VÉDELEM TUDOMÁNY
KATASZTRÓFAVÉDELMI ONLINE TUDOMÁNYOS FOLYÓIRAT

József Zsolt Kersák, Ágoston Restás

EXAMINATION THE PROTECTION TIME OF THE RESPIRATOR

Abstract

The respirator is an important and frequently used protective equipment for firefighters in case of interventions. The literatures in connection with the use of self-contained breathing apparatus deal only with health and safety requirements. There is only a little knowledge about the relationships between air consumption during different activities, physique, work intensity, and stress. In conclusion, the actual protection period of the respirator may vary during the interventions. Consequently, the usage time should be increased as much as possible.

Keywords: respirator, protection time, air consumption

LÉGZŐKÉSZÜLÉK VÉDELMI IDEJÉNEK VIZSGÁLATA

Absztrakt

A tűzoltói beavatkozás egyik nélkülözhetetlen és rendszeresen alkalmazott védőeszköze a légzőkészülék. A rendszeresített környezeti levegőtől független légzőkészülékek használatával kapcsolatban fellelhető szakirodalmak csak a munkavédelmi követelményekre terjednek ki. A különböző tevékenységek közbeni levegőfogyasztásról, a testalkat, munkavégzés intenzitása és a stresszhelyzet összefüggéseiről kevés ismeretanyag áll rendelkezésre. Ennek következtében a légzőkészülék tényleges védelmi ideje a beavatkozások során eltérő lehet, amelyből adódóan a használati időt a lehetőségekhez mérten növelni szükséges.

Kulcsszavak: légzőkészülék, védelmi idő, levegőfelhasználás

1. INTRODUCTION

The 6/2014 instruction of National Directorate General for Disaster Management orders the data provision of the firefighting and technical rescue of the fire departments and of the disaster management bodies. The County Disaster Management Directorates, the Disaster Management Branch Offices and the fire departments are obliged to provide regular data on their firefighting, technical rescue and official activities [1].

The electronic data of the Firefighting and Technical Rescue Reports (hereinafter TMMJ) data sheets is performed using the on-line Disaster Management Data Provider Program (on-line KAP).

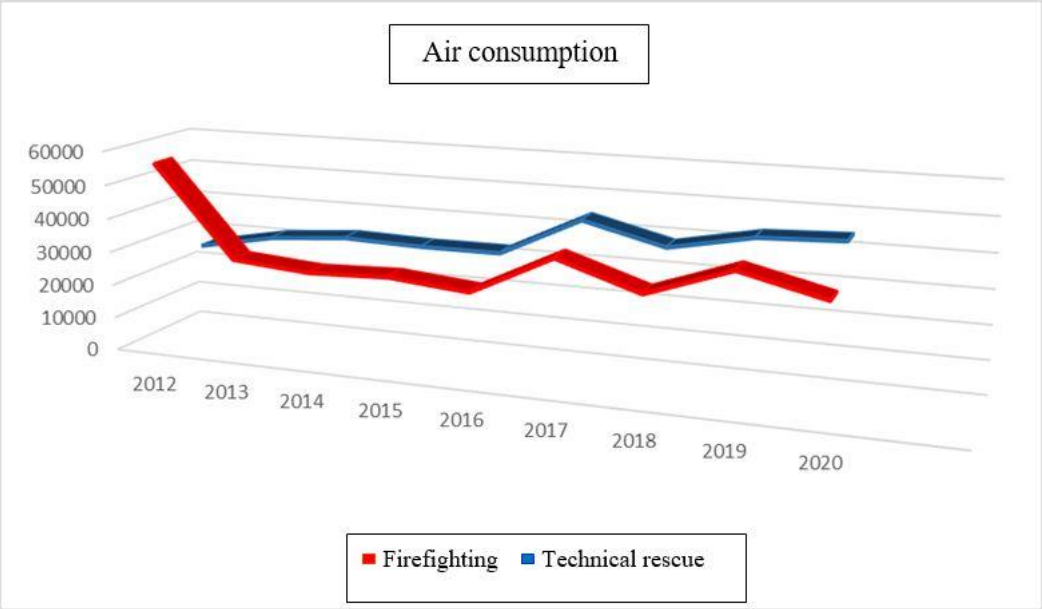

Figure 1 – The use of respirator in case of firefighting and technical rescue. Created by the Author [2].

