosphere without passing through the workers breathing zone.
2. The protective hood must be so designed that the minimum of air needs to be moved in order to give effective control.
3. The dust source must be enclosed as far as possible and a solid fixed barrier of glass or perspex must be installed between the operative's face and the source of dust.
4. The exhaust opening must be so positioned that the air flows across the front of the operators's body, thus avoiding turbulence and retention of dust in the vital area.
5. Day to day maintenance of all appliances must be rigorously enforced.

Fig. 2. *Fettler working with improved towing hood designed by British Ceramic Research Association.*

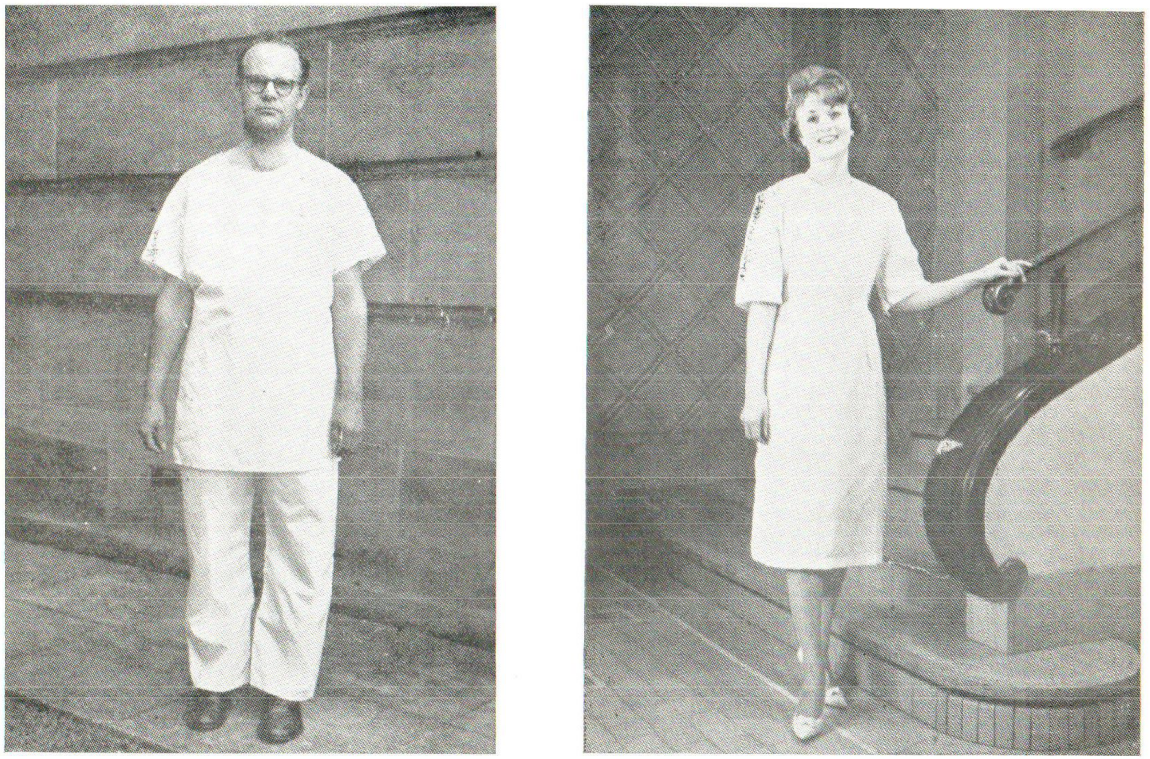

Fig. 3. *Front view of new protective overalls, made of terylene.*

In the case of the improved fettling hoods (Fig. 2) the results of these technological principles are clearly shown on Table 10. It also shows the marked reduction of spillage.

Table 10

Dust in towers' shops.
Particles per ccm. (respirable size)

Type of hood	Working level	Atmosphere	Spillage on floor (G per hour)
Old type	144–310	75–250	15
New type	28–43	22–40	Less than 0.5

Recently it has also been found that the traditional cotton overalls of pottery workers, far from providing adequate protection, constituted a hazard itself. (Bloor and Dinsdale 1962, Bloor 1968). The dust particles collected by the hairy cotton are released by the rapid movements of the operator and carried up into the breathing zone. After many trials and errors it emerged that artificial filament-terylene was a suitable substitute. Table 11 shows that these new garments which have also been

Table 11

Mean breathing zone dust concentrations (respirable size) for workers wearing cotton or terylene protective clothing

Classification of operative	Cotton	Terylene
Very careless	262	48
Careless	142	49
Clean	88	42

designed without dust-collecting front pockets or buttons (Fig. 3) benefited particularly the less careful workers.

