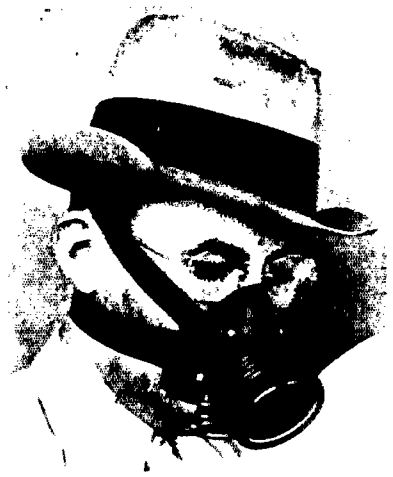

A chemical filter respirator.

What Should We Expect of Respirators?

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The important features to look for are: comfort, no interference with vision, large filtering area, high filtering efficiency, low resistance, and small dead air space

THE need for scientific control of atmospheric pollution has long been recognized but to a large extent neglected. The recent economic disturbance with its million dollar rackets has forced the issue, and today industry is fully cognizant of the value, both economic and humane, of atmospheric pollution control.

Control of atmospheric pollution is largely an engineering problem. From the engineering point of view, there are at present four important specific methods of decreasing the worker's exposure:

1. Control of polluting materials at point of generation.
2. Isolation of hazardous processes.
3. Substitution of non-hazardous processes.
4. Reduction of amount of polluting material in inspired air by means of respiratory protective devices.

While the use of respirators is listed as one of the methods of controlling the hazard, respirators do not control dust or other polluting material; they merely decrease the wearer's exposure. Hence the wearing of respirators is a method of industrial disease prevention, but not a method of atmospheric pollution control.

The use of respiratory devices is not of recent origin. Various types of respirators have been in use since the days of Agricola, but they were not widely used in industry till after the war. Undoubtedly the widespread use of gas masks in the war had a direct influence upon the more general introduction of masks of different types in industry.

Army gas masks were unsatisfactory in industry, even though they afforded effective protection. In the first place, the hazard in industry was extremely mild compared to that in war. Secondly, the resistance to breathing in gas masks was too great for the untrained workman. Consequently respirators, mostly of the mechanical filter type were introduced in industry rather generally.

Practically all of the earlier respirators had small filter areas. Many of them were of the pig snout type which had an effective filtering area of about five square inches. To keep down the breathing resistance it was necessary to have a rather porous filtering material which obviously was not very effective in dust retention.

As early as 1919 Fieldner of the Bureau of Mines indicated very definitely the need for a respirator of large filtering area for industry, and in 1926 Katz, Smith and Meiter further emphasized the advantages of large filtering area.[1,2] They went so far as to construct a respirator in the form of a hat which had a large effective filtering area. To my knowledge, however, this device has never been used in industry.

The Burrell and Fogler masks[3] have large filtering areas in the form of a knapsack which is worn at the waist. They never became popular in industry because the knapsack type filters were burdensome and the face masks used with them covered the entire face. It was not until about 1930 that a large filter area (about 60 square inches) was introduced.

Modern Respirators

The respirators found in industry today may be divided into three general classes:

1. Mechanical filter respirators which protect the wearer by filtering out atmospheric particulate matter from the inspired air.
2. Chemical filter respirators which neutralize or absorb harmful gases or vapors.
3. Supplied air respirators in which air from an uncontaminated source is forced through tubing to the wearer.

The mechanical filter respirator filters out a certain percentage of the dusts, fumes or mists from the inspired air. Obviously a filter respirator should fulfill the following requirements:

1. Should be comfortable and fit the face well, affording an air-tight contact between the face and the mask.
2. Should have no interference with vision and permit the use of glasses or goggles.
3. Should have a highly effective filter which is not bulky.
4. Should have low resistance to breathing over a period of use.
5. Should have small dead air space.
6. Should have both inhalation and exhalation valves.

Filter respirators are usually constructed of a rubber or part rubber face piece and a filtering medium of felted

A mechanical filter respirator of the familiar pig-snout type

A supplied air respirator of the air line type.

material or paper-like material. Exhalation valves are now almost universal. The more common type is the flutter or Saad valve which usually serves also as a drain for the perspiration and condensed moisture. Inhalation valves are supplied in many of the respirators at present in use in industry.

The value of inhalation valves is not generally recognized. They serve two useful purposes. First, they prevent the very humid exhaled air from getting into and fouling the filter, and, second, they prevent rebreathing exhaled air in respirators which have a dead space in the filter unit or in the filter chamber.

Many people think that because a respirator is supplied with a good exhalation valve the exhaled air all passes out through it, but such is not the case. In any system of air flow where there are two or more paths which the air may take, the volume which will go through each path is inversely proportional to the resistance through each respective path. In other words, if the resistance through the exhalation valve of a respirator is the same as the resistance through the filter, one half of the exhaled air will go out through the filter if there is no inhalation valve to prevent it.

Rebreathing exhaled air, which has a high carbon dioxide content, induces panting and causes the wearer to think there is a lack of air and the resistance is very high. To eliminate these difficulties, he will figure out several solutions, all of which will seriously impair the performance of the respirator.

The efficiency of dust retention by a filtering medium of felted or paper-like material of unit thickness is influenced directly by the density of, or resistance to the air flow through the filter. With the same filter material, the resistance is influenced inversely by the area of the filter surface, hence keeping the resistance to air flow constant the efficiency of dust retention is influenced directly by the area of the filter surface.

Furthermore, with other conditions constant, the increase in resistance over a period of use is inversely influenced by the area of filtering surface. This demonstrates clearly what Fieldner and Katz showed over a decade ago; namely, the area of the filtering surface is very important in the selection of a respirator.

The hazards, as well as conditions of use of respirators in industry, are many and varied. It is as illogical to recommend the same respirator for all purposes as it is to expect to find a respirator specifically designed for each different operation. No one would use the same respirator for hay fever prevention that he would wear if he were exposed to a dangerous concentration of quartz. In the selection of the proper respirator for any particular operation, it is important that the buyer specify the conditions as fully as possible when asking for recommendations from respirator manufacturers or preferably from impartial consultants, such as the Bureau of Mines.

Care and Inspection

Where respirators are being used, as with any system of dust control, routine inspection is essential. If a large number of respirators is employed in any one industry, it is advisable to designate one man, part or all of whose work is, to inspect respirators both while being worn and when not in use. The damaged or unsatisfactory parts should be replaced by new parts; the respirators should be cleaned and sterilized regularly.

A mechanical filter respirator with increased filtering area. Approved by the U. S. Bureau of Mines.

When the respirators are in actual service, this routine inspector should see

A supplied air respirator of the abrasive blasting type.

that they are worn properly and that all parts are functioning as intended. This inspection is very important because it is not long until the wearer will have learned a thousand and one ways to decrease the breathing resistance (such as placing a chip of wood or punching a hole in the exhaust valve, leaving out the filter, or one of them if two are recommended, wearing the headbands loose so that the air enters between the mask edge and the face, pushing several holes through the filter with a pointed stick, screwing on loosely the connection which holds the filter, and others) which invariably affect its performance seriously.

With those thoughts in mind it is very apparent that a respirator should have its parts easily replaceable and the functioning parts, such as the exhaust valve and filter element, should be readily visible so that no time is lost in removing the respirator from the wearer for inspection.

Efficiency Tests

While nothing has been published, it has long been known by Drinker and others that the efficiency of dust reten-

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