Ann. Occup. Hyg. Vol. 11, pp. 1–6. Pergamon Press 1968. Printed in Great Britain

THE METHOD USED BY THE U.S. PUBLIC HEALTH SERVICE FOR ENUMERATION OF ASBESTOS DUST ON MEMBRANE FILTERS

G. H. EDWARDS and J. R. LYNCH

U.S. Department of Health, Education, and Welfare, Public Health Service, Bureau of Disease Prevention and Environmental Control, National Center for Urban and Industrial Health, Occupational Health Program, 1014 Broadway, Cincinnati, Ohio

(*Received* 30 *May* 1967)

Abstract—Samples of air-borne mineral dusts are collected by drawing air through cellulose ester membrane filters. Particles smaller than nominal pore size are retained. Varying sampling rate and filter holder controls the distribution of dust across the filter face. Samples are mounted on standard microscope slides using a high viscosity solution of membrane filter material in a mixture of diethyl oxalate and dimethyl phthalate to render the filter transparent. The mount is stable for 28–30 days, but after this period migration of the dust particles causes a loss of areal concentration.

The grain and fiber dust particles, which lie on the surface of the filter, are counted with a phase contrast microscope, using 10X eye-pieces and a 4 mm "high-dry" objective. The field area is delineated with a Porton graticule. Count data are recorded in a form allowing data reduction and statistical analysis by electronic computer. The method, although not suitable to determine compliance with the threshold limit value for asbestos that was developed from a different enumeration method, is highly suited for developing basic data for a more precise recommendation of the limit for asbestos.

INTRODUCTION

IN THE early epidemiologic studies of the asbestos industry by FULTON (1935) and DREESEN (1938), the impinger was settled upon as the standard method for appraising dustiness. Since few fibers were seen it was necessary to count both grains and fibers to obtain a statistically useful count despite the assumption that asbestosis was caused by fibers. This inconsistency notwithstanding, dust control based on impinger results has considerably reduced asbestosis where it has been conscientiously applied in the asbestos textile industry. However, a number of investigators (LYNCH and SMITH, 1955; DOLL, 1955) have suggested other health hazards associated with asbestos, and a more relevant and sensitive method is required for estimation of the hazard, especially in industries using only part asbestos in their product.

A further weakness in the impinger method is that it is not amenable to long personal samples. It is believed that personal samples best approximate the worker's actual exposure, and ROACH (1966) has recommended a sample duration of 10 work shifts for mineral dusts.

New methods were therefore needed, and among those studied were grain and

To prepare a sample for microscopic examination, a drop of the mounting medium is placed on a freshly cleaned standard (25 mm × 75 mm) microscope slide, using a dropper or applicator. The volume of the drop is approximately 0·05 ml. A wedge-shaped piece about 1 cm × 2 cm is excised from the filter using a scalpel and forceps, and placed dust side up on the drop of mounting solution (Fig. 1). A #1½ coverslip carefully cleaned with lens tissue is placed over the filter wedge. Slight pressure on the coverslip achieves contact between it and the mounting medium.

Clearing of the filter with this method is slow, requiring about 15 min. The sample may be examined as soon as the mount is transparent.

The transition of the dust-supporting substrate from translucent solid membrane filter cellulose ester material to a transparent, optically homogeneous gel is very gentle, and at no time does a meniscus sweep across the dust deposit. Rather, the substrate slowly softens beneath the dust, and there is no opportunity for washing away or redistribution of the dust.

The optical homogenity of the resulting mount is nearly perfect, with only a slight background granularity under phase contrast, which disappears within 1 or 2 days.

