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HOW DO SUBMARINES GET OXYGEN?

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Most of us are intrigued by submarines. Those pressure vessels ply underwater to titanic depths and are used for an eclectic range of purposes from research to defence.

Though apparently, their design appears simpler to ships in terms of its symmetric and simply enclosed exo-structure, its propulsive, communicating and other internal systems are far more complicated.

Remember, unlike ships, the submarine does not have the privilege to ply on the surface and can remain underwater for days at prodigal depths.

So, they need to cater for more advanced systems and technologies that can sustain at such levels and also enable the vessel as well as its crew to meet all verticals of service, capabilities, safety, and most importantly, survivability.

Now, a primitive question in the minds of many: How does the crew inside a submarine breathe? It would not be wrong to say that many of us have had this question buzzing in my head since childhood. But as they say, necessity is the mother of invention. So, submarines have their means of producing oxygen continuously to help their crew stay underwater for days at a stretch.

The Environment In Submarine

As expected, the inner environment inside a submarine pressure vessel enclosure is far different as compared to the natural so-called 'open' environment. There is complete detachment from natural phenomena like wind, rain, sunlight, cold, and the overall diurnal cycle as a whole.

The most critical aspect is the balance of gases in such a corralled environment. All of us need a perfect environment like the present atmospheric conditions to survive comfortably. This involves the exact composition of gases with normal levels of saturation and pressure.

Essentially, the proper environment for sustenance would be the following composition (by volume) akin to our earth's natural atmosphere:

- Nitrogen (~78%)
- Oxygen (~21%)
- Other gases including Carbon Dioxide (<1% in aggregate)

Moreover, for living, the safe pressure limits for air and life-saving oxygen gas are 700 to 800 Torr and 120-160 Torr respectively. For a typical adult, the rate of air consumption for sustainable living is around 7 litres per minute at a given 21% normal concentration of oxygen.

So, per day, the consumption of oxygen amounts to around a

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whopping 600 litres of oxygen for an average healthy person. For even a small research submarine with a complement of 10 crew, the consumption would be a humongous 600 liters of oxygen per day. So, storage of such huge amounts (with surplus margins) is itself a great challenge.

Hence, the generation of oxygen for continual supply is one of the major cornerstones for submarine accommodation and systems design.

Generation of oxygen in submarines

Let us have look at the various means and their chemistries for the generation of oxygen in submarines.

Electrolysis of Water

This is one of the oldest and simplest technologies for the generation of oxygen. This is based on the simple chemistry behind the decomposition of water molecules into hydrogen and oxygen respectively. Before the process of electrolysis, desalination is carried out to remove salt content from the water. Two classic techniques are deployed for this:

Distillation:

The oldest and simplest technique, where sea-water is boiled off, the water is evaporated as vapours salts are crystallized (and removed), and the water vapour is condensed back by colling off the steam through a variety of techniques.

Reverse Osmosis:

This is based on the differential concentration techniques where saline water is passed through fine pores of diaphanous membrane-grade substances at calculated high pressures where freshwater is collected at the other side at low pressure and salt content gets trapped as residues. The process is iterated and continued round the clock.

After the desalination, the electrolytic process takes place in what is known as an ion-exchange system. Alkaline electrolysers are used as a medium containing caustic water solution and 25-30% of Potassium Hydroxide (KOH).

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Sodium Chloride (NaCl) and Sodium Hydroxide (NaOH) are used as catalysts. So, the water treated is disposed of other electrolytes.

At Cathode, the chemical reaction is as follows: 2H20= 2OH- + H2 (decomposition into hydroxide ions and hydrogen) At anode: 2OH- = ½ O2 + H2 (decomposition of hydroxyl ion into nascent oxygen and hydrogen atoms) The hydrogen generated is released into the seas.

The neutral oxygen, later in the gaseous state, bubbled above the anode is entrapped and stored in Oxygen Tanks. It has been proven that approximately 15 cells of about 1000 amps are required to produce sufficient oxygen for about 100 people. The system, as a whole, is known as Electrolytic Oxygen Generators (EOGs).

