

Decline in Protection Efficiency in the Use of Dust Respirators

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In Japan, the national certification system of dust respirators ensures appropriate quality of these respirators put into use. Each dust respirator has to carry an approval mark indicating that the particular type has been approved according to the national standards. The efficiency of all dust respirators in use is thus guaranteed.

However, this guarantee system concerns only new respirators put into the market, and does not necessarily ensure its appropriate use at each dust-exposed workplace. Our own experiences show that the efficiency of a dust respirator is greatly affected by increased air flow resistance and lowered filtering efficiency due to dust particles caught on dust filters or by poor maintenance work. We often find reduced efficiency of respirators as a result of inappropriate manual removal of deposited dust from their filters.

Therefore, in order to use dust respirators effectively, it is important to know the changes in their efficiency. For this purpose, we need to have a device that can measure the dust collection efficiency and the air flow resistance of dust respirators in their actual use at the workplace. A new simple device, "Mask Tester" for examining the changes in respirator efficiency, has been developed.

The "Mask Tester" can measure dust filtering efficiency for airborne particles of $0.3\sim 0.5\mu\text{m}$ in diameter found in the room air and determine inhalation resistance for inhalation air flow of 30 or 40 L/min. A dust respirator or filter to be tested can be fixed onto the facepiece of the Tester. And the measurement is done within 10 sec per dust respirator by means of a particle counter installed inside the Tester.

According to the standards of dust respirators, the testing should be conducted by applying quartz particles of $2\mu\text{m}$ or less in diameter. The relation between the dust collection efficiency measured by applying quartz particles meeting the standards and that measured by applying room air-borne particles was examined. When a filter had a dust collection efficiency of 95% for quartz particles, the filter has a corresponding dust collection efficiency of 70% for room air-borne particles. This relation was taken into account in measuring the respirator efficiency by the "Mask Tester."

Dust respirators that had been used by workers in arc-welding and polishing sections of steel mills and ship-building factories were tested. A "Mask Tester" was placed in an office room or a meeting room near the workplaces. Dust respirators being used by workers were brought in, and examined first, while the workers concerned were watching, in terms of the respirators general appearance, the condition of the filter set in it, the inhalation valve, the exhalation valve, the facepiece, the head harness, etc. Then, the respirator was set onto the Tester, and the inhalation resistance and the filtering efficiency were measured. Furthermore, the respirator was opened and the filter conditions and the dust caught in the filter were examined. If the setting of the filter was wrong accompanied with the low efficiency of dust collection, the filter was set again to the respirator and subjected to the measurement again. This helped clarify whether the low efficiency had been due to the wrong setting of the filter or due to the worn filter. These results were explained to the workers who had been watching the testing. The conditions found as to the filter, the inhalation valve and the exhalation valve were also explained. The

workers were given instructions about how to use their respirators properly.

The results of testing 124 dust respirators using electrostatic filters were as follows:

- 1) Conditions of filters. In 29 cases (23.4%), the filters had been set wrongly. In 20 cases (16.1%), the filters had decreased efficiency. The reasons for the decreased filtering efficiency were damages of filters caused when removing dust caught on the filters, washing by water of filters, or inadequate storage.
- 2) Inhalation valves. In 11 cases (8.9%), there was a missing inhalation valve inside the respirator.
- 3) Exhalation valve. In 6 cases (4.8%), the exhalation valve was not in a proper condition

due to a large amount of dust piling within the valve, foreign objects caught in the valve or other reasons. Since each exhalation valve was covered, it was difficult for the users to know whether the valve was dirty or had a foreign object caught in it. It is necessary to examine the valve by removing its cover or by measuring the respirator efficiency.

- 4) Facepiece. In 12 cases (9.7%), the facepiece was inappropriate due to cracks, bending of the parts where the filter was fixed, etc.
- 5) Head Harness. No inadequate conditions were found with respect to shape changes or wear and tear of the head harness being used.

Conclusions

The dust collection efficiency of dust respirators, though guaranteed by the national certification system, could decline when actually used at dust-exposed workplaces. The degree of this decline varies greatly due to control and maintenance conditions of individual respirators. Utmost caution must be exercised in their use.

In promoting the proper use and maintenance of dust respirators, it is recommended to utilize the "Mast Tester" that can measure their efficiency in actual use in a simple and practical manner.