Rough seas ahead

Ralph E. Lewis considers whether refiners can step up their processing capacity to meet the huge increase in demand for low sulphur fuel that will be necessitated by emissions regulations

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The late French mathematician Henri Poincaré once remarked: 'It is far better to foresee without certainty, than not to foresee at all.'

Applying this aphorism to the present questions associated with modern marine fuels, let us take a forward look into two critical questions seemingly consumed with uncertain resolution.

First we will consider potential supply shortfalls that may arise with looming **International Maritime Organization** (**IMO**) mandates for low sulphur marine fuels. Then we will address an alarming trend in bunker quality deterioration – and what remedies are available.

Supply and demand

Considerable attention has recently been drawn to the IMO 2015 mandate for a switch to 0.1% sulphur marine fuels in designated Emission Control Areas (ECAs), and the worldwide change to a 0.5% sulphur fuel in 2020.

The goal, of course, is a reduction in marine vessel emissions, and many consultants and government agencies have conducted comprehensive modelling exercises to justify the mandates. But while it is easy enough to prescribe new standards, the reality of the marketplace can just as easily thwart the best of intentions. Is it a case of too much too fast? Or will refiners ramp up sufficient production capacity to fulfill demand for these fuels?

The answers are dependent on a wide range of factors, but the two major considerations are simply supply and refinery capacity. Both are fraught with challenge.

In 2008, the IMO estimated that annual vessel consumption of fuel oil in ECAs was 27 million metric tonnes (mt). The new ECA area for Canada and the United States, scheduled for implementation in 2015, will require an estimated additional16 million mt, bringing the total for all ECA areas to 43 million mt, barring any increase in marine activity. This level of consumption means that an estimated 771,363 barrels a day (b/d) of 0.1% sulphur fuel will be required when the switch is made, and this is exclusive of any additional ECA zones that may come into play.

To understand potential supply challenges, it is important to understand how low sulphur distillate is produced, what refinery production trends have been and world demand for these fuels in recent years.

Refiners find it easier to produce low sulphur distillate fuels from crude oils that already have low sulphur content. These light, sweet crude oils typically have a sulphur content of 0.5% or less, and produce a much greater portion of the lighter fractions from which gasoline and distillate fuels are derived. In contrast, higher sulphur sour crudes produce less low sulphur distillate.

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Refineries are also designed to process specific crude oil grades. Some units only handle sweet crude, while others are engineered to handle heavier oils. In Southern Europe for example, many refining units are specifically designed to process sweet crudes produced in North Africa. On the Gulf Coast of North America, refiners like **Valero** specialise in processing the heavy crudes of Texas and Mexico.

With increased demand for mandated low sulphur distillate automotive fuels in North America and Europe, it is expected that sweet crude demand will continue an almost parabolic growth. High quality sweet crude already commands a premium price, benefitting the primary producers in the United States, the North Sea, North Africa, China and Southeast Asia.

Yet the future supply picture of sweet crude remains murky.

On the plus side, the Bakken Basin in North America is a relatively new production area thought to have proved reserves of as much as 4.3 billion barrels – possibly much more. So for North America, supply of sweet crude may not be expected to be a problem moving forward.

By contrast, North Sea Brent crude has been declining since peak production was reached in the UK and Norway in 1999 and 2001 respectively. Some analysts believe that production will fall to one-third of its peak by 2020.

Nigerian production is presently about 2.6 million b/d, up from as little as 1.7 million b/d in 2008 when rebel attacks stymied production. Although a government amnesty programme appears to have reversed the tide for now, instability in the region makes the future uncertain.

The biggest bite out of the sweet crude

pie, one that has been driving up prices worldwide, has come from Libya, where bitterness with Gaddafi has slowed production from an average of about 1.5 million b/d to less than 400,000 b/d at the time this article was written. Refiners in southern Europe who rely on Libyan sweet crude for low sulphur distillate production are scrambling for replacement feedstock, and production of low sulphur automotive fuel from these units has waned in recent weeks.

