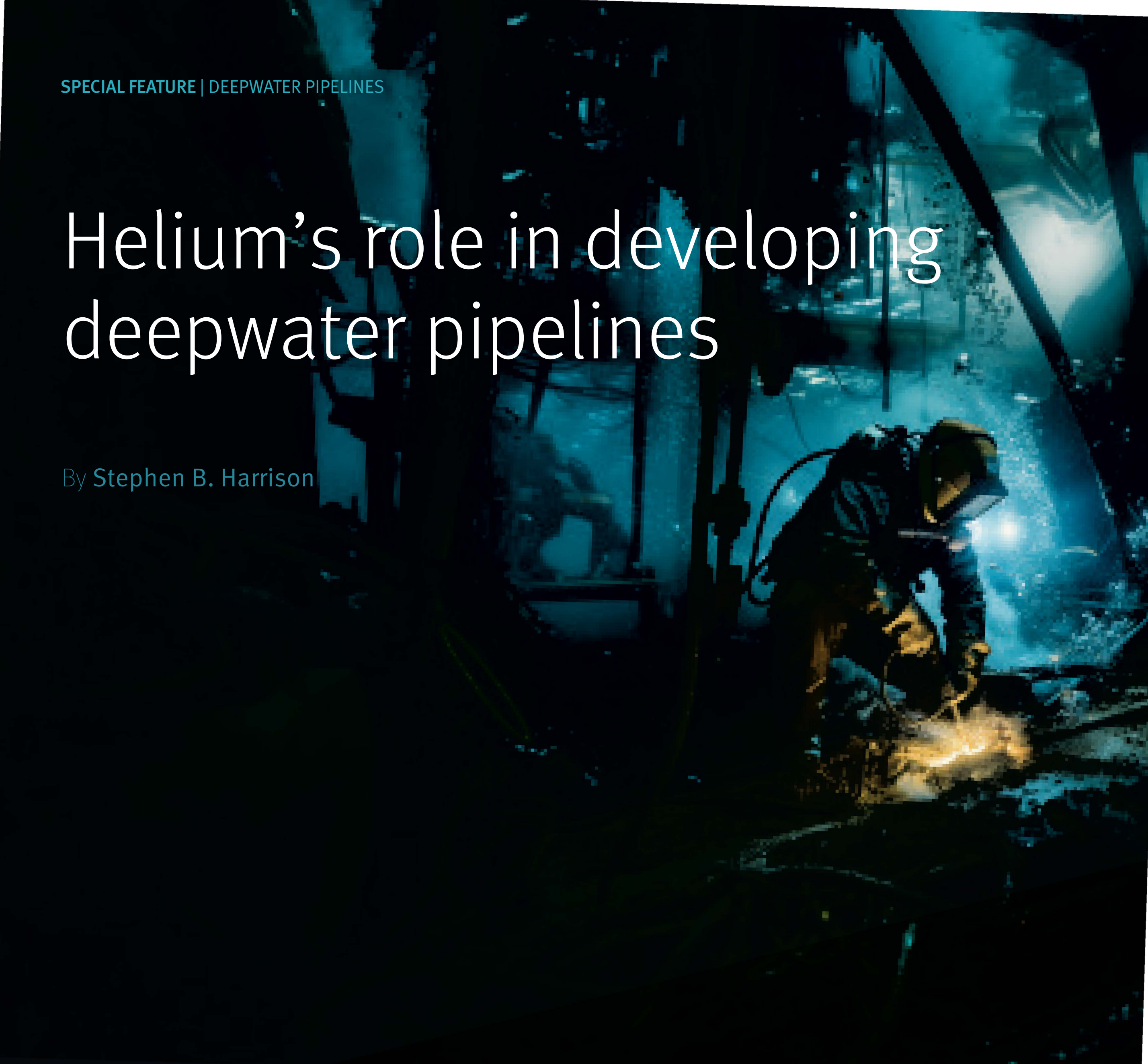
Helium's role in developing deepwater pipelines

By Stephen B. Harrison



Today the seabed is no longer only the domain of oil and gas when it comes to industry. As the energy transition accelerates, new infrastructure is being laid beneath the waves to support carbon capture and storage (CCS) and for hydrogen transport. And these significant developments are reshaping the demands on professional divers to repurpose existing gas infrastructure.

Breathing beneath the surface

Whether installing pipelines for hydrocarbons, CO_2, or hydrogen, the physiological challenges are the same. And all rely on helium-based diving gases.

Nitrox, heliox, and trimix are three mixtures that are the cornerstone of professional diving gases because they enable human intervention at depth. Their use is absolutely critical for safety and for operational efficiency in subsea engineering.