Finally the large scale reconstruction of the North Staffordshire ceramic industry and the dramatic fall in the incidence of tuberculosis in the district must not be forgotten. The reasons for the continuing decline of pneumoconiosis in ceramic factories are certainly complex but it seems that the question by a Registar General of 100 years ago: »What can be done to save the pottery workers« has now become rhetorical.

ACKNOWLEDGEMENTS

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References

1. *Bloor, W. A.:* Assesment of Dust Conditions in: Transactions of International Symposium on Health Conditions in the Ceramic Industry, Pergamon Press, Oxford; in press.
2. *Bloor, W. A., Dinsdale, A.:* Brit. J. Indust. Med. *19* (1962) 229.
3. *British Ceramic Research Association:* Symposium on Dust Control in the Pottery Industry, Special Publication 27, 1961.
4. *Department of Scientific and Indust. Research:* Mineral Dust in Industry, London, H. M. S. O., 1963.
5. *Dinsdale A.:* Review of Progress, in: Transactions of International Symposium on Health Conditions in the Ceramic Industry, Pergamon Press, Oxford, In Press.
6. Joint Standing Committee for Pottery Industry (1962–1966). Unpublished reports.
7. International Labour Office: Occupt. Hlth. & Safety, 9 (1959) 2.
8. *Meiklejohn, A., Posner, E.:* Brit. J. Indust. Med., *14* (1957) 229.
9. Ministry of Labour: Industrial Health. A Survey of the Pottery Industry, London, H. M. S. A, 1959.
10. Ministry of Labour: Dust Control in Potteries, First Report of Joint Standing Committee for the Pottery Industry, London, H. M. S. O, 1963.
11. *Palmer, J. M.:* The Application of Dust Control, in: Transactions of International Symposium on Health Conditions in the Ceramic Industry, Pergamon Press, Oxford; in press.
12. *Posner, E.:* J. Indust. Nurses, 6 (1955) 183.
13. *Posner, E.*, in: Symposium on Dust Control in the Pottery Industry, Brit. Ceramic Research Association, Stoke-on-Trent, 1961.
14. *Posner, E.*, in: Mineral Dust in Industry, Dept. of Scientific and Industrial Health, London, H. M. S. O., 1963.
15. *Posner, E., Kennedy, M. C. S.:* Brit. J. Indust. Med., 24 (1967) 133.

Sadržaj

KONTROLA BOLESTI UZROKOVANIH UDISANJEM PRAŠINE U KERAMIČKOJ INDUSTRIJI U VELIKOJ BRITANIJI

U radu se prikazuju rezultati koji su postignuti u suzbijanju bolesti pluća uzrokovanih udisanjem prašine u industriji keramike i porculana u Engleskoj. Ta je industrija od davnine bila koncentrirana na malom području Staffordshirea. Zbog proširene upotrebe kremena (gotovo 100% slobodni silicijev dioksid) kao jedne od sirovina za proizvodnju većine proizvoda, kao i njegove primjene u fazi obrade nekih proizvoda (posipanje predmeta od »bone china« kremenom prije unošenja u peći), silikoza je predstavljala vrlo ozbiljan zdravstveni problem u toj industriji kroz gotovo 300 godina.

Ukazujući na izvanredan uspjeh koji je u rješavanju toga problema postignut od rata do danas, autor nas upoznaje s mjerama koje su u tu svrhu poduzimane. Zanimljivo je da je samo u nekim slučajevima izvršena zamjena štetnog materijala neškodljivim (npr. kremen je zamijenjen aluminijem pri obradi – pečenje proizvoda od »bone china«); najviše je napora uloženo u poboljšanje kontrole lokalnih izvora zaprašenja i unapređenje općih higijenskih prilika u radnoj okolini. U najnovije vrijeme uvedena su posebna radna odijela izrađena od plastične mase koja ne sakupljaju prašinu, jer se ustanovilo da su klasični platneni ogrtači predstavljali značajan izvor zaprašenja.

Autor ističe da se u kontroli bolesti uzrokovanih udisanjem prašine pokazala vrlo prikladnom modificirana metoda rutinske fluorografije. Podaci pokazuju da je za posljednjih 15 godina samo mali dio uposlenih obolio od pneumokonioze. Premda je, nema sumnje, najopasnija ekspozicija kremenu, pokazalo se da od pneumokonioze mogu

oboljeti i radnici koji rade u proizvodnji »china« porculana, gdje se kremen sada uopće ne upotrebljava. Svakako najznačajnija zdravstvena karakteristika zabilježena posljednjih godina u ovoj industriji jest naglo smanjenje broja pneumokonioza s progresivnom masivnom fibrozom.

Autor napominje da se u Vel. Britaniji jednostavni oblik pneumokonioze (prema klasifikaciji Međunarodnog biroa rada) još ne smatra oboljenjem. Međutim, to je važan biološki indeks aktuelne ekspozicije prašini.

Stoke-on-Trent,
Engleska

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