More strength in the tank

Tank cleaning is a tough job: Not only is the work physically demanding, the required personal protective equipment also puts additional strain on the workers. In this case greater comfort isn't a luxury, but rather increases performance and efficiency.

The challenge: To develop an optimal PPE solution for tank cleaning

Adequate personal protective equipment (PPE) for the workers is essential for tank cleaning. At the same time, however, the weight of the equipment, the elevated temperature and humidity in the protective suits, and the breathing resistance generated by masks results in considerable additional strain on the wearer. For this reason, strict limits are placed on the duration for which the equipment can be worn.

Selecting the most comfortable equipment makes sense, not only from an occupational health and safety aspect but also in light of economic considerations:

1. Higher performance during the deployment: The less strain is put on the wearer by the protective suit and respiratory equipment, the more energy can be put into the work – this increases motivation as well.

2. Higher safety: Heat stress and higher cardiovascular stress compromise the ability to concentrate, thus increasing the risk of mistakes and accidents.

3. Higher efficiency: More comfortable equipment means that the workers aren't as exhausted and can subsequently perform better at other tasks.

Precisely regulated

Tank cleaning is one of the routine jobs in the oil and gas industry as well as the chemical industry – and at the same time extremely dangerous. Entry into the container is usually required. Hydrogen sulphide, hydrofluoric acid, ammonia, sulphur dioxide and other poisonous gases and vapours from the residual materials can be dangerous to the workers who enter the tank. Additional topics the safety officer must keep an eye on are the potential lack of oxygen and often also the risk of explosion. Preventing the inhalation of hazardous substances, as well as skin and eye contact due to splashing and particles, is essential. How the personal protective equipment (PPE) of the workers has to be designed for this task is defined on the basis of the respective risk analysis and the applicable laws and regulations.

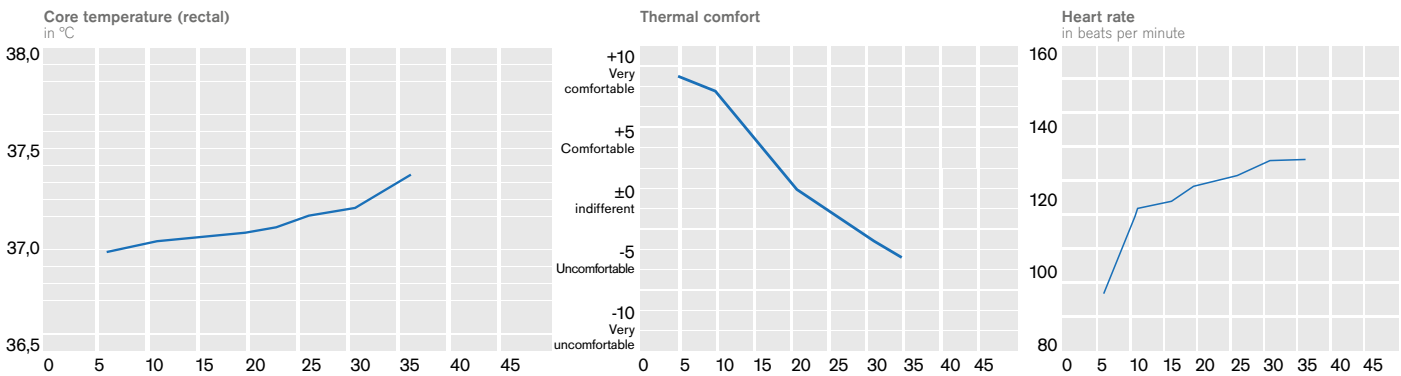
Special rules and regulations for entry into containers are, for example:

- DGUV Working in tanks, silos and confined spaces (BGR 117-1)
- OSHA standard 1910.146 "Permit-required confined spaces"

The selection and use of respiratory equipment is regulated in guidelines such as EN 529 or OSHA 1910.134. The quality requirements for breathing air are described in the guidelines EN 12021 and/or OSHA ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989.

Heat stress compromises efficiency

An elevated ambient and body temperature compromises performance and increases the risk of mistakes – this negative relationship has been verified through various studies. The temperature and stress on the cardiovascular system rise quickly in chemical protection suits without cooling.