Chemical Oxygen Concentrator

This is a more advanced, expensive, and risky process but can produce a constant supply in all conditions. This is commonly used in aircraft, fighter warships, mines, and even spacecraft. So, in submarine technologies, this is often deployed, optimizing the combustible risks and better supply performance.

The chief sources of oxygen are mainly superoxides, chlorates, perchlorates, ozonides, etc. In a typical case of a traditional thermal concentrator, also known as the 'Oxygen Candle', Sodium Perchlorate (NaClO3) acts predominantly as the reactor, is mixed with iron or ferrous powder, sometimes Barium Peroxide (BaO2) or Perchlorates in very small amounts (5%) for removal of unwanted residues like hypochlorites.

This combustible mix, when ignited at high temperatures (>600 degrees C) cracks down into Sodium

Chloride (NaCl), Iron Oxide, and thermally decomposed oxygen. The iron or ferrous compound acts as a substrate for continued and prolonged combustion. So, the reaction can be defined as:

2 NaClO3 = 2NaCl (sodium Chloride) +3O2 (generated oxygen)

The removal of chlorites and hypochlorite by Barium peroxide is as shown below:

BaO2 + Cl2 = BaCl2 (Barium Chloride) + O2 (Oxygen)

2BaO2 + 4HOCl (hypochlorite) = 2BaCl2 + 3O2 + 2H2O

Alternately, potassium or lithium chlorates or perchlorates can also be used. A combustion time of 45-50 minutes can produce roughly 115 SCF of oxygen at high temperatures. Smoke and salts are removed by filtration. This inflammable system poses a fire hazard and needs to be operated and maintained with high caution.

Solid Polymer Oxygen Generator

This technology is increasingly superseding existing conventional electrolytic methods in EOGs as described above. This is an improvement over the electrolytic technology and uses Solid Polymer Electrolytic Cell (SPE) for carrying out the electrolysis of water in bigger Oxygen Generating Plants (OGPs).

One of the greatest features of this method is the redundancy of using electrolytes like potassium and sodium hydroxides and insulating materials. The plastic or polymerized diaphragm acts as the electrolyte as well as the insulator.

Another very crucial feature is the rapidness of oxygen generation where it takes less than 1/20th of the time required in conventional electrolytic cells as in EOGs. Moreover, it can operate in low-pressure environs in the order of 500-600 psi in charged conditions.

From the viewpoint of safety, it is also becoming a viable option imputing to the low concentration of combustible Hydrogen Gas expended in the process.

Lastly, the rate of oxygen generation is found to be 50% more than EOGs, which augments the endurance capacity of submarines and can cater for adequate oxygen supply with a lesser number of charging cycles.

So, all these fortes of this advanced technology make it a widespread potential replacement of conventional electrolytic EOGs in all new building or retrofitting.

Removal of Carbon Dioxide

Now, every pro has concomitant cons. Here, in submarines, after the generation of oxygen, the removal of harmful carbon dioxide is equally important.

The machinery, internal systems, and equipment, as well as the human crew subsisting inside, will produce carbon dioxide gas. In a corralled environment like a pressure vessel, which is the submarine, there are no viable means of escape of CO_2 like in normal open environments.

This poses a problem. Accumulation of carbon dioxide in concentrations greater than 5% can be harmful and the cumulating accretion (superseding even available oxygen levels) can even be fatal or impairing. Hence, this carbon dioxide needs to be continually expurgated from the inner environment. This process is essentially known as 'Scrubbing'. Some of the methods are:

Soda Lime Removal

It is the most popular and inexpensive means of removal used for more than a century, also called 'Carbon Trapping.' Soda Lime is a mix of Calcium and Sodium hydroxides in water. So, in this process, the carbon dioxide trapped in the gaseous form is liquified. Then this reacts with sodium hydroxide to produce sodium bicarbonate. This Bicarbonate then reacts with calcium hydroxide to yield removable calcium carbonate and water.