Another short-term factor occurred with the 11 March earthquake in Japan. The catastrophic destruction of the Fukushima Dai-Ichi nuclear power plant, and the damage to many others, knocked out more than 8,600 megawatts (MW) of power generation. This deficit is being made up by conventional oil and coal-fired plants – requiring an additional 250,000 b/d of fuel oil, much of which is low sulphur.

Unexpected natural disasters, regional political turmoil and depletion of known reserves will always play a role in supply, and prices can be expected to change accordingly – affecting consumer demand. Price goes up, demand drops – the basic lesson in *Economics 101*.

The wild card is government legislation, and in the case of marine fuels it is a big one. Even with an adequate sweet crude supply, can refiners step up processing capacity to meet the huge demand necessitated by the IMO mandate?

The answer hinges on the capability of present and projected refinery configurations to actually produce sufficient 0.1% sulphur distillate.

In Europe, with the new standard for automotive low sulphur diesel already phased in, demand has grown considerably in recent years and regional refiners have not kept pace. Since 2008, the shortfall in European low sulphur diesel fuel has been made up largely by United States refiners – most of them on the US East Coast.

So far, US refiners have been up to the task, due in no small part to the world economic recession which has dampened US demand for low sulphur diesel fuel. Yet an economic uptick could be a real game changer – stressing US refinery production capacity with potential supply shortfalls for Europe.

One critical factor is the *US Energy Policy Act of 2005*. This legislation resulted in the blending of more than four billion gallons of ethanol annually into US gasoline in 2008, with an expected increase to 7.5 billion gallons by 2012. Although 7.5 billion gallons less gasoline will be produced in 2012, less diesel, heating oil and jet fuel will be refined as all products are refined simultaneously.

To compensate, some US refiners are adjusting to European demand by relying more on units designed to process sweet crude – a move that is also contributing to tightening supplies.

So given recent supply disruptions of sweet crude, a modest economic recovery in the years ahead could potentially spell trouble. At present configurations, US refiners can increase distillate production between 3% and 5%, and with additional infrastructure investments, as much as 8% more capacity could possibly be added, according to data from the **US Energy Information Administration** (**EIA**). Yet it still may not be enough to make up for shortfalls in Europe.

US annual diesel fuel production – most of it low sulphur – presently stands at a little more than 4.1 million b/d. A 5% increase in production would result in an additional 205,000 b/d. When the 0.1% ECA comes into force in North America in 2015, an estimated additional 287,000 b/d will be required just in this ECA alone. While this may go a long way in meeting demand for the North America ECA – it leaves little, if any, for European ECA zones, even if demand stays constant.

If the IMO numbers for ECA demand remain the same for 2015 as estimated for 2008, an additional 484,344 b/d would be required in Europe. This begs the question as to where the new production will come from.

Alarmingly, a number of older, less efficient refining units in Europe are being offered for sale, or are being completely scrapped over the next several years. Last year **JBC Energy**, a Vienna-based consulting firm, reported that 19% of Europe's refining capacity is under threat of closure by 2020 – a potential loss of some 3.4 million b/d of production. Another study predicts that by 2015, as much as 1.3 million b/d will be lost.

Although it always makes better sense to build refineries close to market areas, European refiners have been hampered by high investment costs and environmental regulations. While some expansion plans are underway, there is virtually no planning for new refineries in the region.

Others are stepping up to meet some of the demand. Saudi Arabia is planning a multi-billion dollar refinery upgrade over the next several years involving at least five units. One of the Saudi projects, for example, is a new export refinery planned at Yanbu on the

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Red Sea which is expected to produce more than 400,000 b/d of clean product – the low sulphur distillate portion slated for European customers.