Source: Dräger

A practical example

Thus the requirements are: Maximum safety and greatest possible comfort. How can this be implemented in practice? The starting point for this analysis is a typical scenario from the oil and gas industry:

- There is often no stationary breathing air supply in the immediate vicinity of the tank. Therefore a mobile system must be used to provide breathing air.
- The work should be performed by a team of two people. Since the cleaning work is very physically demanding, a breathing air consumption of approx. 60 l/min has to be assumed.
- The deployment time is defined as not exceeding 120 minutes.
- Severe contamination with fluids and particles is expected. In this scenario, cleaning the protective suit seems costly; a disposable spray protection suit which is disposed after use is more economical.
- According to the pre-entry gas measurement, contamination of the tank atmosphere with up to 500 ppm of hydrogen sulphide (H_2S) must be assumed. The occupational health and safety limit is 5 ppm – this results in a required protection factor of 100 (see sample calculation).
- Visibility in the tank is poor and it takes several minutes to leave it. An emergency air supply is therefore essential.
- The temperature in the tank can easily rise above 35 °C. Therefore, body cooling is recommended.

Fundamentals of selecting PPE

The selection of suitable respiratory and body protection is always performed on the basis of so-called protection factors. These are calculated on the basis of the measured harmful substance concentration, divided by the respective limit of the harmful substance.

Required protection factor = maximum harmful substance concentration / maximum allowable concentration (MAC)

In this example, the calculation would be as follows:
500 ppm H2S / 5 ppm (MAC) = 100

Among other things, the required amount of breathing air is a key factor in deciding on the breathing air supply. It is necessary to ensure that the amount of air required according to the number of people to be supplied is available at all times and for the entire planned deployment duration.

The required total air quantity is calculated using the formula:

Required air quantity = air requirement per person x number of persons supplied by the air source x planned working timea

In the outlined scenario, the breathing air demand is 14,400 litres (60 l/(min and person) x 120 minutes x 2 persons).

Another important factor in assessing a breathing air source is the quality of the breathing air. It must meet certain quality requirements, for example according to EN 12021.

Solution: Comfort concept with cooling

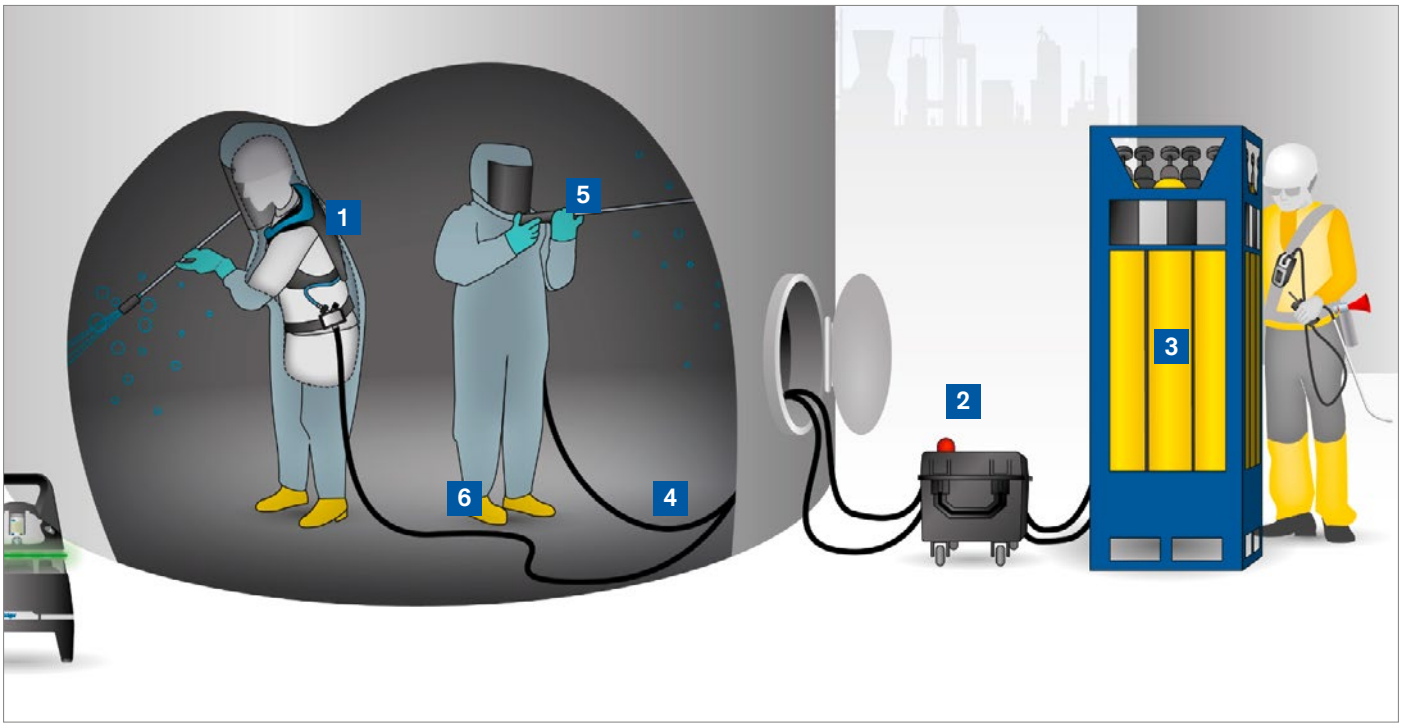
With this PPE combination, workers are fully protected and optimally cooled all around. The new CVA 0700 cooling vest makes sure of that. It is worn underneath the suit and ensures that approx. 350 litres of air per minute circulate throughout the entire suit – especially where cooling has the greatest effect: On the back and head area of the wearer.

