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H2PORTS. HYDROGEN REFUELLING SYSTEM DEVELOPMENT IN THE PORT OF VALENCIA

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Abstract* - *Hydrogen is an energy carrier with great potential for clean, efficient power in transport applications. Hydrogen can be obtained from different sources, which in combination with fuel cells it can improve energy efficiency. This project tries to introduce hydrogen as an alternative fuel in the port industry.

The H2Ports project is an Action aligned with the needs and objectives of the European Commission and the port industry. The aim is to provide efficient solutions to facilitate a fast evolution from a fossil fuel based industry towards a low carbon and zero-emission sector.

H2Ports aims to test and validate hydrogen-powered solutions in the port-machinery industry with the target of having applicable and real solution without affecting port operations while producing zero local emissions. The project involves a mobile hydrogen refueling system which supplies hydrogen to two different heavy duty vehicles. The port machineries are a reach stacker and a yard tractor. Both vehicles are in two different terminals, MSC and Grimaldi.

Because ports regulation, the port machinery cannot leave their terminals so the solution that has been developed is a mobile refueling station which will travel along the port to supply hydrogen to the heavy duty vehicles in their terminals. The facility will be based in the port of Valencia allocated near both terminals.

***Index Terms* – Hydrogen refueling station, mobile hydrogen station, decarbonation of maritime ports.**

I. INTRODUCTION

Maritime transport and the port sector are a powerful source for job creation and economic welfare. The increase of foreign trade in European ports has led the expansion and improvements of many of them from many perspectives. This evolution has provided remarkable benefits in the society boosting global trade and facilitating the access to goods worldwide. However, the increase of infrastructure, services and logistics have important negative impacts on the environment, especially on the cities located nearby ports.

The intensive consumption of energy during port operations, with a significant part coming from fossil fuels, leads to the release of pollutants and greenhouse gases. This has motivated port authorities from all around the world to become cleaner and more efficient, and the Port of Valencia has a clear strategy in this sense in which the use of hydrogen plays an important role. This is aligned with Regulation 2014/94/EU of the European Parliament related to the implementation of an infrastructure for alternative fuels, hydrogen is called to be one of the alternative fuels to current fossil-based ones.

The main tool that the European Commission has deployed to promote the hydrogen sector is the FCH 2 JU, a unique public private partnership supporting research, technological development and demonstration (RTD) activities in fuel cell and hydrogen energy technologies in Europe.

In 2017, the FCH 2 JU launched the initiative entitled "Fuel Cells and Hydrogen for Green Energy in European Cities and Region" to support regions and cities reducing emissions and favoring their energy transition. Port applications were identified in the study as one having high environmental benefit even though their low Technological Readiness Level. FCH 2 JU's Annual Work Plan 2018, promoted the development of vehicles in port operations and selected H2Ports project in order to demonstrate that hydrogen is a feasible alternative and cleaner energy source to take into account in the port-maritime sector.

The H2Ports Project aims to develop, deploy, test and to benchmark industrial heavy duty port cargo-handling equipment powered with Fuel Cells (FC) to be used in real port operation. A Yard tractor and a Reach stacker have been selected as those specially fitted to the use of FC in port facilities.

H2Ports helps to facilitate a fast decarbonation of the port-logistic industry applying hydrogen technologies already used in other sectors but not adopted yet in the European port sector. So this project is a novelty idea to be implemented in more ports in the future. H2Ports is a highly ambitious project, aiming to deploy port equipment working with hydrogen as a fuel, in the Port of Valencia (Spain) as a test and demonstration site.

II. HYDROGEN REFUELLING SYSTEM

A. Process Introduction

The facility will be based in the port of Valencia allocated near both terminals [1]; it will have four main parts:

- Reception hydrogen storage
- Compressor
- Cascade pressure system
- Dispenser

Due to port regulations the vehicles cannot leave the terminals so the refueling station should move along the port and the terminals to refill the vehicle tanks. Therefore, the installation will have two different parts:

- Mobile unit: the dispenser and the cascade pressure vessels
- Static part: the compressor and the storage tank.

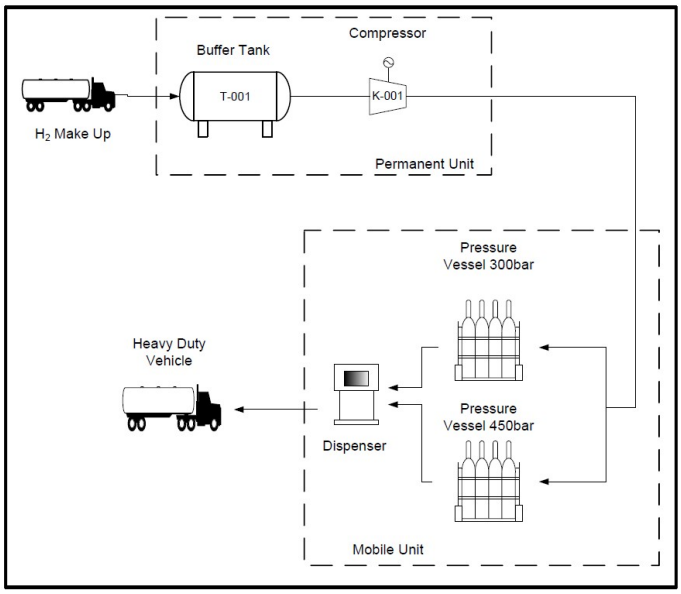

Figure 1. Hydrogen Refueling Station Schematic

B. Process Description

The hydrogen refueling system (HRS) facility has been configured in such a way that the set of two heavy duty vehicles will be able to refuel fuel hydrogen within their terminals [2].

The HRS receives the hydrogen gas from the gas supplier and it is stored in the buffer tank. This deposit is connected to the compression part where the gas will be compressed up to 450bar. Once the hydrogen has been compressed, it is connected to a cascade pressure tank system which has a dispenser integrated. The pressure system is a cascade pressure system and has 2 levels of pressure. 300 bar and 450 bar.

This entire unit is a mobile unit and it will move from the HRS facility to the terminals to refuel the vehicles which have been mentioned previously.

C. Facility Details

Buffer Tank: The storage tank will receive the hydrogen gas from the supplier and will store the pressured gas at 40bar. The storage tank is a horizontal vessel with a volume of 50m^3 at 40bar.

Compressor: The compressor will receive the hydrogen gas from the buffer tank at a minimum of 10bar and maximum 40bar. The compressor will be able to compress the gas up to 300bar and 450bar due to the FC vehicle admit the gas at 350bar.

Cascade pressure system: The high pressure storage facility on this project is a cascade storage system. This system has two pressure vessels which are medium pressure (300bar) and high pressure (450bar). There have been studies showing a better performance over the buffer systems and it is considered as the most appropriate configuration for the storage system [3]. This configuration allows the facility to start the refueling with the lowest pressure vessel. When the flow rate gets the set point value the flow will come from the highest pressure level till the tank in the heavy duty vehicle is completely full

Dispenser: Hydrogen dispenser will supply hydrogen to the heavy duty vehicle up to 350bar. During filling, the vehicle hydrogen tank is first connected to the lowest pressure vessel up to reach equal pressure level; afterwards, hydrogen will be supplied through the highest pressure vessel up to get 350 bar in the on-board tank. Regarding standard regulation the supply should be done at 3.6kg/min as maximum flow rate [4].

III. Conclusion

H2Ports sorts out the issue of refueling final user where the access to a hydrogen fuelling system is not as easy as in a standard refueling station. This mobile unit solution allows to heavy duty vehicles do not leave their terminals to be refueled due to Maritime Port´s regulations.

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