An end to emissions? Why hydrogen fuel-cells will revolutionise maritime

Wed 14 Nov 2018 by Selwyn ParkerFuel cells are compact and light, important ingredients in vessel designAs potentially the cleanest of all power sources, hydrogen fuel-cell technology is under intense scrutiny in the world’s laboratories, writes Selwyn ParkerNorwegian maritime research group Sintef Ocean and Zurich-based ABB have launched a collaborative project exploring the potential of powering full-sized vessels with fuel-cell technology.The two companies will start work in Sintef’s laboratory in Trondheim, using its vessel simulator to test different combinations of diesel, battery and fuel cells under varying loads. If the science stands up, it could lead to an important breakthrough in propulsion.“Ultimately, any type of commercial or passenger ship could be driven by fuel cells,” say Sintef Ocean research manager for maritime energy systems Anders Valland.And while nobody is predicting the imminent demise of fossil fuels, Sintef’s scientists believe fuel cells could provide a viable alternative, even in big vessels, in the not too distant future. “These trials are expected to provide a platform for fuel-cell [technology] to build on, so it can take a position in the maritime sector that is competitive with fossil fuels,” said ABB Marine and Ports product manager for energy storage and fuel cells Jostein Bogen.“These trials are expected to provide a platform for fuel-cell technology to build on, so it can take a position in the maritime sector that is competitive with fossil fuels”Some experts predict that fuel cell-powered ships will be plying the oceans much sooner many had assumed. Nicolas Pocard, marketing director of Ballard Power Systems, which has been working on the technology for years, said: “Marine applications are currently in development; they should become widely available within three to five years after the first systems are implemented and proven in the field.”And why not? Hydrogen fuel-cell power has been successfully installed in buses, trains and trucks. And the cruise industry, for which there is a strong business case for zero-emission propulsion, is deeply interested in the technology.From kW to MWWorking alongside ABB, Ballard Power Systems is leveraging the current kW-scale fuel-cell technology into a full MW-scale output; quite enough to push big vessels through the water.And Ballard is making good progress. In mid-2018 it came up with a unit capable of producing 3 MW – or 4,000 horsepower – in a unit no bigger than a standard fossil-fuelled marine engine.In November, in a blog entitled Zero-emission regulations are coming to the marine industry, Mr Pocard argued that shipowners and operators will be forced to have at least some zero-emission vessels in their fleets “within a very few years”.He cites four key benefits of hydrogen fuel-cell technology: stable, direct-current power that can be distributed across the entire vessel, including all its electrical requirements; the fast-improving capacity of fuel-cell systems, now up to 55% electric efficiency; clean, usable water as the only by-product; and long service life with low maintenance. (Classification organisation DNV GL adds two other virtues to fuel-cell power: much lower vibration and less noise.)In fact, Mr Pocard considers fuel-cell power as superior to battery power because “hydrogen has a much higher energy density than batteries, [so] fuel cell-powered vessels can run longer and travel further before refuelling.”At the Trondheim laboratory, the fuel cells under development are known as proton-exchange membrane (PEM). The project is built around PEM because they offer several advantages over their solid-oxide counterparts; they operate at lower temperatures, are more compact and lighter.“Marine applications should become widely available within three to five years after the first systems are implemented and proven in the field”And while the various research teams working on this technology cannot put a precise date on when combustion-free, hydrogen-powered fuel cells will drive environmentally pure deep-sea ships, they are convinced it will happen, to the considerable advantage of the planet. “With the use of renewables to produce hydrogen for fuel cells and stored energy for batteries, the entire chain can be clean,” predicts ABB Marine and Ports’ Mr Bogen.Currently fuel cells, broadly classified as energy converters, are thought to be the natural technology for hydrogen, but other hybrid applications are being developed in laboratories around the world. For instance, gas turbines or the traditional internal-combustion engine can be incorporated into fuel cells, instead of as stand-alone operations.Similarly, fuel cells can be combined with batteries and, possibly, super capacitors, according DNV GL in its latest analysis of where the maritime industry stands with alternative fuels. “[These] add peak-shaving effects [and are] a promising option,” the society notes in its report, Assessment of alternative fuels and technologies.Looking further ahead, the report highlights the potential of a different kind of fuel cell – the proton exchange membrane fuel cells (PEMFC). Because they are made of more flexible materials, PEMFCs could improve fuel-cell lifetimes significantly, as they are better protected against the heaviest loads, suggests the paper.However, it also notes the outlook for solid oxide fuel cells (SOFCs) is less promising: “[They] must be applied in a hybrid environment using peak-shaving technology to be a realistic alternative for shipping.”A measured approachEven methanol-fuelled ships such as the Stena Germanica emit more pollution than fuel cells (image Stena Lines)At Trondheim the researchers are taking a measured approach, conducting their experiments and simulations on terra firma, albeit in a simulated maritime setting. “Finding unknowns and coping with them in a controlled environment, rather than risking surprises onboard ship, will be central to these trials,” said Mr Bogen.Still, no one is doubting the project’s ambitions; as ABB Marine and Ports research and development engineer Kristoffer Donnestad explained: “We will be seeking the decisive and practical solutions to develop fuel-cell technology for main propulsion.” Trondheim laboratory has a good track record in converting research into results. Some of ABB’s most advanced maritime technologies were jointly developed there, such as its Onboard DC Grid, that allows diesel engines to run at variable speed to achieve maximum efficiency according to the load.The research into fuel-cell technology is taking place against a background of intense interest in increasingly clean fuels, those that can be made even cleaner than LNG. For all its benefits in terms of the near elimination of sulphur and high reduction of NOx particles, LNG’s greenhouse gas (GHG) emission results are not negligible, due to the high possibility of methane slip,” explained Europe’s Environmental Defense Fund in a mid-2018 paper entitled Alternative fuels: the future of zero-emission shipping.If LNG doesn’t cut it in environmental terms, shipowners are bound to look at

other options. “Other alternative fuels that will be able to tackle both GHG and air pollution emissions in the maritime sector are methanol, biofuel, ammonia and hydrogen,” the paper adds.And, if the predictions are even close to being accurate, hydrogen power could soon join this group and perhaps overtake it as the most favoured and cleanest maritime power source.