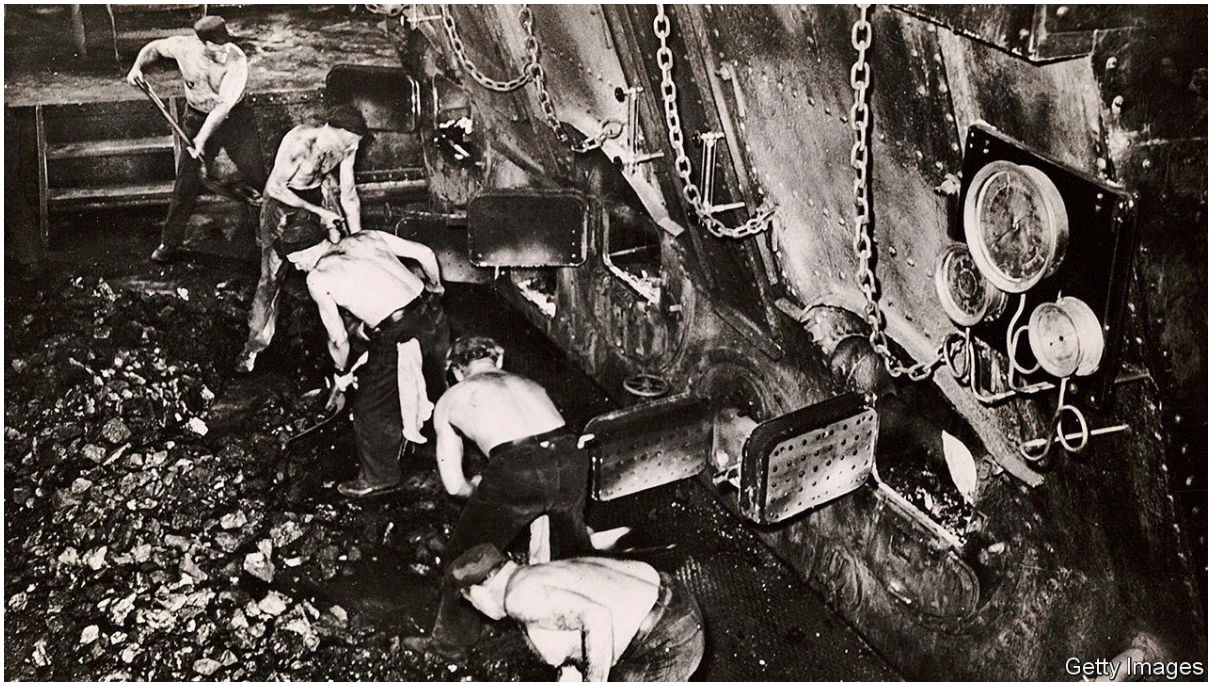
The Economist

Cleaning up shipping

Shipping regulators plan to cut greenhouse-gas emissions

That will require bold thinking



Print edition | Science and technology

Nov 1st 2018

SHIPPING IS A dirty business. Since the late 19th century, when steam replaced wind as the main means of propulsion, ships have relied on filthy fossil fuels. Coal-fired steam has given way to internal-combustion engines. But these still burn stuff that is so gunky as to be almost solid unless heated. Like coal, these refinery dregs, known as bunker fuel, release a lot of carbon dioxide—perhaps 3% of global emissions of this greenhouse gas. Cleaning up ship exhausts is therefore a good idea if the world is to get anywhere near the goal, enshrined in the Paris climate agreement, of keeping global warming "well below" 2°C relative to pre-industrial times.

Ironically, the matter is made more urgent by the decision of the International Maritime Organisation (IMO), the United Nations body responsible for the world's shipping, to reduce the amount of sulphur allowed in bunker fuel from 3.5% to 0.5% by 2020. Sulphur is nasty stuff. When burned, it forms sulphates, which cause acid rain and pollute the air. A paper published last February in *Nature*

Communications, by Mikhail Sofiev of the Finnish Meteorological Institute, found that the IMO's new rule could stop between 139,000 and 396,000 premature deaths a year.