We examined the statistics of the data sheets and determined that the use of respirators (in case of firefighting and technical rescue) averages 70,000 times a year in Hungary. Figure 1 illustrates the use of a respirator during the firefighting and technical rescue. In addition, it can be stated that from the year 2013, there were more uses of respirators during the technical

rescue operations. The use of a respirator is justified by the fact that in case of technical rescues, vapours and gases may be released, which have a harmful effect on the health of the interveners [3]. Such interventions are a complex task, as well as a recovery after natural disasters [4] [5].

During the exercises with respirators, the technique of the proper breathing can be mastered through practice. This practical knowledge will help to increase the protection time of the respirator for the safe interventions [6].

2. PROBLEMS, OBJECTIVES AND HYPOTHESIS

One of the living conditions is to have clean air with appropriate oxygen content. Under normal breathing conditions, this oxygen is received by the human body from the surrounding air. Based on anatomical knowledge, respiration is a vital function, its organs are the respiratory tract, upper respiratory tract, trachea, lung lobes, and the air sacs in them. The composition of the air is 78.08% nitrogen, 20.95% oxygen, and approximately 1% other gases.

Activity	Air consumption
Easy movement, walking	10-25 litres/min
Medium intensity work	30-50 litres/min
Hard intensity work	70-100 litres/min
Very hard intensity work	150-200 litres/min

Table 1 - Average air consumption of an adult in case of various activities. Created by the authors [7]

A person breathes 16 times on average in 1 minute under normal conditions. Air consumption in case of adults is greatly influenced by the activity they are doing. Table 1 illustrates the

average air consumption of the adults during various activities, based on the measurements of Róbert Frenkl [7].

Protection time is a measurable period of time, expressed in minutes, which is the time of the usage of the respirator. This time is approximately 45 minutes in case of easy work with a respirator with 300 bar pressure and 6.8 litres capacity. As the actual usage time of the respirator is not constant during the interventions, consequently, it is necessary to increase the usage time.

The usage time can be affected by many factors, such as the stress, the worry, the overweight, the respirator, other equipment and the inexperience. It has been proven and experienced that the number of breaths increases during the interventions when using the respirator. The objective of the authors was to help the use of respirators and to increase the protection time during the interventions with the help of the present experiment. During our research, we constantly examined the statement described in the thesis of Ferenc Kanyó [8]. He considered it important to develop a training and assessment system that measures the firefighting interventions in specially modelling conditions such as endurance, strength and speed [9] [10] [11].

3. FIREFIGHTER EXPERIMENT WITH THE USE OF RESPIRATOR

We perform a test with 5 professional firefighters, who volunteered to participate in the measurement. Ages and length of service were important during the selection. The participants were marked anonymously with letters. Categories such as age group and length of service were not determined due to the small group size, but they were marked. Weather conditions such as temperature and atmospheric pressure were the same for both tests. This is important to note because the weather has an influence on the effectiveness of the firefighting. [12] [13]

Measurements: elapsed time, covered distance, and pressure difference in the breathing bottle (air consumption could be determined from the pressure difference).

Figure 2 - Illustration of an experiment. Created by the authors.

The experiments were divided into two main groups:

First attempt: The task was to cover 100 meters with a respirator, protective clothing, at a normal speed. In the present phase, the goal was to measure the average air consumption with time and covered distance. These data were needed to determine the air consumption with minimal movement.

Second attempt: During the task, the firefighters had to go up to the fourth floor in a respirator, in protective clothing, at a normal speed. In the present phase, the goal was to measure the average air consumption, with the time, covered distance and level difference. These data were needed in order to determine the air consumption under increased movement and load.

