

The Diving Medical Advisory Committee

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Partial Pressure of O₂ in Bail-Out Bottles

Recommendation
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DMAC endorses the principle published in the AODC Safety Newsletter No 3 (below) concerning the partial pressure of oxygen in diver-carried emergency gas supplies in mixed gas diving. Further, it is agreed that this is best achieved by standardising the mixture on, for instance, 20:80 oxygen : helium. It is recommended that diving contractors give serious consideration to the practicalities of implementing this measure.

Increasing Diver Survival Capability by Using an Increased Oxygen Partial Pressure in the 'Bale-Out' Supply

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What is the world underwater breath-hold record? It would hardly seem to be a relevant question to professional divers – but gas supplies can fail. Most people, given some training, can manage to hold their breath for four or five minutes, but the record underwater is nearly 14 minutes and on the surface over 21 minutes. Both were achieved following pure oxygen breathing and deliberate hyperventilation which 'washes out' carbon dioxide from the body.

Breathing pure oxygen at surface pressure (1 bar, 1 ATA) increases the oxygen pressure in the lungs five times above that resulting from breathing air ($1/0.2 = 5$). Oxygen is carried in combination with haemoglobin because, being poorly soluble in water or plasma, not enough can be carried in solution for the requirements of body tissues. Even breathing air at normal atmospheric pressure haemoglobin is almost completely saturated with oxygen so the extra oxygen transported when breathing a raised partial pressure of oxygen is dissolved in plasma. The amount of oxygen carried in solution increases directly with the increase in partial pressure, so that at, say, pO_2 0.6 bar three times as much oxygen is dissolved than at 0.2 bar. Eventually increasing the partial pressure to about 2.5 bar enough oxygen can be carried in solution to completely satisfy the body's requirements without the haemoglobin transport system. This has been proved in pigs and dogs, but not yet in divers ...

It is usual to increase the partial pressure of oxygen in diving to about 0.6 bar in saturation and 1.6 bar during lock-out in bounce diving and it is of course usual for the bale-out supply to contain the same gas used for the dive.

The duration of the bail-out supply unfortunately decreases with depth so that at 150 metres (492 feet) few will last longer than about 2.5 minutes given ordinary levels of gas usage. If the supply ceases before the safety of the bell is reached then the diver will become unconscious because of a combination of carbon dioxide build-up and oxygen lack. Increasing the partial pressure of oxygen in the bale-out supply above that in use will increase the reserves of oxygen dissolved in the blood and increase the survival time in the event of a successful recovery back to the bell.

What level of pO_2 should be used? The industry has been brainwashed about oxygen toxicity but very high partial pressures can be used for short times without risk of convulsions. In fact, the first use of oxygen to reduce decompression times in heliox diving was at 200 feet (7 bar). Most divers have breathed oxygen at 2.8 bar (18m/60ft) during decompression or for the relief of decompression sickness and we suggest this level should be used in the bale-out supply.