STABILITY

Observers noted a reduction with time in apparent concentration for samples mounted with only dimethyl phthalate and diethyl oxalate. By observation, this loss was due to the migration of the dust particles outward from the center through the gelatinous material of the fixed mount, with a decrease in areal concentration. The cause of this migration was not determined but may be related to a disordering or distortion of the membrane filter polymer caused by partial solution. To determine the magnitude of this loss, a group of samples was mounted using 1:1 dimethyl phthalate and diethyl oxalate only, and counted at 1–3 day intervals for periods ranging up to 76 days. Counts were displayed as fractions in per cent of the original, or first day counts (Fig. 2). At the end of 1 week, samples mounted by this method yielded only 75 per cent of their original values. By 30 days after mounting,

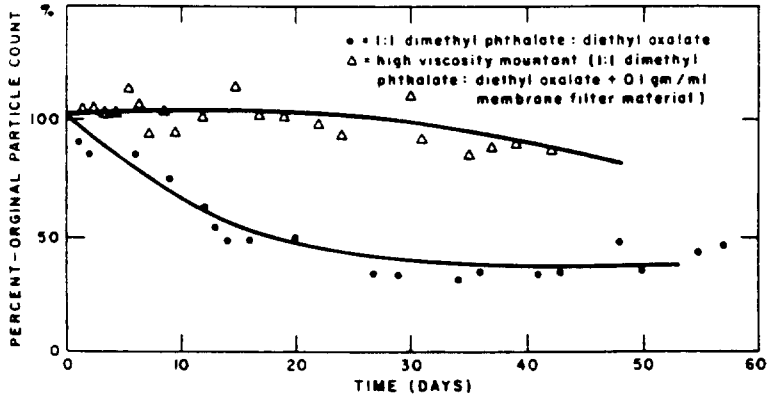

FIG. 2. Decrease in percentage of original particle count with time for the original 1:1 dimethyl phthalate–diethyl oxalate mixture and for the high viscosity mixture containing 0.1 g/ml of membrane filter material.