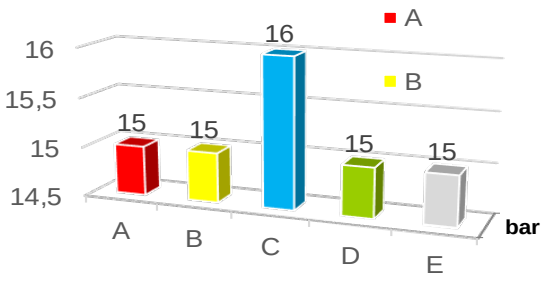

Figure 3 - Air consumption of the first attempt, broken down by each participant, expressed in bar. Created by the authors

Firefighters covered the 100 metres on horizontal terrain at normal speed for 1 minute 20 seconds with an average speed of 1.25 m/s (It is important to note that they were traveling at the same speed at the same time. It was a request) and their air consumption was 0.15 bar/metre in a metre. It was observed that their air consumption was common 15 bar over the distance. Firefighter „C" was an exception. His value was 16 bar, which is illustrated in Figure 4. It can be stated that in protective clothing, with the use of a respirator, their air consumption was the same independently from the age and length of service at normal speeds. However, the fire protection rating of protective clothing is another problem [14].

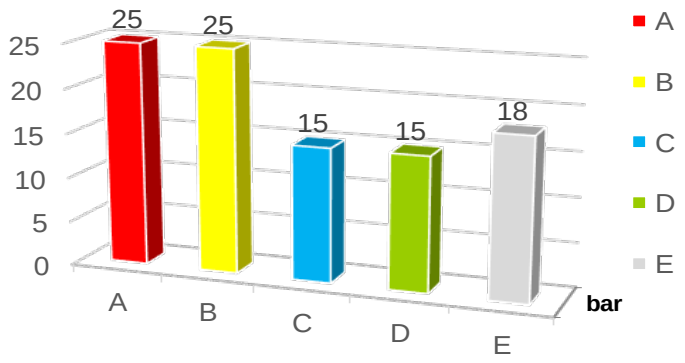

Figure 4 - Air consumption of the second attempt, broken down by each participant, expressed in bar. Created by the authors

Results of the second attempt: The firefighters covered 54 metres horizontally, with a slope of 16.3 metres, at a normal speed in 1 minute 40 seconds, their average speed was 0.54 m/s. (It is important to note that they were traveling at the same speed at the same time. It was a request). In the present test, there were already large differences in the air consumption. It was found that based on age and length of service, younger firefighters and those with fewer service time had higher air consumption. Firefighters marked “A” and “B” covered the distance with a decompression of 25 bar, with an average consumption of 0.46 bar/metre. Firefighters marked “C” and “D” covered the distance with a decompression of less than 15 bar, with an average consumption of 0.27 bar/metre, and it was observed that no more air was used. Firefighter "E" completed the distance with a minimum of more than "C" and "D", but significantly less than "A" and "B", with an average pressure drop of 18 bar. He completed the distance with an average consumption of 0.33 bar/metre.

4. SUMMARY

In Hungary, the use of respirators is 70,000 times in a year in case of firefighting and technical rescue. This poses a risk to the interveners [15]. From this, it can be concluded that the use of a respirator is essential for the safe intervention. The need for the present studies has been demonstrated by the fact that the literatures only deal with the occupational safety requirements, but does not provide guidelines for the use in different situations. During the studies, it was observed that the air consumption was the same at minimal load, but in case of higher intensity the air consumption of the younger firefighters was higher than for the older age group. Consequently, during breathing exercises, the technique of proper breathing should be mastered through practice. The present practical knowledge helps to increase the protection time of the respirator, so that it is possible to intervene further in time with the use of minimized air. These are later contributed by the experience of operations management [16]. The importance of it has also appeared in the education [17].

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József Zsolt Kersák
FF Major, deputy commander Professional Fire Fighter Headquarters, Siófok, Hungary
E-mail: jozsef.kersak@gmail.com
ORCID: 0000-0001-5703-4082

Restás Ágoston
associate professor University of Public Service,
E-mail: Restas.Agoston@uni-nke.hu
ORCID: 0000-0003-4886-0117