POSTER

EFFICIENCY OF ORGANIC VAPOR FILTERING HALF MASK AGAINST ACETONE AS A FUNCTION OF THE AIR FLOW PATTERN

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Introduction

The use of activated carbons as an adsorptive medium in respiratory protective equipment such as respirator cartridges and filtering facepieces is well known. Filtering half masks are usually tested for their adsorption efficiency towards specific organic vapors in standardized experiments at a constant air flow.

The choice of maintaining the flow at a constant level is not self evident, as the actual breathing through the half mask is pulsating. Evidence proves that air flow pattern may influence air purifying capacity and breakthrough time considerably [1, 2].

This experimental work was performed to obtain an insight into this influence on the basis of an existing physical model that enables evaluation of filtering half mask performances in the actual bi-directional pulsating gas flow regime through a facepiece.

Experimental material and method

Prototype of air filtering organic vapor valveless half mask was used in this study. The mask was consisted of the two layers of activated carbon materials : (1) polyurethane foam impregnated with powdered activated carbon, and (2) activated charcoal cloth. Overall mass of activated carbon materials in the half mask was 9.8 g and effective filtering area of 234 cm^2. The mask was tested as received from the manufacturer.

The test system consisted of a test gas mixture generator, test chamber with half mask support, breathing machine and gas chromatography analytical section, as described in the previous study [3]. The half mask was sealed to the support by tape to avoid peripheral inward leakage.

Filtering half mask performances were characterized for exposure to several values of acetone vapor concentrations. The air flow patterns were continuos and pulsating.

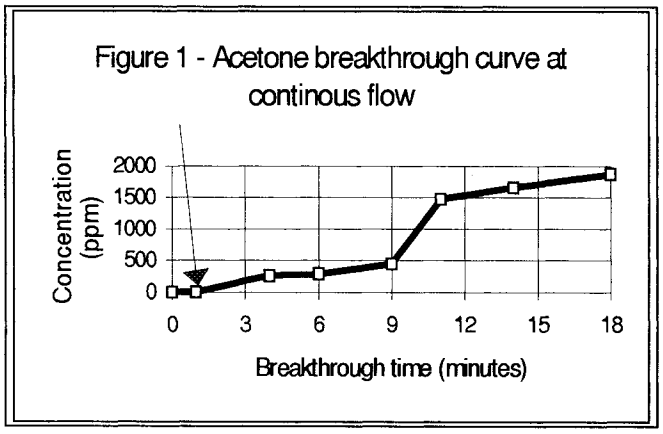
The first phase of testing involved tests using a constant air flow of 30 dm^3 / min. following standard cartridge testing procedure. Breakthrough properties of a filtering half mask were obtained at the inlet acetone concentration of 2000 ppm.

The next phase of experiment utilized mechanical breathing machine. The three pulsating flow patterns were applied : 14.2, 37.3 and 75.3 dm^3 / min., corresponding to light, medium and heavy work rate respectively. Inlet test concentration levels were : C_{i1}=1000 ppm, C_{i2} = 2000 ppm and C_{i3} = 3000 ppm. Relative humidity of gas mixture in a chamber was maintained at 50%. The expired air was heated to 36-37^o C at 95% R.H. before passing through test mask.

The experiment was designed as two factor (concentration / air flow) factorial plan at the three levels and triple replications. The two-way ANOVA was used for statistical evaluation of experimental results.

Results and discussion

Figure 1. shows acetone breakthrough curve at a challenge concentration Ci = 2000 ppm in continuos air flow. Breakthrough time of a half mask was 1.1 minute at the 1% breakthrough concentration.



The second phase of experiment was conducted in the pulsating flow regime. As experiment design limitations dictated different flowrates and contaminant concentrations it is not meaningful to compare breakthrough times as an index of filtering half mask efficiency. Howewer, mask efficiency can be estimated in terms of " protection factor ". "Protection factor" may be expressed as a ratio between inlet and outlet gas concentration. Table 1 shows the experimental conditions and resulting average outlet acetone concentrations. On the basis of results from continous breakthrough tests duration of each pulsating flow test was lasted fifteen minutes.

Table 1 - Influence of inlet to outlet concentrations

Air flow dm^3/min	$C_{i\,1}$ (ppm)	C_{i2} (ppm)	C_{i3} (ppm)
14.2	9	22	31
37.3	23	43	59
75.3	98	183	252

When the outlet concentration values are compared, it can be seen that there were significant effect for both factors. At the other hand, results shown in figure 2. indicate that protection factor variance due the concentration is not significant,contrary to the influence of air flow, .Avarage protection factors varied between 48 and 52 due concentration variation. Average protection factors were 92,47 and 11 at the air flows of 14.2 , 37.3 and 75.3 l/min, respectively

Conclusion

Air filtering valveless half mask exposed to the pulsating air flow pattern has extended protection efficiency for acetone vapor as compared to efficiency in the continuos flow. Partial desorption of the contaminant from the sorbent during exhalation is responsible for service life extension.

References

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