Preventing Breathing-Gas Contamination

Incidents involving bad breathing gas — be it air, nitrox, trimix or another mixture — are rare, yet they do occur. Health effects on divers vary depending on the contaminant breathed. Among the most severe symptoms of breathing contaminated gas are impaired judgment and loss of consciousness, both of which may be deadly underwater.

Sources of contamination include hydrocarbons from compressor lubricants, carbon monoxide (CO) from engine exhaust (or overheated compressor oil) and impurities from the surrounding environment such as methane and carbon dioxide (CO_2). Dust particles in breathing gas can also be hazardous, potentially impairing respiratory function or damaging diving equipment. Excessive moisture can cause corrosion in scuba cylinders and other dive gear and may cause regulators to freeze due to adiabatic cooling (heat loss subsequent to increased gas volume).

Contaminant	Signs and Symptoms
Carbon monoxide (CO)	Headache, dizziness, weakness, nausea,vomiting, shortness of breath, impaired judgment,confusion, unconsciousness, potential death
Carbon dioxide (CO_2)	Hyperventilation, dizziness, confusion, unconsciousness
Volatile hydrocarbons	Fatigue, headache, confusion, impaired judgment, numb-ness, cardiac arrhythmias, unconsciousness
Oil (condensed)	Headache, nausea, impaired respiratory function
Dust (particles)	Impaired respiratory function
Methane	Asphyxia due to dilution hypoxia

Recommendations for Compressor Operators

Compressor operators can help prevent gas contamination and mitigate the risk of dive accidents in several ways.

Attentive compressor maintenance. Proper compressor maintenance helps ensure breathing-gas quality as well as extends the life of the compressor. Breathing-gas contamination is less likely in well-maintained and properly functioning compressors. If maintenance is neglected and the compressor overheats, the lubricating oil may break down and produce CO and other noxious byproducts.

Effective procedures. A fill checklist can help ensure safety procedures are remembered when cylinders are filled. Before starting to fill tanks, the operator should inspect the compressor’s filters for damage and

note the presence of contaminants such as cigarette smoke, paint fumes or engine exhaust near the intake. If the operator notes any chemical or oily odors after filling has started, he should shut down the compressor immediately. Other useful strategies for reducing the risk of gas contamination include keeping records of air fills and maintenance, ensuring operator qualifications are up to date, using proper oil and filters, and maintaining a clean and organized tank-filling room.

Air-quality testing. As a diver descends and ambient pressure increases, the amount of gaseous contaminants breathed also increases. This explains why a contaminated gas that is not toxic at the surface may be at depth. Breathing gas must be tested for a variety of contaminants both regularly and continuously to ensure compliance with diving-adjusted contaminant levels.

Compliance with breathing-gas quality standards is not strictly enforced, and most of the responsibility for testing lies with the operator. Several methods of testing are available to compressor operators, and they vary in price and complexity. Continuous CO-monitoring devices include electrochemical sensors with color indicators. Devices that continuously monitor moisture level are also available. Operators can perform analyses on site, using typical indicator tubes or they can send a breathing-gas sample to an accredited laboratory for analysis of oxygen, CO, CO_2, moisture, oil/hydrocarbons and even particulate matter; this is recommended on a quarterly basis.

Air Quality Specifications for Recreational Diving

Contaminant	**Maximum Levels**
Oxygen	20-22%
Carbon dioxide	500 ppm_v
Carbon monoxide	10 ppm_v
Total hydrocarbons, including methane	25 ppm_v
Oil/particles	0.5 mg/m^3
Water vapour – up to 20 Mpa – up to 30 MPa	 62 ppm_v 31 ppm_v
Objectionable odours	No odour

Source: EN 12021[*]: Compressed Gas Association (CGA) Grade E, National Fire Protection Association (NFPA) 1500, American National Standards Institute (ANSI/CGA G-7.1’97) [*]*(BS) EN 12021:1999. Respiratory protective devices – Compressed air for breathing apparatus. European Committee for Standardisation (CEN), Belgium, 1999.*

Recommendations for Divers

Ask questions and be observant. If you are unsure about the breathing-gas quality at a fill station, ask questions about compressor maintenance, procedures and testing. Ask if the compressor operator monitors for CO and how often they send samples to a lab for analysis. Look for posted breathing-gas-analysis reports, and note whether the fill room is clean, organized and well ventilated. Observe the proximity of the compressor intake to sources of exhaust, and look to see whether the compressor has an hour meter that can be monitored for regular maintenance.

Always conduct a predive gas check. If your breathing gas has an unusual odour or taste, do not dive with it — this is a red flag for oil or combustion contamination. However, keep in mind that not all contaminants can be detected this way; CO, for example, is odourless and tasteless. Electronic CO detectors or products such as DE-OX® SAFE can be used to detect the presence of CO in breathing gas. Divers should always use oxygen analyzers to determine the level of oxygen in a nitrox mixture to prevent oxygen toxicity.

Confirming Contamination

Identifying contamination incidents based on symptoms alone is difficult, as the associated symptoms are often similar to other diving-related and nondiving illnesses. If a diver suspects he was exposed to bad breathing gas, he should seek a medical evaluation and have the gas tested. Observing the health of other divers who had their tanks filled at the same source may be helpful in determining whether a diver's symptoms are related to contamination.

DAN Europe Launched the Air Quality Safety Campaign in 2014.

If it wasn't for scuba cylinders that give us the possibility to breathe underwater, we wouldn't be able to enjoy the wonderful marine life. However, that is no reason to blindly trust your breathing gas. There are various kinds of contaminations that can turn your underwater life support into pure poison. The slogan "Safety is in the air" wants to make divers attentive to the risk of contamination in the breathing gas.

Discover more about this and other DAN Europe safety campaigns on www.daneurope.org

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