

UDT 2019 – Hydrogen: a future vision from the underwater domain

Abstract — Since 2011 the Italian Navy has issued guidelines in terms of energy efficiency, and the resolution to invest in the latest generation of Air Independent Propulsion (A.I.P.) Submarines, the U212A Class, based on Fuel Cells technology, has fully followed the guidelines. Due to twenty years of operation use of the AIP Submarines, the ITN Submarine Force has developed extremely specialized know how and mature skills on the production, storage, transportation and consumption of hydrogen as modern energy carrier. In this context, the ITN can assume a leading role for national hydrogen R&D and regulation, supporting the national vision of Hydrogen as one of the most disruptive energy carrier for the near future, in full synergy with the circular economy paradigm.

1 Purpose

Today, hydrogen already represents a versatile energy carrier that can be easily transported and converted; but the versatility involves great hydrogen quantities storage achievable only through energy production and an appropriate infrastructure development.

Related technology is nowadays still expensive but the ever more widespread use of hydrogen-based systems like the Fuel Cells, in leading sectors such as automotive, is increasing the systems efficiency, lowering the costs.

The ITN Submarine Force has been successfully employing Fuel Cell as source of power, and hydride cylinders as storage solution, for almost fifteen years, successfully operating at sea, from ashore, 80.000 kg of hydrogen; such a specialized knowledge has to be synergized to the “civil world” in order to support and boost the green economy change.

Actually hydrogen, zero emissions extracted, represents the best energy storage solution, and surely, as long term choice, it will contribute to achieve the European Community targets to reduce the carbon emissions in the next decades.

In the automotive field the technology is already available in the need just to reach a sustainable market to grow; in the marine field it seems more challenging to identify feasible solutions to ensure the required autonomy and cost-effectiveness in a so hard environment as the sea.

2 Introduction

After fifteen years’ experience, the ITN Submarine Force has reached a comprehensive expertise in the refuelling procedures and in the storage of hydrogen on board of its submarines, consolidating its support position to the development of an hydrogen network.

Indeed the IT Navy can be one of the actors leading the regulation process of the refuelling procedures, taking part to the national hydrogenation process such as the creation of production and storage sites and the design of a national distribution network.

Furthermore, the ITN is moving towards new solutions in the submarine field: the next steps will be to develop new solutions to store a larger amount of hydrogen on board taking advantage of technologies nowadays available, such as new generation high density hydride or high pressure vessels designed for these challenging special applications.

3 Future Work

The R&D department of the ITN Submarines Dpt. is exploring the opportunity to implement high pressure vessels solutions instead the actual hydride storage solution, or to develop new material with an higher absorption capacity in order to increase the boats autonomy and maintainability of the system.

Furthermore these studies will boost the research of new solution for the automotive market oriented towards the high-pressure storage solutions, being more cost-effective and lighter than hydride cylinders. Mutually this field of research will encourage the introduction of new solution in marine applications not only for the underwater domain.

Our vision for the future is a sustainable circular economy of hydrogen: sites of production from renewable energy, efficient long-term storage systems and deployable stations all in-one; a similar solution could be adopted for a submarine home base.

4 Conclusions

The A.I.P. propulsions system of the ITN submarines, based on the Fuel Cell technology, allowed to reach high performances unmatched in any other application in terms of green concealment and underwater mobility. To reach this goal the ITN Submarine Force has performed more than one hundred refilling operations of liquid and gaseous hydrogen in the last fifteen years, far from home and safely, developing a rare expertise.

In order to support the capacity building of a national green circular hydrogen economy and the development of the required hydrogen networking in terms of zero

emissions production, storage and distribution, the ITN is focusing on R&D of more efficient technologies, fulfilling the regulations of hydrogen storage and delivery.

Speaker Biography

Lt Cdr Fabio Nicoletti is a Submariner, Naval Engineer (*"Vibration and Noise Active Control on board ships"* as Master's Degree) in service in the Italian Navy since 2001. After the finalization of the degree course and qualification to be a submariner, he has been an engineer on board Sauro Class submarines and U212A Class for 11 years, becoming in 2013, for 5 years, the Chief Engineer of the ITS Todaro (AIP – Fuel Cells Conventional Submarine), supporting its efficiency and operational safety as head of the engineering team of the crew: in the last three years, he has spent 9.500 hours and 45.000 nautical miles of operations at sea.

Actually he's working in the Engineering and Safety Office of the Italian Navy General Staff Submarine Department, making available the experience gained at sea at the service of the growth of the know-how of the Submarine Italian Force, and attending a second degree course in Electric Engineering and Energy Management to support the Italian Navy actual and future green vision.