



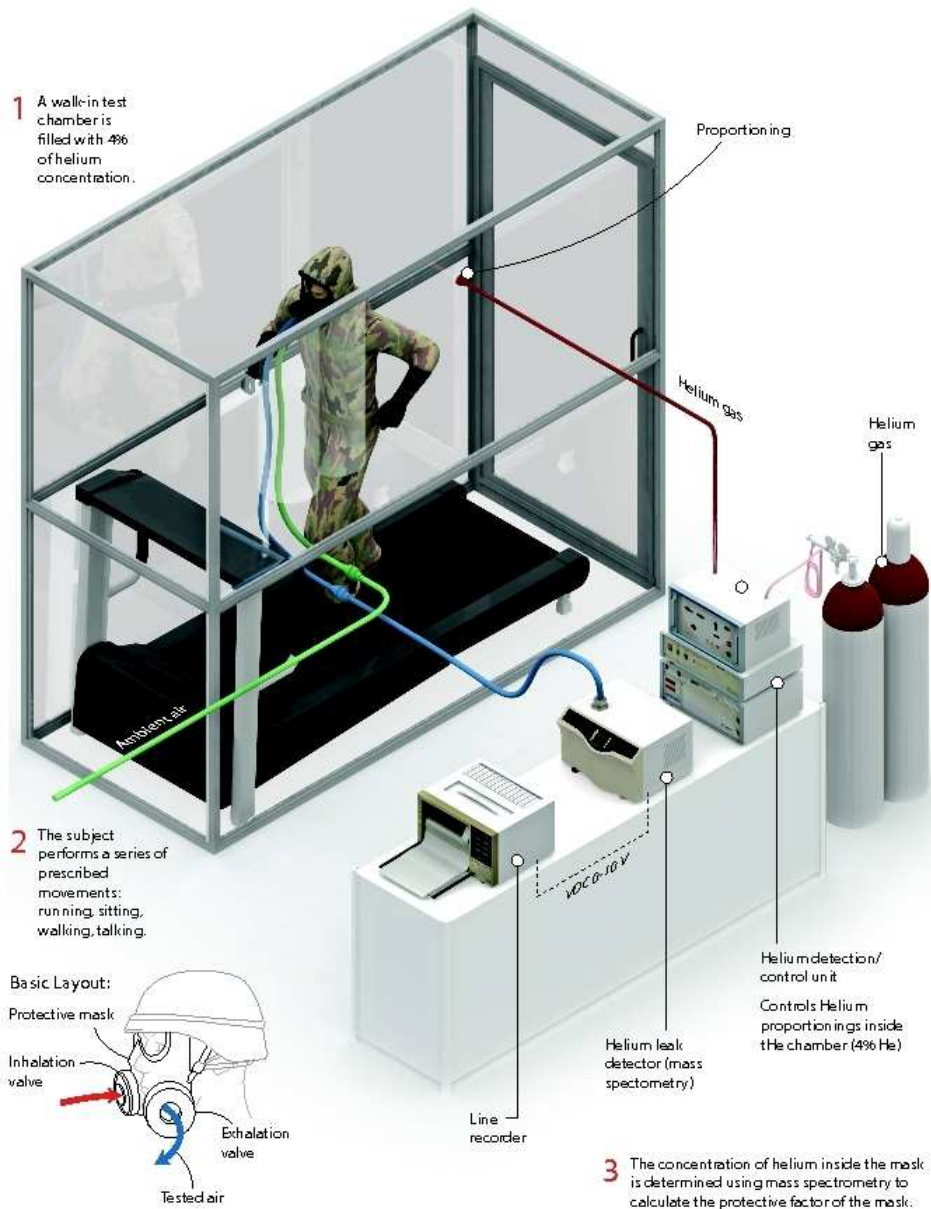
Fact Sheet

21.09.2010

Testing of NBC Protective Respirator

Summary

The inward leakage is the determinant of the effectiveness of a protective mask. SPIEZ LABORATORY has different methods to check the effectiveness of a protective mask: from the purely qualitative IPA test, the semi-quantitative aerosol test and to the high-precision helium method.



1. Introduction

Anyone who comes into contact with hazardous chemicals is exposed to risk and therefore must protect himself. However, the risks are different either for firemen, soldiers or chemical workers. Correspondingly there is a wide variety of personal protective equipment (PPE) which is tailor-made to the type of exposure. Nevertheless the principles of protection are the same and the most important is: respiratory protection has first priority.