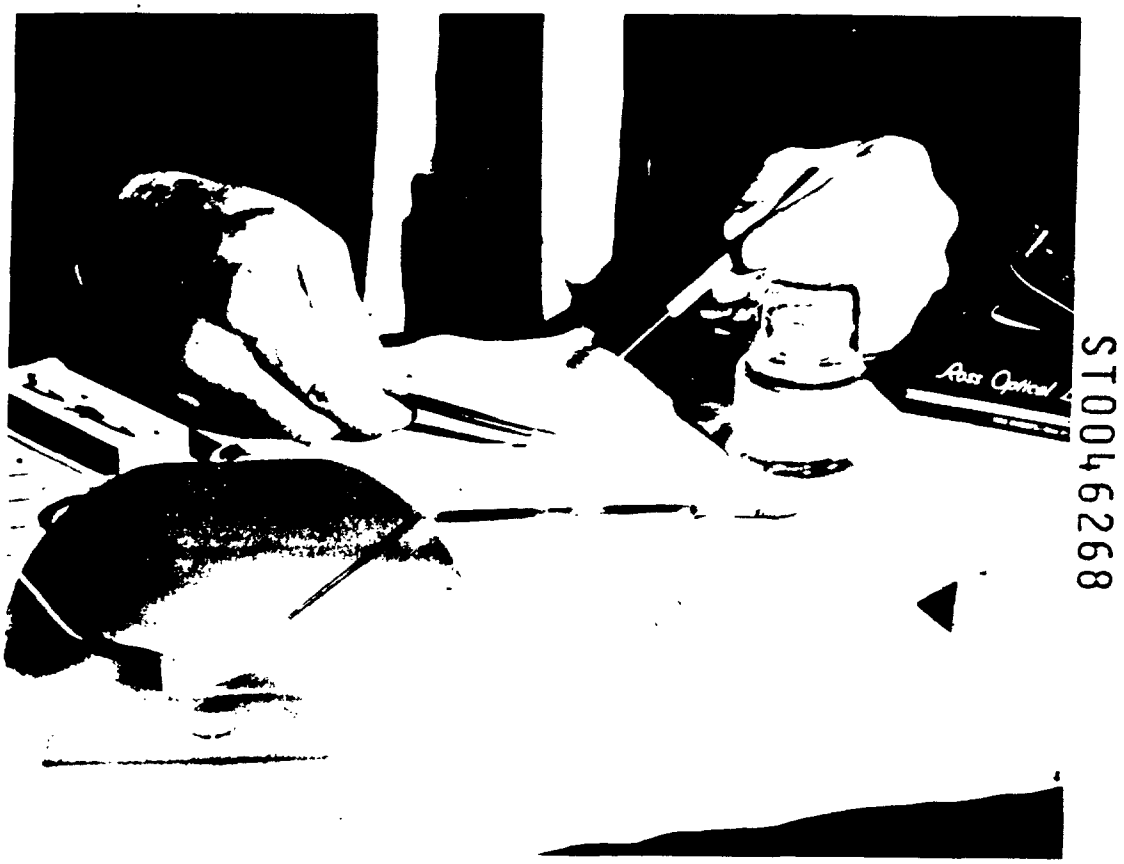

FIG. 1. The wedge-shaped piece of membrane filter is placed dust side up on a drop of mounting medium which has been applied to a standard microscope slide. The mount will be covered with a #1½ coverslip.

(*facing p.* 2

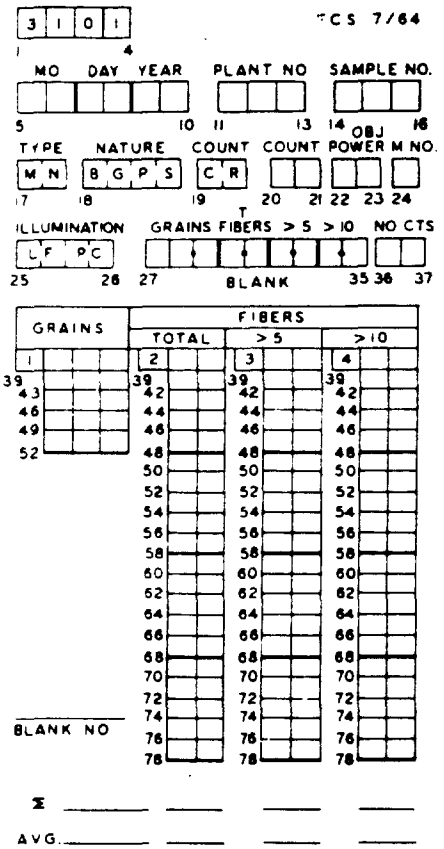

FIG. 3. Count tabulation form used for the evaluation of dust samples taken on membrane filters. *M* = Membrane filter, *U* = Elutriated membrane filter, *B* = Breathing zone sample, *G* = General sample, *P* = Personal sample, *S* = Sequential sample, *C* = Count (1st), *R* = Recount. *COUNT* provides for the technician's initials, *OBJ POWER* indicates the magnification, *M. NO* provides for the microscope number for calibration purposes, and *LF* and *PC* are light-field and phase contrast.

SUMMARY

A method for sampling and counting asbestos dust using membrane filters has been developed and evaluated. The mounting medium developed clears the filter gently so as to not redistribute the dust deposit, and produces a mount with adequate dimensional stability for a period of 30 days. This method has been used in developing environmental data in connection with the Public Health Service study of the asbestos products industry, and is recommended for research studies in other dusty trades although not for application to Threshold Limit Values. A system of data handling involving electronic computer processing, which is also applicable to other studies, was discussed.

3. Once all the insulation has been removed (at least 18 inches below each insulation support ring) the vessel should be scraped with foamglass to eliminate any remaining asbestos residue.

4. Apply a fine mist to the surrounding to further retard fiber release. Do Not Spray on Tower.
5. A final clearance sample should then be taken to determine the fiber count. If the results indicate the fiber count is at an acceptable level, below 0.1 f/cc, a hole will be cut in the poly to pass the disposal bags into the basket.
6. The basket should be lined with 6 mil polyethylene. The bags are placed in the basket and lowered to the ground by the 35 ton crane.
7. The bags are then to be placed in the asbestos disposal bin.
8. Any bags that have been punctured by the chicken wire will be placed in drums before being put into the disposal bin.
9. Remove the poly that made the enclosure and place it in disposal bags.
10. Wash off the plywood template and place at the next level.

III. MANPOWER

Each level should take four men approximately three days each to prep, abate, and clean-up. It should be noted that productivity should increase as the workers progress towards the lower levels. Thus the anticipated manpower and duration is an average per level.