The breathing air supply is ensured through a mobile breathing air compressor (MAC) or a cylinder bundle. The required air demand is calculated according to the above formula, as follows:
Air demand: 350 l/min. x 120 min x 2 pers. = 84,000 litres of capacity if a cylinder bundle is used.

The size of the cylinders can be calculated using:
Number of cylinders x cylinder size x (cylinder pressure – remaining pressure after warning),
e.g. 8 x 50 l x (300-50 bar)= 100,000 litres.

In case of an air supply fault, the MAV 1200 mobile air supply unit ensures that the workers can leave the tank safely.

Protective equipment for tank cleanings: Safe all-around and with extra comfort



1 SPC 3700 splash protection suit, type 3/4 made from Tychem® F for one-time use according to EN 14605 +
X-plore® 9000 belt set with ventilation vest CVA 0700, constantly ventilated vest for breathing air supply and body cooling:

- Air flow rate approx. 350 l/min for optimal cooling over the entire deployment period
- Safe and easy to use
- High protection factor of 1000
- Vest together with protective suit approved according to EN 14594 class 4A

2 MAV 1200 mobile breathing air supply including backup air supply and filter unit:

- Robust and easy to clean, since it is encapsulated in a protective plastic housing
- Reliable, continuous breathing air supply through automatic switching to the integrated backup breathing air supply if the external supply fails
- Audible and visual warning signal when switching to the limited backup breathing air supply
- Escape time with two cylinders (6.8 litres / 300 bar): 5 minutes
- Up to 1000 l/min of filtered breathing air according to EN12021 through integrated filter unit

3 Primary air supply via mobile breathing air compressor or cylinder bundle

4 Two connection hoses with a length of 20 metres as well as a connector set on the input for the supply hose

5 Tricotril® overglove

6 PVC safety boots

The sizes of suit, gloves and boots are matched individually to the respective wearer.

Added value: Higher safety. Higher performance. Higher efficiency.

The cooling vest performs three functions: It provides pleasant ventilation, lowers the temperature and humidity in the suit and also supplies breathing air for the wearer. Thanks to the hood, breathing resistance is not an issue.
The air circulating through the vest prevents the visor from fogging up, so that the wearer still has good visibility even after working for a long time.

The physical stress on the workers is reduced significantly. Thanks to the higher wearer comfort, their efficiency improves as well. By adjusting the activity-specific risk assessment accordingly, this solution can sometimes even be used to extend the wear duration and thus the length of deployment.

The breathing air is simply supplied by the mobile breathing air compressor or cylinder bundle. Thanks to the integrated backup air supply in the MAV, a separate backup air supply system carried by the worker is no longer required. The MAV generates a warning signal if the backup air supply is activated.
If the supplied air doesn't meet the standards for breathing air - for example because a stationary ring line with process air is present after all - then the system reliably filters water, particles, oil vapours and odours from the process air (5-10 bar) and will clean and condition it according to the international standard EN 12021*.

** (No CO/ CO_2 filtration)*

The single components at a glance

Panorama view
Wide visor offers larger view from side to side and up

Emergency exit cord
Can be pulled to immediately take off suit

D-18003-2014

Suit valve
The overpressure in the suit keeps the wearer safe from leaks

External air supply
Safe and reliable connection to external air supply


D-15736-2014

Adjustable and protected airflow
Provides cooling air to the torso and inside the suit as well as breathing air to the wearer

Auto test function
Ensures the correct airflow and means no pretesting


D-15737-2014

Warning whistle unit
An alarm sounds when air supply is interrupted or airflow is too low


D-6871-2014

MAV
Filters particles, liquids, oils and odours from the air, serves as warning device with emergency breathing air supply and can distribute the air to two persons

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