International
Chamber of Shipping
Shaping the Future of Shipping

Key Issues

Developing Zero CO_2 Fuels

The vision of the shipping industry, also articulated by the IMO Green House Gas strategy adopted in April 2018, is to achieve zero CO_2 emissions as soon as the development of new fuels and propulsion systems will allow.

The huge technical challenges and research required should not be underestimated and, taking account of the new bunkering infrastructure that would also be required, the worldwide availability of zero CO_2 fuels could take at least another 30 years to deliver. However, ICS is now engaged in a number of initiatives with various industry stakeholders, including engine manufacturers and academics, to explore what the path to a zero CO_2 future might be.

The greater use of LNG and biofuels may well form part of the interim solution, supplemented by renewable sources such as wind and solar. But the ultimate goal of zero emissions can only be delivered with genuine zero CO_2 fuels that are both environmentally sustainable and economically viable.

Batteries

Advances in chemistry and technology could eventually mean that even large ocean going ships powered by batteries, using renewable sources of energy, could potentially become a viable zero CO_2 alternative.

Although currently only suitable for ships engaged on short voyages, there is potential to apply battery hybrid technologies widely used in the automotive sector. There are already ferry conversions and offshore support vessels using hybrid propulsion to optimise efficiency and reduce fuel consumption. Engines can run at a constant stable load, with batteries either boosting output or being recharged by the engines according to operating conditions.

In the longer term, there seems to be a genuine potential to utilise batteries as the primary source of power even for larger ships. Such batteries would probably be extremely large, but with appropriate adjustments to the ship the loss of cargo capacity could be offset by eliminating fuel tanks and conventional engine machinery.

Large batteries are currently expensive, and their high energy density imposes additional risk management requirements. The availability of sufficient rare metals to manufacture batteries with necessary power might also limit viability.

Adopting pure battery power operations – including more frequent port calls to permit recharging – will require radical adjustments to how ships are operated and careful route management. A global recharging infrastructure would be needed with access to electricity from renewable energy, capable of recharging extremely large and high capacity batteries quickly. But the challenges involved might not be insurmountable.

Hydrogen

Significant research is underway to develop energy efficient processes for producing hydrogen from water using thermochemical processes (unlike most commercially available hydrogen which is currently derived from fossil fuel feed stocks). The main challenges for hydrogen as a marine fuel are the cost of production, transport and storage. An appropriate bunkering infrastructure will also be needed.

Hydrogen can be utilised by direct combustion in a conventional engine. But fuel cells are more efficient and avoid NOx emissions. However, fuel cell stacks (the component where energy conversion takes place) have a finite life, which can be quite short in terms of the service life of a ship.

Hydrogen has a lower energy density than conventional fossil fuels and would need careful risk management. It has a very wide flammable range and very low minimum ignition energy, while embrittlement of metals might lead to leakages. However, hydrogen could be reformed on board ship from almost any feed stock in order to ease fuel storage and handling, and to minimise the safety risks

At atmospheric pressure, liquid hydrogen would need to be cooled below -252°C, significantly below the temperature required to liquefy LNG. Compressed gaseous hydrogen would probably be impractical on longer voyages.

Ammonia

As an alternative to liquefied or compressed hydrogen, ammonia could be used as a hydrogen carrier, avoiding the necessity for a cryogenic plant on board. (Methanol is also being explored as another possible hydrogen carrier.) Liquefaction of ammonia, at far higher temperatures than for hydrogen, is possible under pressure (similar to propane gas). Ammonia can also be stored as an aqueous solution which is safer.

Although 'green' ammonia production (like hydrogen) from renewable sources is more energy intensive than traditional processes, the increased availability of carbon free electricity generation could make this viable.

Ammonia could be used as a fuel itself, but technical difficulties mean it is more likely to be used with hydrogen fuelled systems after dehydrogenation, avoiding the cryogenic systems necessary for the carriage of liquid hydrogen or the limited voyage length required if using compressed hydrogen gas.

The principal concern about using ammonia as a marine fuel is safety. Exposure to gaseous anhydrous ammonia can cause caustic burns, lung damage and death. Some types of fuel cell stack are incompatible with ammonia, so that even very small quantities of ammonia remaining after reforming into hydrogen could seriously affect performance. Nevertheless, as with battery technologies, the challenges involved might not be insurmountable.

Nuclear

Nuclear fuels are a proven technology that could be readily applied to many merchant ships in order to eliminate CO_2 emissions completely. Only a small nuclear reactor would be required, with a life of many years, removing the need for ships to refuel or carry bunkers. Russia successfully operates a number of nuclear ice breaking vessels in the Arctic. However, it is currently assumed that widespread use of nuclear fuels is unlikely to be viewed as politically acceptable by the majority of governments, due to concerns about safety and security.