A respiratory protective device provides “*minimum standards for breathable air in suitable quality*”. This device can work in two ways: either the ambient air is purified or there is an independent air supply. This may be a compressed air reserve (self-contained breathing apparatus) or the air is regenerated in a closed circuit system (closed-circuit breathing apparatus). The SPIEZ LABORATORY checks the quality of compressed air in accordance with EN 12021 and has its own accredited Testing Laboratory for Adsorbents and Respiratory Protective Filters (STS 022).

The face piece is a key component of any breathing apparatus, *connecting the respiratory system of the user to the other parts of the apparatus and protects against the ambient atmosphere*. If the fit of the face piece is poor, its protective performance under certain conditions can be compromised.

The individual fit is checked by measuring the mask leakage. The leaktightness is expressed as the ratio of the concentration inside the mask to the concentration outside. SPIEZ LABORATORY uses two tests which are optimised to suit their specific field of application. Factors include expenditure of time, validity (detection limit, quantifiability), as well as the usage site.



NBC protective mask 90 (SM90)



Proband on treadmill in the test chamber

2. Test Setup

2.1. Helium-Method

The test and measurement equipment consists of four main components:

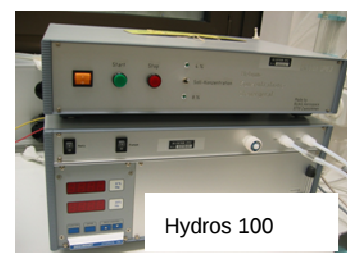
- Test chamber
- He detection & control unit
- Leak detector (He detection device)
- Device for calibration

The test chamber has a volume of about 4 m³ and can either be filled with 4% or 8% helium-air mixture. In the test chamber, a slight negative pressure of about 5 Pa is established.

The helium concentration (outer concentration) is continuously measured by a Thermal Conductivity Detector (TCD) (HYDROS® 100) and replenished automatically via a control unit.



Test chamber



Hydros 100

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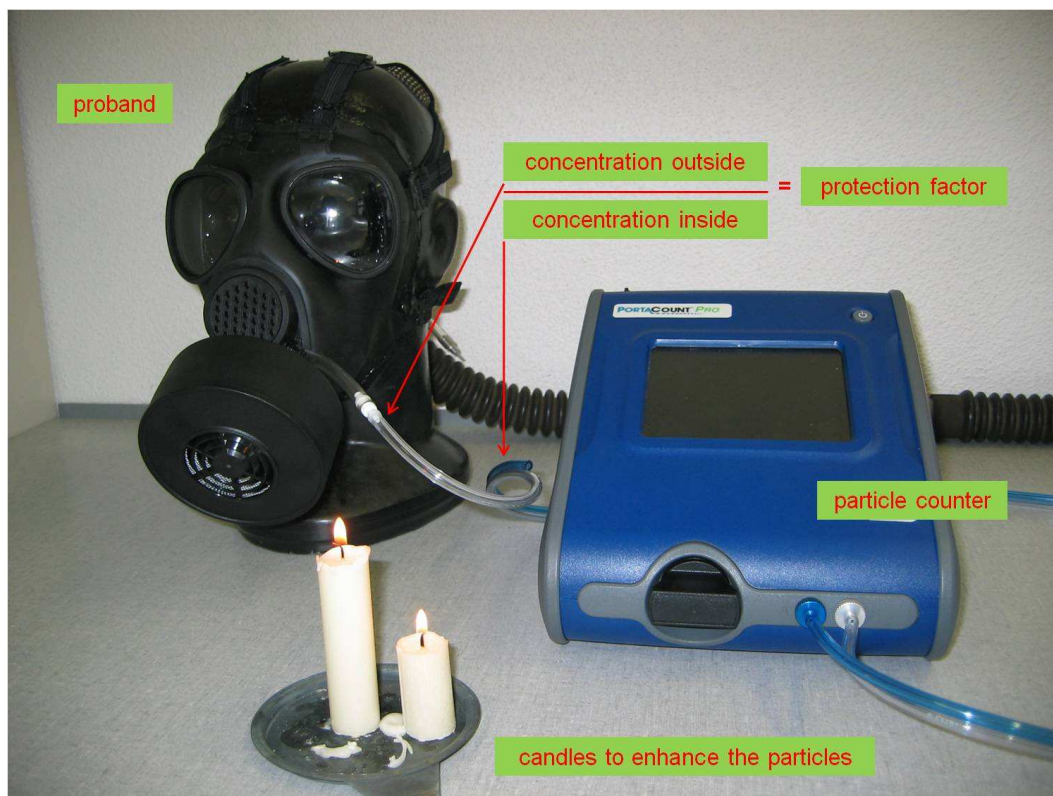
The leak detector (He mass spectrometer) is connected through the drinking connector or an adapter to the protective mask and measure the inner concentration of helium. The detection limit is given by the 5 ppm He in ambient air and the 4%(8%) He concentration inside the test chamber. The detection limit can be increased by the use of artificial air.

