PHYSIOLOGY OF MINE ESCAPE: PERFORMANCE DECREMENTS DUE TO RESISTANCE BREATHING DURING THREE EXERCISE PROTOCOLS

Kurt Saupe, Graduate student
Eliezer Kamon, Professor.
Penn State University, Noll Laboratory for Human Performance Research, University Park, PA.

ABSTRACT

In the event of a mine fire or explosion, an irrespirable atmosphere is formed and self-contained breathing apparatus are necessary to support life. An ideal breathing apparatus would simulate ambient air in every way; however, this has not been achieved in any type of portable apparatus. Apparatus that are used for escape are best when light in weight and small in size. Small size and light weight, however, usually result in apparatus that are physiologically stressful in other ways. The most common stressors of concern are levels of CO_2 and O_2, temperature, and breathing resistance. From research being conducted at the Noll Laboratory for Human Performance Research, it has been found that breathing resistance can significantly affect performance in a number of areas. One significant finding is that a given level of breathing resistance may negatively affect escape speed if the speed is high and yet not affect escape at a lower escape speed. Three exercise protocols were performed to study effects on maximum attainable oxygen consumption rate and, thus, escape speed. It was found that the higher the exercise intensity, the greater the negative effect of a given breathing resistance.

INTRODUCTION

To fulfill all the potential needs of a worker, a respirator should not limit the worker's performance under a wide range of conditions. Some of these conditions include low-intensity steady-state exercise, short-duration high-intensity exercise, and gradually increasing work to ventilatory exhaustion. These three conditions place different demands on respirators. Resistance is the stressor that seems to have the greatest effect on the standard measures of performance, such as maximum attainable speed of travel. This is probably due to the lower attainable ventilation rate, and consequently, lower attainable oxygen consumption rate, so that the worker is forced to slow down. Conclusions about the amount of resistance that can be tolerated before a performance limitation is seen may well be different depending upon the intensity of exercise used to evaluate the resistance.

The purpose of this investigation was to quantify the performance decrements caused by resistance breathing during a simulated coal mine escape. Since there is no one protocol that adequately simulates all the possible scenarios that might be encountered during an emergency mine escape, three different escape protocols were examined. These three protocols were chosen both to represent a wide range of demands on the respirator and to