The trouble is that sulphates also scatter sunlight and help to form and thicken clouds, which reflect solar radiation away from Earth. As a result, shipping is thought to reduce rather than increase man-made global warming—by 7% throughout the 20th century, according to one study. Dr Sofiev's research showed that this cooling effect could fall by 80% after 2020, with the new low-sulphur standard in place.

The obvious way to offset the loss of sulphur-related cooling is by steep cuts to shipping's planet-cooking carbon-dioxide emissions. The IMO wants these to fall by half, compared with 2008 levels, by 2050, regardless of how many vessels then ply the seas. But unlike desulphurisation, which is both imminent and legally binding, the CO_2 target looks fuzzy and lacks any enforcement mechanism. An attempt to begin fleshing it out, at a meeting of IMO member states which concluded in London on October 26th, foundered.

Happily, many shipping companies appear keen to cut emissions anyway. They prefer to be ready for stricter rules that climate-friendlier places like the European Union might erect in the absence of a global standard. They also want to slash soaring fuel costs, which have swelled from a third of their spending a decade ago to half or more now—and are expected to rise further. Low-sulphur bunker fuel, of the sort needed to meet the new IMO standard, is expected to cost $600 a tonne when its use becomes compulsory. The current price of bunker fuel is $450. What companies are mostly doing, though, is making small improvements to existing arrangements. That is good. But it does not grapple with the bigger changes needed if the IMO's target for 2050 is to be taken seriously.

Small is beautiful

One way to cut fuel consumption is to reduce drag by redesigning hulls and propellers. This is happening. In the past five or so years many ships' propellers have been fitted with tip fins analogous to the turbulence-reducing upturned winglets on aeroplanes. According to Charles Cushing, a naval architect in New York, these reduce fuel consumption by about 2%. Polishing propellers is also a good idea. The International Council on Clean Transportation, a think-tank in Berlin, reckons this can trim consumption by 3% or more.

Further percentage points can be shaved away by smoothing hulls. This means, in particular, stopping barnacles and other creatures growing on them. Tin-based antifouling paints are now banned as toxic to sea life, so paintmakers are

returning to an 18th-century solution to the fouling problem—copper. Then, navies nailed copper plates to the bottoms of warships to poison the larvae of sessile organisms. Now, copper-based paints are being developed. Modern antifouling paints often also include silicone, a material so slippery that barnacles cannot get a grip on it.

Hulls can be scraped smooth, too, but restrictions on littering waters with paint chips and species from foreign parts have made such cleaning problematic. This may change, though, thanks to an underwater drone described by its Norwegian maker, ECOsubsea, as "a cross between a vacuum cleaner and a lawnmower". Rather than scour hulls with a metal brush, ECOsubsea's robots blast water at an angle almost parallel with the hull's surface, which mostly spares paint from abrasion but hits marine growth perpendicularly, and thus hard. A suction system hoovers the dislodged gunk ashore. Some 350 vessels have already been cleaned in this way at Southampton, a port in southern England. The service, which costs between $17,000 and $25,000 for a big ship, will be available in Antwerp in December.

Another drag-reducing technique on offer is air lubrication. This works by spraying compressed air through nozzles in a ship's bottom. The bubbles that thus form reduce the hull's contact with water. Depending on how flat the bottom in question is, 5-10% less fuel is burned, says Noah Silberschmidt, the boss of Silverstream Technologies, a firm in London that is developing such kit. Shipping firms typically recoup the cost in about two years, and demonstrating the saving is straightforward, Mr Silberschmidt adds: switch on the bubbles and the ship accelerates. Three big ships have now been retrofitted to use Silverstream's system, and a dozen more are being built with it incorporated.

