With the 2020 date for the global sulphur cap now firmly etched in shipowners’ minds and rapidly approaching, the choices for complying may seem limited but a new option may soon become available if appropriate partnerships can be set up in time.

Once the 2020 date arrives, ships everywhere outside of SECAs are obliged to use fuel with a sulphur content no higher than 0.5% by mass. Undoubtedly there will be some cheating and some flag states may give waivers to vessels on their registers when operating in domestic waters or even on the open sea if supplies of compliant fuel cannot be found. Even if supplies are available those flag states may choose not to penalise operators for contraventions but that is not a situation that can be relied upon. Port states – at least a good many of them – are not likely to offer any concessions except in extreme circumstances.

The IMO believes that sufficient supplies of compliant fuel will be available even if others with their ear closer to the ground do not. Price of available fuel was not a factor in the IMO’s deliberations even if it must be for operators. Assuming that refiners do not produce sufficient quantities of compliant HFO, the choice for the vast majority of owners is stark; use distillate fuels or install a scrubber. The argument that refiners will even have trouble producing sufficient quantities of distillate – it would require as much as a five-fold increase over current quantities - is one that has fallen on deaf ears.

An option that very owners have yet considered is the possibility of removing the sulphur from fuel before it enters the engine rather than after it has been burned. Although there is as yet no commercial offering available for doing this, there are a number of organisations that are developing systems that can.

Refiners have already invested large sums in de-sulphurisation equipment to meet demand for low sulphur road fuels. They have had to do this because the regulations in most countries that restrict sulphur levels prohibit sales of anything that is non-compliant. When allowing exhaust gas cleaning systems and other treatment methods for ships to comply with its rules, the IMO has allowed the continued use of fuels with any sulphur content. Some see that as an error but it was at the request of the shipping industry which wanted the option of staying with cheap fuels and using technology to solve the problem.

The technology and equipment used for de-sulphurisation in refineries is not practical for shipboard use for a variety of reasons. In refineries, the technique most commonly used is known as hydrodesulphurisation (HDS). The process makes use of hydrogen which in the presence of a catalyst combines with the sulphur to form hydrogen sulphide which is a toxic gas. This takes place in trickle-bed reactors which are commonly operated at temperatures in the range 300–450°C, and at high pressures approaching 140 bar. Quite clearly with a dangerous gas involved and high temperatures and pressures, HDS is not suitable for small scale operations on ships.

Another process which could be much more suitable is Oxidative De-sulphurisation (ODS). The process can be carried out at between ambient temperature and 80°C and pressures of 3.5 bar or lower and although hazardous chemicals are involved they are in liquid form and easier to manage. The process also uses a catalyst which can either be solid or liquids. The latter being easier for scaling to increase flow and production. Instead of hydrogen the ODS system uses an oxidant such as hydrogen peroxide (H₂O₂) which reacts with the sulphur oxides to form sulphuric acid (H₂SO₄) which can then be removed from the fuel using a solvent.

There are variations on this process which although first patented some time ago is still being developed and improved in a number of ways. The fuel produced is not affected by the process other
from the fuel has a commercial value as sulphuric acid, elemental sulphur or as sulphates for agricultural and horticultural use.

APT is looking for parties interested in moving the project forward with bunker suppliers being high on the list of likely candidates. ShipInsight believes that the process could also prove attractive to parties other than bunker suppliers. In the liner trades in particular, shipowners might consider using the process in main ports where all ships could take advantage of compliant fuel from one plant rather than separate systems on board ships. Excess production could be sold to other owners, or in the case of distillates used for powering port plant. While some components of an ODS system do have a limited lifespan, assuming it is well maintained a shore facility could operate for longer than the life of a single vessel.

Another organisation developing an ODS system is International Ultrasonic Technologies (IUT) based in Calgary, Canada. Its version of the technology is basically the same as that described above but it also incorporates an ultrasonic probe in the reaction chamber (see diagram below). As the feed of fuel and catalyst flow through the chamber, the ultrasonic probe causes cavitation and as the small bubbles formed expand and then collapse, the heat and energy created by the implosion of bubbles produces localised conditions of heat and pressure that accelerate the chemical reaction in which the sulphur compounds are oxidised. The company refers to its process as Ultrasonic Assisted Oxidative De-sulphurisation (UAODS)

IUT has completed a commercial validation of natural gasoline in a US refinery that successfully reduced sulphur content from 500ppm to 15ppm. A unit is capable of treating around 3,000bpd of LFO or approximately 2,000bpd of HFO using single lines. The amounts can be scaled up with the addition of more lines. Again, the size of the equipment is quite small and comparable to the APT unit or even a little smaller but if larger quantities were needed then scaling would increase the footprint.

In terms of costs and requirements, IUT says the power for the pilot size system is around 75-95kW at 480V three-phase for a two-line version. The company puts the lifecycle as 20 years with exception of the pumps and wear on the ultrasonic parts. Pump lifecycle is estimated to be between 12 to 17 years. Ultrasonic parts will need to be replaced every 3 to 6 months which has been factored into
the estimated operating costs. IUT’s estimate of operating costs is about $1 per barrel of fuel treated.

IUT is looking to commercialise the UAODS process either working in joint ventures with possible partners or lease or sale for use under licence. While they do not rule out shipboard use, it would seem sensible to suggest that a shore-based facility connected to a bunker supplier or similar would be the best option for the reasons already covered.

While APT and IUT are both exploring the potential of alternative methods of de-sulphurisation, another organisation also based in Calgary, Canada is looking to market its own technology that improves upon the basic process used in refineries. Genoil, has developed what it calls the Genoil Hydroconversion Upgrader (GHU). The unit converts heavy crude oils and refinery residual products into cleaner fuels and specifically of interest to shipping removes sulphur from HFO without altering the quality.

The GHU is not suitable for shipboard use but is intended to be operated either close to a refinery or bunker supply depot. Genoil has received some financial backing and has been in discussion with major bunker suppliers to develop large scale supplies of complaint fuel. Earlier this year, it was announced the Genoil had signed an MoU with Bomin Group for a potential collaboration to develop low sulphur fuels to meet the 2020 cap.

Three years earlier Genoil entered into a similar agreement with the now defunct OW Bunker. Canada seems to be particularly fertile ground for de-sulphurisation technologies, possibly because of the exploitation of the country’s oil sand reserves of very heavy oils. Another company involved in bringing a concept to commercialisation is Field Upgrading which has a project called Cleanseas which has just received funding from the Canadian government.

The project employs Field Upgrading’s De-Sulphurization & Upgrading (DSU) process involves mixing elemental molten sodium and relatively small quantities of hydrogen with the feedstock to produce a low sulphur upgraded heavy oil product. The process also removes heavy metals and nitrogen simultaneously. The sodium and hydrogen is mixed with the feedstock and breaks it down by precipitating metals and removing sulphur and nitrogen as salts. Hydrogen attaches to the open ends of molecules that were exposed after removing the sulphur and metals to prevent formation of cyclic hydrocarbons and olefins.

The second stage of the process involves recovery of sodium using a patented ceramic transport membrane reactor. The sodium salts are dissolved in a solvent, and when electricity is applied to the ceramic membrane, elemental sodium is extracted ionically through the membrane and recycled to the process. The remaining product is elemental sulphur.

As things stand, all of the de-sulphurisation projects are a little behind scrubber development and not all may be ready in time for 2020 but they are showing a promising alternative for further along the line. For ship operators and bunker suppliers interested in the potential, it is probably a good time to weigh up the options when determining the strategy to adopt for the crunch date.