Tests can either be done with a proband or on a test dummy. When the dummy is used it's breathed through an artificial lung. The proband absolves a defined motion sequence such as resting, walking, talking, nodding, etc.



2.2. Aerosol-Test

SPIEZ LABORATORY established annual fit tests on the protective masks of all its personnel. It uses a new type of test which overcomes the shortcomings of the helium and the military tests. The test has a high enough detection limit to detect small leaks. In contrast to the He method this method is unable to determine the performance limit of a mask. But the test can be performed anywhere quickly (10 minutes per person). The test agent is the respirable dust found in the air which can be multiplied easily by lighting a candle. This method is also suitable for on-site tests, e.g. in our partner organisations.



The individual fit of the protection mask thus is vital for guaranteeing the user's safety and checks should be carried out regularly.

2.3. IPA- und CS-Test

For large-scale tests in the Swiss army the IPA-test or the CS-test is used. Both, the functionality and individual fit of the mask is verified. The principle of the two methods is to smell (IPA, banana oil) or to sense (CS, teargas) a substance that is dosed in a suitable room if the mask has a considerable leak. Both tests are only qualitative and a fit factor can't be determined. Also the odour or irritation threshold for a substance is not absolute but subjective for each proband.

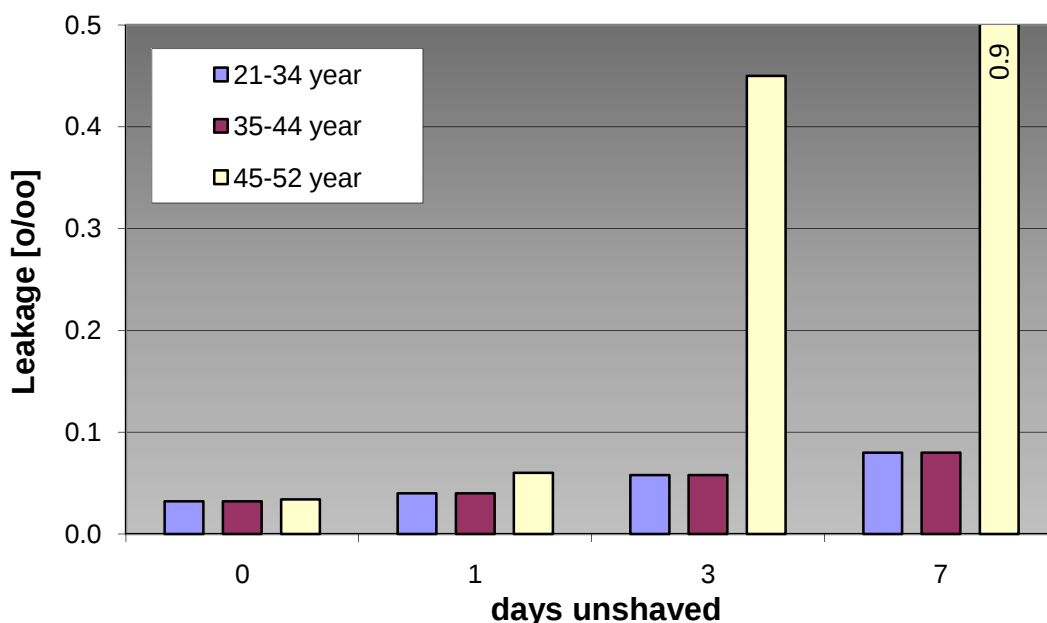
¹⁾ IPA: Isopentylacetat

²⁾ CS: 2-Chlorbenzylidenmalonsäuredinitril

3. Interpretation

The performance of a protective mask is specified by the "inward leakage". It's calculated as the ratio of internal to external concentration of the test substance and often is stated in percentage. The reciprocal value is the protective factor (see also protective clothing). The protection factor is also called "fit factor".

As example, a measurement used to study the effect of increasing growth of beard on the leakage of the SM90. The technical performance requirement of the SM90 is a leakage of 10^{-4} . This limit is easily achieved for all three probands when they are freshly shaved. With increasing beard growth the inward leakage increases significantly. Strands of hair or even an eyeglass frame in the mask sealing frame can lead to complete loss of the protective performance of the mask.



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