Performance-management software also offers a way to cut emissions. This monitors data from sensors and from records of a ship's past voyages, and adds in weather reports. It then uses this information to calculate optimal settings for things like engine speed, to keep fuel consumption down. When all is said and done, however, these various tweaks are just that—tweaks. For the dramatic cut in emissions that the IMO seeks, entirely new ways to power big ships will need to be found. And that will be tricky.

Big is better

Many have hopes of returning to wind propulsion, and engineers have devised various modern versions of the sail. None has yet succeeded. A system developed by SkySails, a firm in Hamburg, for example, relied on kites to pull ships along. It was installed on five ships from 2008-11, but proved fiddly to use and maintain. Another approach is to fit revolving vertical cylinders known as Flettner rotors.

These generate thrust via a phenomenon called the Magnus effect. (This is also responsible for the curved path taken by spinning footballs when players try to "bend it like Beckham".) Only a handful of vessels use the kit at the moment, but it is being tested by Maersk, the world's biggest shipping company, so may soon be deployed more widely.

Some hope to cut marine emissions by employing batteries and electric motors. For transoceanic shipping this looks a long-shot. But local shipping might benefit. Norway, for instance, has started to introduce battery-powered ferries. And a Dutch company called Port-Liner is building electric canal barges for transporting shipping containers. These barges will begin operating next year.

From the barge owners' point of view, this is a good deal. By eliminating the engine room and the need to store bunker fuel, the barges' capacity will increase by about 8%. Environmentally, though, it is dubious. Batteries have to be charged. If the electricity used to do so is generated by burning fossil fuels (which is the case for 92% of Dutch power) the emissions benefits are slim. And the technology is expensive. Without taxpayer subsidy it would hardly be a runner—a fact also true of the Norwegian ferries.

The problem of shifting emissions around rather than eliminating them also applies to the idea of powering ocean-going vessels using fuel-cells. These generate electricity by reacting hydrogen and oxygen together. Though nowhere near ready for heavy-duty use yet, fuel cells have the advantage over batteries that their range is limited by the amount of fuel carried, not by the number of cells on board, since the cells themselves do not store the energy. But that fuel, hydrogen, has to be made, and the commonest way of doing so, steam reformation of natural gas, generates carbon dioxide as a waste product.

Given that electric propulsion more usually disguises emissions than eliminates them, some suggest the most practical approach to reducing shipping's contribution to global warming is to switch to low-carbon fuel systems rather than conducting a futile search for no-carbon fuels. One alternative is diesel-electric propulsion. In this a diesel engine drives a generator. Power from the generator may be used either to run an electric motor or stored in a battery. Because the diesel engine can thus operate at a constant speed, rather than having to track the needs of the propellers, this arrangement is a third more efficient than conventional oil-fired propulsion.

Liquefied natural gas (LNG) is another option. Burning LNG releases about a quarter less carbon dioxide than burning bunker fuel does. According to Sustainalytics, a Dutch firm that rates companies on environmental performance, around 100 big vessels already run on the stuff. And ten other vessels around the

world run on methane's chemical cousin, methanol. This is a liquid at room temperature, so easier to store than LNG. But it is hard to see the environmental advantages of using it. In effect, methanol is methane (one carbon atom and four hydrogens) plus an atom of oxygen. You get more or less the same amount of CO_2 by burning it as you get from burning methane.

If the IMO target is to be met, then, some radical thinking is needed. In the view of Vince Jenkins, head of technology at Lloyd's Register, a London maritime consultancy, such thinking leads to nuclear propulsion. This releases no carbon dioxide, and shipboard reactors are an established technology. Some 140 icebreakers, warships and submarines are so propelled. A nuclear-powered fleet, capable of terrific speed, could move more goods with fewer vessels.

Few, though, share Mr Jenkins's line of reasoning. Cosco, a Chinese shipping giant, dropped its study of nuclear freighters after the reactor meltdown in Fukushima, Japan, in 2011. How the IMO's target will actually be reached, if it is to be reached at all, is thus obscure.

This article appeared in the Science and Technology section of the print edition under the headline "In need of a clean up"