$CO_2 + NaOH = NaHCO_3$ (Sodium bicarbonate)

$NaHCO_3 + Ca(OH)_2 = CaCO_3$ (calcium carbonate) $+ NaOH$

————————————————

So, the net reaction turns out to be:

$CO_2 + Ca(OH)_2 = CaCO_3 + H_2O$

Using Alcohol Amines

In this method, the water is bubbled through an aqueous solution of an alcohol amine compound. These are chained organic carbon-based compounds.

The most used substance for CO_2 scrubbing is monomethyl amine, or shortly known as MEA. There is an exchange column, containing 25-30% of aqueous MEA, through which the air is passed.

The carbon dioxide is trapped in this process. The relative humidity is kept at around 75%. 70-90% of carbon dioxide is removed with one flow. The MEA solution is itself recycled over stainless screens.

The mixture of the MEA with trapped carbon dioxide is passed through glass rings and heated under pressure, driving off the carbon dioxide. Then the MEA is reutilized for absorption. The carbon dioxide is compressed, liquified, and discharged overboard.

Lithium Hydroxide Absorbers

These are also used for removing CO_2. The air is passed through the gas canisters holding the lithium hydroxide compound ($LiOH$). However, here the compound can't be purified unlike MEA and this is a non-reusable means of carbon dioxide disposal.

Burners

Carbon dioxide and other unwanted substances can be removed by forced oxidation methods. The air is heated and soaked into a Cuprous Oxide-Manganese oxide (CuO-MnO_2) catalyst environment at very high temperatures. The gaseous mixture is then cooled off and passed through a surface of lithium carbonate (Li_2CO_3) to remove any acidic gases. In the final stage, the purified air is passed through activated charcoal where the carbon dioxide is stripped off. Here the catalysts are reusable and can be renewed for further filtrations.

Activated Carbon

This is one of the easiest and lately popular means of carbon dioxide elimination. Charcoal is a form of carbon and is 'activated' by heating with steam. This removes all unwanted substances from the air by adsorption and capillary action. Activated charcoal has an enhanced adsorption capacity.

Emergency Means of Breathing

In accidents or exigent scenarios, like any other vessel, submarines have an eclectic range of emergency apparatus for their crew before evacuation or resolution of the issue. Emergency Air Breathing Apparatus (EAB) or the submarine's bespoke Built-in-Breathing System (BIBS) caters for direct breathing of crew with the help of face masks connected to cylinders or the vessel's surplus air storage tanks.

Other self-contained units like Oxygen Breathing Apparatus (OBA) using potassium superoxide (KO_2), which produces breathable oxygen and removes exhaled CO_2 in tandem, or rechargeable and portable breathing gear akin to deep-sea scuba divers are also used.

Over to you. Please let us know your ideas….

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Courtesy:marine insight

CASE STUDY: SAFEGUARD FROM ELECTRICAL SHOCKS AND TURBINE ACTIVATION DURING MAINTENANCE

SIDHARTH KUSHWAHA-B.TECH-IV

Securing the flow of green energy by safely servicing and maintaining fast growing numbers of wind turbines on land and at sea, is no small challenge. Part of that challenge is to optimally protect against electrical shocks and to make turbine activation impossible while maintenance is still ongoing.

The company needed a practical and reliable safety solution to keep maintenance safety at the highest levels.

Solution: Optimal safety with padlock & key

The company's safety experts were already well informed about Lockout/Tagout, a safety procedure that can temporarily neutralise machines from their energy supply. Because of this, Brady was able to quickly offer dedicated Lockout/Tagout solutions with an optimal fit to our customer's machines and electrical cabinets based on pictures shared by the customer.

After seeing videos of how to easily implement each Lockout/Tagout solution, our customer decided on Brady's universal mini circuit breaker lockout device, the compact safety padlock with thin shackle and Brady's standard safety padlock.

Brady supplied the solutions in practical Lockout/Tagout bags, 1 per maintenance professional. Each bag includes universal mini circuit breaker lockout devices to easily block circuit breakers in the off-position. Padlocks in the bag can be used to lock the universal mini circuit breaker lockout in place. They are personalised with an engraving, and keyed alike so that maintenance professionals can open all of their own padlocks with a single key. They are keyed different versus the padlocks in every other bag, so nobody can accidentally remove the padlock of a colleague who might still be servicing the machine. The padlocks are also colour-coded using green for all electrical lockout, and red for mechanical lockout.

