REDUCING AIR EMISSIONS FROM SUPERYACHTS

SOLENT UNIVERSITY

INTRODUCTION

The maritime sector is one of the worlds highest contributors in air pollutants such as greenhouse gases and sulphur oxides. Since the superyacht industry is set to grow exponentially in upcoming years; this project focuses on the most effective emission-reducing technology that can be integrated with an existing superyacht.

PROJECT AIMS AND METHOD

This project aims to determine the most effective emission-reducing technology for a superyacht by investigating 4 methods that are currently in use within the maritime industry. These methods are: PEM fuel cells, hybrid battery-ICE, scrubbers, and plug-in vessels. An additional goal is to achieve zero-emissions whilst in port.

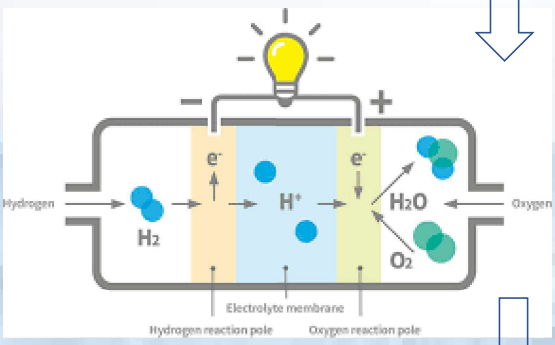
To achieve this; an options analysis and weighted matrix have been used to reduce the number of potential options from 4 to 2. The remaining 2 potential solutions have then been analysed using calculations and applying them to a case study vessel (M/Y Eclipse) to determine the final solution.

A system drawing was then completed to demonstrate the required system components.

PEM FUEL CELL OPERATION

$$2H_2 + O_2 \rightarrow 2H_2O + energy$$

The fuel being used for this fuel cell system requires seawater which can be converted into the hydrogen fuel onboard. This solution exceeds the zero-emission goal as a vessel operating with fuel cells only produces heat and water.



A weighted matrix was used to evaluate vital criteria selected from the product design specification against the 4 potential solutions.

Criteria	Importance	Fuel Cells	Scrubbers	Plug in vessel	Hybrid battery-ICE
1.1	3	+3	+3	+3	+3
2.3	2.5	+2.5	S	S	+2.5
2.4	1	+1	+1	-1	+1
3.1	2.5	+2.5	S	+2.5	+2.5
4.1	2	S	-2	-2	S
4.2	1	S	-1	S	S
TOTAL		**+9**	**+1**	**+2.5**	**+9**

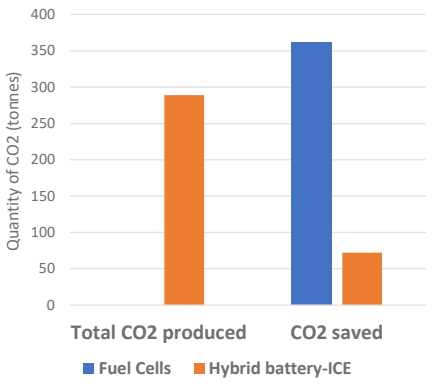
SO_2 and CO_2 emissions were calculated for the 2 highest scoring potential solutions: PEM fuel cells and hybrid battery-ICE. Applying and comparing these technologies to a case study vessel allowed the most effective emission-reducing method to be determined.

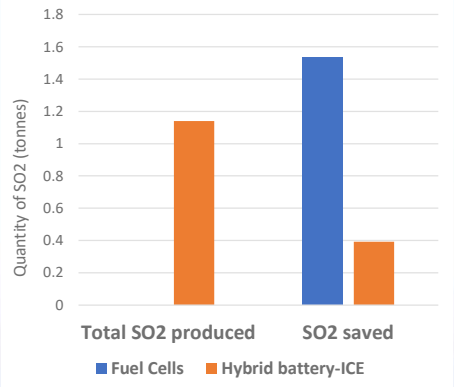
CASE STUDY EXAMPLE VOYAGE

Vessel: Motor Yacht Eclipse
Speed: 16kts
Initial port: Dubrovnik, Croatia
Destination port: Monaco

Time spent in port: 32hours
Sailing time: 55hours
Engines running in port: 1
Engines running during voyage: 5

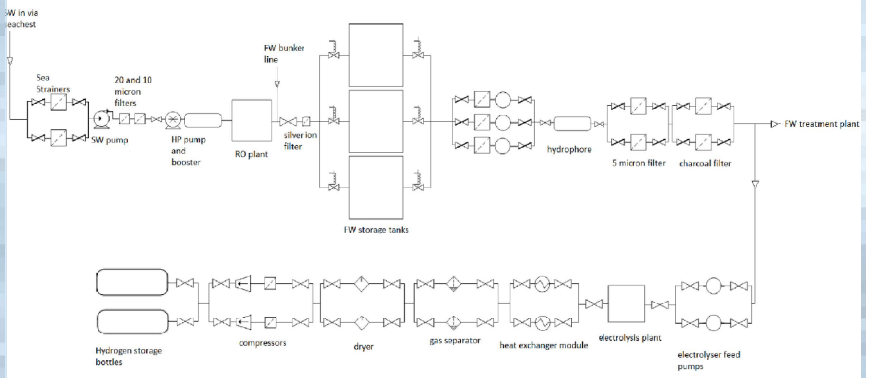
RESULTS

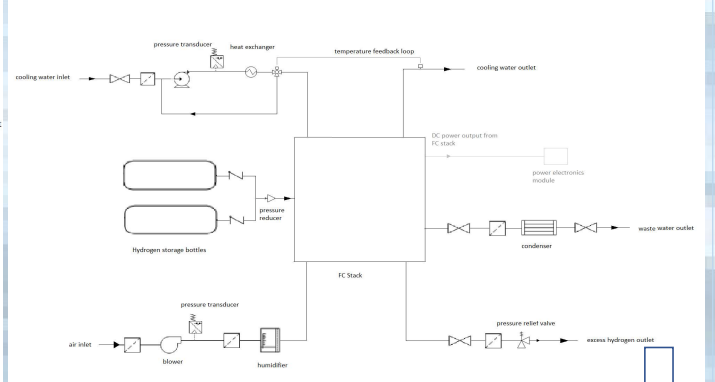




Following the calculations, M/Y Eclipse would save over 350tonnes of CO_2 and over 1.5tonnes of SO_2 using fuel cells which is greater than the savings made by using a hybrid battery-ICE system. Therefore fuel cells have been selected as the final solution for the project.

SYSTEM DESIGN





CONCLUSION

The comparison between CO_2 and SO_2 emissions produced by hybrid battery-ICE systems and PEM fuel cells establishes that fuel cells are the most promising solution to reduce air emissions from superyachts. PEM fuel cells will significantly reduce emissions produced as their only emissions are heat and water, therefore vessels can operate with zero-emissions in port and during service and since their fuel is hydrogen which can be produced onboard from seawater.

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