test. A group of animals is exposed to each time interval concentration level point. After the animals have been observed for a month or six weeks after exposure a mortality table is established. The data are then plotted on log-log scale as used by SAYERS and YANT.[1] We have made one exception to this method. We plot two curves: one represents the lowest concentration level—shortest time interval where all animals die; the other representing the highest concentration level—longest time interval at which all animals survive. This chart gives a clear picture of the acute toxicity of the vapor studied.

Chronic Vapor Toxicity

SOME reasonable period of exposure had to be chosen in extended chronic studies. A period of eight hours exposure and an interval of 16 hours between exposures has been arbitrarily chosen. SMYTH and SMYTH[2] used the same interval. It has some reasonable basis in our standard work day. These eight hours per day exposures are continued with week end intervals of rest for a period up to six months. Occasionally a longer total than six months is used but this is our standard. There is no doubt that a different period of exposure or a different interval of rest between exposures would change the results profoundly. Studies of the effect of interval variation would be most illuminating when time permits. Several different species of animal should be tested in order to avoid the individual vagaries of any one species. We have, however, used the rat as preferable for a standard animal.

At intervals during the six months, exposed animals are removed for complete histological study and at the conclusion of any series of exposures all the remaining animals are so examined. Other important studies made during chronic exposures are blood examinations, tissue analysis, urine analysis, and function tests where such are indicated.

Such complete toxicological studies on the chronic vapor toxicity of even our common chemicals are few and far between. They are, however, the basis upon which the industrial hygienist and safety engineer must base his work. Nearly any material may be handled in industry without serious hazard if its properties including its physiological effect are clearly understood and intelligently used.

The procedures and apparatus just discussed are for the purpose of furnishing in so far as it is possible the toxicological data by which an intelligent engineer can design or control an industrial plant for the manufacture or use of essential chemicals with the minimum of hazard.

References:

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Air Sampling of Asbestos Dust

—*Comparison of Impinger and Electrostatic Precipitator Methods**—

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DURING the past 10 years the Industrial Health Section of the Metropolitan Life Insurance Company has been studying the effect of the inhalation of asbestos dust by employees in plants in the United States and the Province of Quebec engaged in mining asbestos fiber and manufacturing asbestos products.

In 1929, the American asbestos industry was practically uninformed of the health hazard associated with asbestos dust, although a few British articles had been published describing cases of asbestosis contracted in English plants. In 1927, Cooke and Hill[1] and McDonald[2] gave the first detailed description of what are known as "asbestosis bodies." Asbestos fibers as long as 360 microns were described as occurring in the lung tissue of asbestos workers.

We, therefore, made an effort to distinguish asbestos fibers in our collected air samples and, while we used the impinger method of sampling for the determination of dust counts or concentrations, we also collected a large number of samples with the electric precipitator[3] for examination of physical structure and determination of particle sizes. We were, however, unsuccessful in finding much fibrous material in the air-borne dust and very few of a length greater than 50 microns and practically none of the 360 micron size. We found that 50% of the dust was less than 2.5 microns in the longest diameters while 97% was less than 10 microns. These particles are of the same dimensional sizes as those encountered generally in industrial plants.

Later Fulton[4] and his associates reported that not more than 3% of the air-borne plant dust was greater than 10 microns in the longest diameter which agrees with our findings, although he had surveyed only one of the dozen plants and mines studied by us. Recently the U. S. Public Health Service[5] issued a comprehensive report on the asbestos textile industry covering one of the plants we had previously surveyed, but also many others in other geographical locations. In their survey they took impinger samples for dust counts in order to evaluate the degree of exposure of employees engaged at various operations. On page 23 of this report the following statement is made:

"The relatively low percentage of fibers in suspended dust explains the small number of fibers observed while making dust counts of impinger samples." They determined the percentage of fibers by means of samples collected with the Owens jet dust counter, while Fulton made his fiber deter-

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minations on electric precipitator collected samples.

Recent work published by Gardner[c] indicates that chrysotile fibers less than 3 microns is no more active than the silicate serpentine which has the same chemical composition but which is massive rather than fibrous in structure. He states that by inhalation, chrysotile, ground to such fineness that its fibrous structure is no longer recognizable, has produced no fibrosis in guinea pigs after a year's exposure. All his observations suggest a mechanical rather than a chemical form of irritation, also that the reaction to asbestos is restricted to the lungs because only these organs possess the proper structure and physiological activity to permit friction with a stiff fibrous foreign body.

Recently, the electrostatic dust collector has been placed on the market. This device employs a combination of ionization and electric precipitation in entrapping dust. It is highly efficient in entrapping fine dusts and fumes. It was, therefore, considered advisable to study its efficiency, as compared with the impinger, in determining asbestos dust with the object of distinguishing fibers.

While cotton is used in the manufacture of asbestos textiles, no attempt was made to differentiate between cotton and asbestos fibers. The U. S. Public Health Service[a] in their study were unsuccessful in distinguishing individual types of fibers.

In our study the standard impinger method of

TABLE I.

Sample No.	Impinger Sampling M.P.C.F. Cu. Ft. Air Sampled	Total Dust	Fibers	% Fibers	Electrostatic Precipitator Sampling M.P.C.F. Cu. Ft. Air Sampled	Total Dust	Fibers	% Fibers
Preparation Department								
1	38	8	.40	5.0	180	4	.40	10.0
2	46	5	.10	2.0	144	4	.30	8.0
3	45	3	.08	3.0	180	3	.30	10.0
4	56	4	.4	10.0	144	4	.30	8.0
5	44	2	.03	2.0	129	5	.40	8.0
6	56	5	.07	1.0	225	6	.50	8.0
7	38	3	.20	7.0	135	6	.50	8.0
8	36	3	.70	21.0	135	4	.50	12.0
Average	47	4	.30	6.0	159	5	.40	9.0
Carding Room								
1	42	2	.1	5.0	135	2	.1	5.0
2	42	2	.1	5.0	135	2	.1	5.0
3	44	2	.2	10.0	135	4	.4	10.0
4	42	3	.1	3.0	135	3	.3	10.0
5	44	3	.1	3.0	135	2	.1	5.0
6	44	2	.3	15.0	135	3	.4	13.0
7	44	2	.1	5.0	135	4	.3	8.0
8	37	2	.2	10.0	114	3	.4	13.0
9	36	2	.1	5.0	114	3	.2	7.0
10	52	1	.1	10.0	162	2	.2	10.0
11	45	3	.3	10.0	135	4	.3	8.0
Average	43	2	.2	7.0	134	3	.3	9.0
Mule Spinning								
1	29	3	.1	3.0	90	4	.5	13.0
2	34	3	.2	7.0	No sample			
3	34	3	.2	7.0	93	4	.6	15.0
Average	32	3	.2	6.0	92	4	.6	14.0
Spooling, Twisting & Winding								
1	34	3	.1	3.0	135	6	2.0	33.0
2	44	3	.1	3.0	135	6	2.0	33.0
3	36	2	.1	5.0	135	4	.4	10.0
Average	38	3	.1	4.0	135	5	1.5	25.0
Weaving								
1	44	3	.1	3.0	135	4	.3	8.0
2	34	1	.1	10.0	135	3	.3	10.0
3	44	3	.1	3.0	135	4	.4	10.0
5	46	3	.4	13.0	135	2	.3	15.0
6	44	1	.1	10.0	135	1	.2	20.0
Average	35	2	.1	5.0	135	2	.3	11.0