The bag also holds a Lockout/Tagout hasp to allow multiple padlocks on a single universal mini circuit breaker lockout device. This will keep a machine neutralised until all maintenance professionals involved are finished and removed their personal padlock.

Results: Increased maintenance safety

Brady has also supplied its BMP21-PLUS Label Printer with B-427 vinyl labels. Brady's practical mobile label printer makes cable labelling in the field that much easier and faster. On top of this, Brady also supplied custom signs and tags with advanced outdoors resistance to reliably communicate information and warning messages on outdoor electrical cabinets.

Together with the Lockout/Tagout devices and padlocks, labels, signs and tags provide protection and vital information to maintenance professionals in the field. They are important to avoid electrical shocks and accidental machine activation while maintenance is ongoing.

Courtesy: Offshore - Energy.Biz

Posted by Savannahweeda

New Study Reveals Ferry Industry's Huge Economic Impact – Inter ferry

VAIBHAV SHUKLA-B.TECH-IV

A study commissioned by trade association Interferry has revealed startling statistics on the far-reaching extent of the global ferry industry's value to the world economy.

Research into the latest pre-Covid full-year figures found that, in 2019, ferries carried 4.27 billion passengers – on a par with aviation – and 373 million vehicles across a worldwide fleet of 15,400 vessels.

Among other findings, the industry provided 1.1 million jobs, contributed $60 billion to the world GDP and represented approximately 20% of shipping's economic value to the European Union.

The study was carried out by UK-based consultancy Oxford Economics, a world leader in economic impact assessment. It quantified three core channels through which the ferry industry drives economic activity and employment – direct support generated by the industry, indirect support generated within its supply chain, and induced support from ferry and supply-side personnel spending their pay on goods and services.

Interferry CEO Mike Corrigan comments: 'We already knew that the ferry segment punches well above its weight – it comprises only 3-5% of the total shipping industry – but the scale of the findings surprised even seasoned insiders.

'Now perhaps we'll get the political consideration that all too often is more focused on airlines, rail operators and road transport. It's long overdue for governments and the general public to appreciate the huge part that ferries play in passenger and freight transport – and this study confirms our sector's vital importance in the process.'

Corrigan announced the findings last week at Interferry's 45th annual conference in Santander, Spain, hosted by Brittany Ferries. At the event – themed The Future is Ferries – more than 300 participants debated positive solutions and prospects in response to challenges such as Covid and climate change.

In a keynote address, research by

London-based L.E.K Consulting into the post-pandemic outlook for Europe's passenger ferry market was reviewed by Becrom Basu, a partner in the company's transport and logistics practice. He noted that successful vaccination roll-outs had given governments the confidence to gradually ease stringent travel restrictions. This in turn was releasing pent-up demand that pointed to a significant uplift in European travel towards 2019 levels by next year.

Stressing that the ferry market looked best placed to capture this potential, he added: 'Online searches for ferries have largely returned to pre-Covid levels, while searches for flights remain significantly lower. Ferries ranked highly as a safe form of travel. Sentiment towards them has improved while aviation has suffered.

'The pandemic has created a much more positive view of ferries and a large proportion of previous nonusers are likely to consider this option for their next trip. Ferries have emerged as a clear winner in the battl ***Towards zero emissions – view from the top.***

CEOs from ferry companies in eight nations in Europe and the Americas took part in panel discussions that largely centred on plans to reduce greenhouse gas emissions over the next decade – with notable emphasis on the need for shoreside infrastructure to support operator initiatives. Among their comments:

Niclas Martensson, Stena Line, Sweden: 'Zero is a must – it's a survival tool – but there is no silver bullet. We are talking about different alternatives including hydrogen, methanol and batteries. We don't yet see that the public is willing to pay for this but we can't wait for their willingness. The industry must have the mindset to take the first step. We have to protect Mother Earth.'