Mission critical gases

Why do these mixtures matter? For deep-water commercial divers, the health risks arise from nitrogen narcosis, oxygen toxicity, and decompression sickness. Diving gas selection is therefore a mission-critical decision, based on dive depth, duration, and task complexity. Let's take a look at each.

Nitrox for shallow operations

Nitrox, a blend of nitrogen and oxygen with a higher oxygen content than air, is widely used for dives up to 40 metres. It reduces nitrogen uptake, lowering the risk of narcosis and allowing longer bottom times.

In shallow waters, nitrox offers a cost-effective and safe solution. However, its use is limited by oxygen toxicity, which becomes a concern at greater depths. For deeper operations, alternative gas mixtures containing helium are required.

Trimix for intermediate depths

For technical diving operations between 30 and 90 metres, trimix, a blend of oxygen, helium, and nitrogen, can be used.

Due to the presence of nitrogen, the use of trimix is limited to shorter durations and shallower waters than heliox, which excludes nitrogen in the gas mixture.

Heliox for saturation diving

Saturation diving enables extended stays in pressurised habitats, reducing decompression cycles. Heliox, composed of helium and oxygen, is the standard gas mixture for saturation diving in depths ranging from 30 to 300 metres. Helium's inert nature eliminates nitrogen narcosis, while its low density reduces breathing resistance, making its qualities ideal for the challenge.

A group of 15 divers may live for weeks in a pressurised hyperbaric living chamber aboard the diving support vessel (DSV). Teams of three rotate in shifts between resting inside the hyperbaric living chamber and working underwater. Transfer from the chamber to the seabed is via a pressurised diving bell, or transfer capsule.

The pressure of the transfer capsule and living chamber match the dive depth. For example, when diving at 200m, they would be pressurised to 20 bar. They are pressurised with the same gas mixture used for the dive.

It is possible in such saturation diving systems to recycle the exhaled gases from the hyperbaric living chamber. In this case, the valuable helium is re-used, exhaled carbon dioxide is removed by purification, and oxygen is replenished.

Beyond oil and gas

Historically, subsea pipelines have served the oil and gas industry, transporting hydrocarbons from offshore fields to onshore terminals. In the future the seabed will also host decarbonisation infrastructure.

In Europe's North Sea, heliox is routinely used for pipeline installation and maintenance on oil and gas infrastructure. With CCS projects like Porthos underway, helium-containing diving gases such as trimix and heliox will also support the installation of carbon dioxide-carrying pipelines. Porthos involves a 20km subsea pipeline from Rotterdam to depleted gas fields under the North Sea.

And hydrogen corridors such as H_2Med are emerging to connect wind and solar-powered electrolysis plants ▶

© DLeng | Diving support vessel

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in Iberia with heavy industry in France and Germany via subsea pipelines. It will transport 2 million tonnes of hydrogen annually, which equates to 10% of Europe's projected demand by 2030.

As part of the H_2Med infrastructure, the 450km BarMar undersea hydrogen pipeline will connect Barcelona and Marseille. The BarMar pipeline will reach depths of up to 2,600 metres. This is too deep for saturation diving so installation must be performed by remotely operated vehicles, known as ROVs for short.

Helium-based shielding gas mixtures

These emerging CO_2 and hydrogen underwater pipeline applications demand similar precision and resilience as traditional oil and gas projects, but with added complexity. Hydrogen embrittlement, CO_2 corrosion, and ultra-high pressures are just a few of the engineering challenges.

Welds are the weak points in any pipeline. Deep-sea professional divers must be expert welders and have access to the best suite of wet welding shielding gases . In addition to helium being a core component of heliox and trimix diving gases, it is blended with argon, CO_2 and nitrogen to produce shielding gas mixtures for wet welding.

