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DIVER POISONING WITH CONTAMINATED COMPRESSES AIR

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ABSTRACT

The paper describes the case of a military diver who suffered from a complicated poisoning caused by hydrocarbons contained in his breathing air. The hydrocarbons came from a malfunctioning compressor which was used to fill the diving cylinders; the compressor sucked in the exhaust gases of its own motor. Exhaust gas poisoning was further complicated by hypoxia and hypercapnia as the diver spat out the mouthpiece and started to breathe from inside the suit. This resulted in a loss of consciousness. The diver was extracted to the surface and was given oxygen to breathe. The course of treatment was successful. On the same day, symptoms of exhaust gas poisoning occurred in several divers using cylinders filled with the same compressor.
Keywords: diving, exhaust fumes, poisoning, hypercapnia, hypoxia, accident.

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INTRODUCTION

Air quality becomes particularly important when it is necessary to breathe under increased pressure, as under these conditions the partial pressure of individual air components increases significantly. This, of course, applies both to gases that are part of the atmospheric air and to other volatile, sometimes toxic, substances that are accidentally found in this air [2,3,10].

The circumstances accompanying the compression of air create a high probability of air pollution. Some harmful components may be present in the compressed air as a result of the suction of already contaminated air by the compressors, or as a result of its contamination during the compression process. Most often the air is polluted by exhaust fumes from the motors driving the compressors and by the lubricants in the compressor piston and the products of oil degradation. [3,10].

Depending on the type of engine and fuel in the exhaust gas, the following products can be distinguished: carbon monoxide, carbon dioxide, hydrocarbons, aldehydes, nitrogen oxides, sulphur oxides, lead compounds, soot and smoke [2,4,11]. Such accidental admixtures of air administered to divers or scuba divers can cause poisoning, with serious consequences in underwater conditions.

Table 1 shows the limit values of pollutants (according to the draft industry standard of the Ministry of Foreign Trade and Maritime Economy) that may be present in the air intended for breathing during a stay under water at a depth of up to 60 m or in a decompression chamber at a pressure of up to 0.6 MPa [10].

Tab. 1

Draft industry standard of the Ministry of Foreign Trade and Maritime Economy (BN 77/3747).

No.	Requirements	Draft standard BN 77/3747
1.	Carbon dioxide % vol. at maximum	0.05
2.	Carbon oxide mg/m3 at maximum	3.0
3.	Nitrogen oxides mg/m3 at maximum	0.7
4.	Hydrocarbons mg/m3 at maximum	5.0
5.	Water/water vapour/mg/m3 at maximum	0.01 0.1
6.	Dust	impermissible
7.	Odour	impermissible
8.	Other substances harmful to health	impermissible

Note. Items 2, 3, 4, 5 – after decompression to atmospheric pressure.

Recently, there has been an increase in the number of air poisoning by contaminated compressed air in divers and scuba divers, most often due to faulty compressor operation. [13].

This can be illustrated by the following case.

CASE STUDY

A military diver, C.W., aged 21, dived in light equipment on 23.09.1982; air apparatus, constant volume dry suit with mouthpiece inside the helmet in the Gulf of Gdańsk as part of a training activities. Diving depth - up to 5 m. Weather conditions: air temperature 16 °C, water temperature 16 °C, sea state 0 °B. He descended at 09.10 am. After a few minutes of diving, dizziness, orientation disorders, muscle weakness and nausea occurred. He pulled out the mouthpiece and started breathing from inside the suit. He does not remember any further actions until he regained consciousness. The signaller noticed that C.W. was swimming in a different direction, stopped moving his flippers and did not react to a signal. He was immediately extracted from the water and placed on a motorboat, where his suit was cut open. He was unconscious, pale, there were traces of vomiting, the pupils reacted lazily to light, his heart rate was low, about 80/min, his breathing was slow, about 10 breaths/min, cyanosis of mouth and fingers were observed. After cleansing the mouth from the vomit, pure oxygen was administered through a mask. After a few minutes the diver regained consciousness. He complained about general weakness, headaches in the frontal and temporal area, dizziness, nausea, dry mouth. For further observation, the diver was referred to the infirmary in a military unit. The results of specialist and laboratory tests did not deviate from the norm.

At the same time, 5 more divers went underwater, in whom dizziness, scotomas, orientation disorders, muscle weakness and nausea occurred while swimming. The dive was discontinued after a few minutes. On completion of the dive, the divers complained about general weakness, headaches and dizziness, nausea, imbalance. Medical examination showed tachycardia, hypotonia and shortness of breath. Oxygen therapy was applied to all subjects. The symptoms persisted for several hours. On the following day, the results of specialist and laboratory tests were normal.

In connection with this situation, the air in the cylinders of the diving apparatus and the SM-14K compressor, from which these cylinders were charged, were inspected. The testing was carried out in the Chemical Research and Analysis Laboratory of the Department of Legalisation and Repair of Rescue Equipment of the Navy.

The organoleptic test of the air revealed the smell of burnt oil. Determinations were made of: oxygen, carbon monoxide, carbon dioxide, volatile acids and alkalis, halogen derivatives, nitrogen oxides, hydrocarbons. It was found that the applicable standard of hydrocarbons exceeded 30 mg/m3 measured as carbon. Hydrocarbons were determined by gas chromatography using a flame ionising detector, or FID, on a column filled with glass beads. The remaining components did not exhibit any abnormalities.

DISCUSSION

In acute hydrocarbon poisoning, the affected person loses the ability to properly assess the situation, which poses a particular danger to a diver. An example is the described case where the diver spat out his mouthpiece and started to breathe from inside the suit. This resulted in hypercapnia, anoxia and then loss of consciousness. Luckily for the diver, he was at a relatively shallow depth from where he was immediately brought to the surface. The main cause of the accident was the quality of compressed air; pollution by exhaust gases, mainly hydrocarbons, due to their suction from the motor driving the SM-14K type internal combustion compressor.

This case merits attention on account of the serious risk to the diver and the complex nature of poisoning - with hydrocarbons from polluted air and carbon dioxide while breathing from the suit.

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