Patty Rubstello, Washington State Ferries, USA: 'Our customers want it and they don't have to pay for it because the government will come up with the dollars. In future we will be fully hybrid. I'm struck by the industry's single-minded attitude towards reducing emissions. We're not trying to avoid it, we're looking for solutions.' Mark Collins, BC Ferries, Canada: 'We see reducing emissions like safety – it's expected. Electrification is the way to go for Canadian operators as we are blessed with a lot of clean hydro power. Meanwhile we see LNG as a sensible interim since British Columbia has the world's cheapest supply – but all our LNG vessels are designed to be electric in the future.'

Georges Bassoul, Balearia, Spain: 'Six years ago we decided to go for gas and today eight of our vessels are operating on this, with more to come. We are very proud that emissions are down 40%. We've had to work with port authorities on bunkering and train our people. But we know gas is probably transitional so we are also studying other technologies.'

Mauricio Orozco, Ultramar, Mexico: 'Regarding let's go green and reduce emissions…it strikes me that we might be causing emissions someplace else to get that fuel to your boats. I would love zero emissions vessels but we have only one port with charging facilities.'

Spiros Paschalis, Attica Group, Greece: 'Operators can't do it alone. We need a joint effort with port authorities and equipment manufacturers.'

David Sopta, Jadrolinija, Croatia: 'Ports must be equipped with the infrastructure to supply green fuel.

If financing all falls on ferry companies it's not fair because it's not just our problem.' John Napton, Condor Ferries, UK: 'We depend on ports and they have to be involved. The key message from this conference is that to reduce emissions our port partners need to come on board.'

Morgan Mooney, FRS/San Juan Clipper, USA: 'The fact that the global ferry industry is able to meet again after the pandemic and share our vision reinforces what Interferry constantly reminds us about…that we are stronger together.'

Regarding the ultimate drive towards electrification, CEO Mike Corrigan has now signalled Interferry's intention to get governments, ports and energy companies onside in order to provide adequate power infrastructure so that ferries can plugin.

He asserts: 'Going forward, we will use the findings from our study on the ferry industry's size and economic impact to push decision-makers towards funding port-side power development. A unified the approach is critical in supporting operators' own commitment to achieving the emissions reduction targets set by the IMO, European Union and other regulators on the path to zero.'

Courtesy: marine insight

UK Parliament puts a spotlight on shipping emissions

KARTHIK KUMAR-B.TECH. IV

The Environmental Audit Committee (EAC) in the UK Parliament has launched a new inquiry in an effort to look at how the shipping and aviation sectors can best achieve net-zero emissions.

As explained, shipping and aviation together make up 10% of UK greenhouse gas emissions, and decarbonising these sectors will play a key role in achieving net-zero emissions by 2050.

The International Maritime Organization (IMO) warns that carbon emissions from shipping are projected to increase by up to 50% above 2018 levels by 2050 if no action is taken. What is more, aviation is set to be the largest emitting sector by 2050 on current trends.

During the inquiry, the EAC will be considering a number of areas which could play a significant role in reducing emissions for the two sectors.

These include the commercialisation of new technologies and low, transitioning to zero, carbon fuels; reductions in demand; and options to drive international action to lower global emissions from these sectors.

The European Commission recently unveiled its 'Fit for 55' plan which will tax aviation and maritime fuels for the first time while setting targets on shipping emissions and sustainable aviation fuels. This is in addition to the expanded Emissions Trading Scheme covering shipping within the EU from 2023.

"Aviation and shipping make up 10% of the UK's greenhouse gas emissions. As we get back to normal after the pandemic, we must find ways to support the aviation and shipping sectors while drastically reducing their carbon footprint: it won't be plain sailing but failure to do so will never see net zero Britain take off," Rt Hon Philip Dunne MP, Environmental Audit Committee Chairman, said.

"International shipping transports more than 80% of global trade, and if no action is taken, its emissions could double by 2050," he added.

"There are bold ambitions – unveiled by government only last week – for new technology to lower our share of international aviation's carbon emissions to net zero by 2050. It is welcome that the government has launched serious engagement in this year of COP26 to include these emissions in developing plans for Net Zero Britain. But the technical challenges are immense and we wish to shine a light through this inquiry on the opportunities and risks in achieving these goals."

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