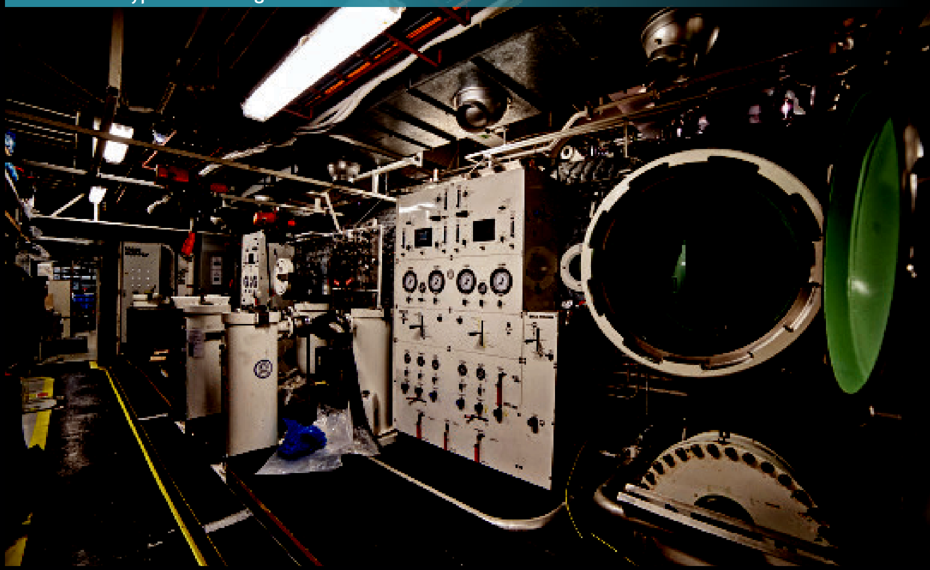
In wet welding, shielding gases are essential. For instance, when working with an electric arc welding rod, the bubbles released around the arc are a mixture of hydrogen, CO_2 and carbon monoxide. The shielding gas protects the weld area from water and oxidation. This is essential, because oxygen can cause cracks in the weld.

European hotspots

The North Sea remains the epicentre of mixed gas diving, with DSVs supporting pipeline installation and maintenance. North Sea activity is spread across ongoing oil and gas operations and new CCS infrastructure development.

Aberdeen in Scotland and Stavanger in Norway are a major hubs which serve deep-sea commercial diving in the northern sectors of the North Sea. Great Yarmouth in England and Den Helder in the Netherlands are bases which serve the more southerly sectors. For operations in the Danish sector, such as the Greensands CCS project,

Pressurised hyperbaric living chamber



© APCI | Helium tube trailer

saturation diving vessels are mobilised from Esbjerg.

For the Northern Lights project in Norway, liquid CO_2 is transported from a shoreside terminal by ship. This avoids the need for a subsea CO_2 pipeline. However, on arrival at the injection platform CO_2 is pressurised to flow into geological formations beneath the seabed. The platform itself and the subsea infrastructure at the storage location wellhead will require deep sea welding operations.

Around the world

West Africa's oil and gas operations also continue to rely on heliox for deepwater exploration and resource extraction. Diving operations in this region are served from France's largest industrial port of Marseille–Fos.

Ravenna, in Italy, has also long served as a saturation diving hub for the Mediterranean. Its services may be required again to support hydrogen pipeline construction. For example, the proposed Hydrogen Backbone includes a subsea intercontinental pipeline from Tunisia to Sicily and then on to mainland Italy.

In Asia, Singapore is unquestionably the regional diving gases hub.

and gas operations in the Gulf of Mexico are meanwhile generally served from Galveston in Texas, or the ports of Morgan Cita and Fourchon in Luisiana.

Macaé and Rio de Janeiro are two main bases for Brazil's offshore oil and gas operations. Petrobras has for many years been the world's largest

Gas cylinders on board a DSV

offshore CCS operator. When oil and gas extraction plateaus at some point mid-century, Brazil is likely to remain a highly active diving region with the transition to enhanced oil recovery and offshore geological CO_2 sequestration.

Seasonal asset utilisation

The rainy season in Brazil, from May to August, is combined with severe electrical storms. Rivers carry sediment into the sea and reduce visibility. Lightning is also not safe for diving operations. The Gulf of Mexico is notoriously dangerous in the Atlantic hurricane season from June to November. During these periods, DSVs are active in the North Sea.

During the months of December to March there are severe storms in the North Sea, which coincides with the Northeast monsoon season in Asia. In these months, DSVs sail to calmer waters east of Brazil and in the Gulf Coast. Asset utilisation is key, at every turn. And the high-pressure gas cylinders onboard the DSVs must be capable of being refilled in multiple locations around the globe.

Safety and standards

Here a run-through in closing of the relevant safety documents.

The International Marine Contractors Association (IMCA) publishes detailed guidelines for commercial diving gas mixtures, including heliox and trimix. It also sets standards for gas purity, storage, analysis, and delivery systems. Relevant documents include IMCA D 018 (Guidelines on diving gases) and IMCA D 023 (Design for saturation diving systems).

IMCA's members include major diving contractors, vessel operators, and subsea engineering firms. Covering the US and the Americas more widely, the Association of Diving Contractors International (ADCI) focuses on commercial diving standards.

The European Industrial Gases Association (EIGA) also has a relevant document, EIGA Doc 206/23 – Guideline for Defining Specifications for Non-Medical Breathing Gases. The scope includes commercial diving gases and the document has many references to other relevant standards and guidance notes. gw