Other sources offer hope. Completed in 2009, the massive second unit of the Jamnagar refinery in India, operated by **Reliance Petroleum**, has a production capacity of 661,000 b/d – primarily for export of both gasoline and distillate fuels to the European market. Additional sources of distillate are available from Russian refiners, where many refinery upgrade projects are expected to be completed by 2015 at a cost ranging from $13 billion to $24 billion. Even so, these projects involve more modernisation efforts and are not expected to see any major increase in refinery output.

'What is helping right now is demand destruction brought on by world economic conditions,' says Colin Crooks, General Manager of **Shell Marine Products**, Europe/Africa. 'If markets begin to improve, substantial investment by refiners will be required to meet increased demand if the 2015 standard is to be met.'

Crooks cautions that investment decisions for refiners are predicated on a number of economic factors, and that the time required for engineering, financing, design and construction for a refining unit can result in as much as a 10-year project.

Even more challenging is the 2020 worldwide standard mandating a 0.5% sulphur fuel. Based on IMO data, world marine fuel consumption ranges from a conservative 333 million mt to 500 million mt of heavy fuel oil annually. Such a change would require a step-up in gasoil production from an estimated 6 million b/d to almost 9 million b/d.

To put this in perspective, total world distillate production in 2007, based on US EIA data, was 24 million b/d – a figure that includes diesel fuel, kerosene, heating oil and jet fuel. Hence, a minimum 27% increase in output would be required to meet the 2020 standard – probably a much greater percentage.

Consensus? The jury is still out. Making the 2020 deadline is unlikely, some think. Fortunately, there is some breathing room. A revision to *MARPOL* Annex VI calls for a review in 2018. 'Looking ahead, I do not see a possible change to 0.5% sulphur fuel until at least 2025,' says Robin Meech, Managing Director of **Marine and Energy Consulting Ltd** (**MECL**), an independent consultancy based in the UK.

Regarding the ECA mandate, Meech says a combination of factors will likely help vessel owners comply with targeted emissions reductions. Exhaust gas scrubbers, he says, are expected to be 'financially viable' by 2014. Liquefied natural gas (LNG), sometimes touted as the 'clean' solution, will play a role, although a very minor one, he believes.

Meech says that better fuel utilisation can and will be achieved – resulting in both emissions reductions and cost control. Among these opportunities are retrofit technologies such as improved propulsion systems design, the use of proven fuel additives, new technologies like improved hull design, better waste heat recovery, and implementation of advance software and slow steaming.

Bunker quality deterioration

In an article previously published in this magazine, I cautioned that the 1.5% sulphur fuel then designated for ECA zones was proving problematic for some vessel owners, given that some suppliers were having to use a higher than normal amount of cutter stock to dilute the end product to a proper sulphur percentage (see *Bunkerspot*, April/May 2007, page 26). We cautioned that given the nature of certain cutter stock qualities, these heavily blended fuels posed potentially serious operational threats.

Independent petroleum testing laboratories are now reporting more incidents of very problematic fuels which are having a dramatically negative impact on vessel operation. Many of the stems are in ECA zones.

Dr Vis, of Houston-based **Viswa Labs**, reports that in 2010, he encountered 22 cases of purifier and filter choking, 18 cases of piston ring breakage, and 11 cases of fuel pump jamming, among other issues. He also notes that, not unexpectedly, the 1% sulphur ECA fuels have higher cat fines and water content, are typically of lower viscosity than specification and are sometimes prone to poorer ignition quality.

'We've received innumerable complaints – including reports of incidents where the crew has had to endure panic moments with main engines suddenly coming to a halt,' he says. 'The perils for the ultimate fuel user – the staff – seem to have increased greatly.'

Dr Vis suggests that vessel owners maintain an ongoing fuel analysis programme, and that onboard engineering staff optimise efficiency of the onboard treatment plant and consider the use of chemical fuel treatment.

The story is similar with **DNV Petroleum Services** (**DNVPS**). A survey conducted by DNVPS earlier this year of bunker buyers representing 95 companies also suggests quality issues are on the upswing. Of

those responding to the survey, almost 80% complained of off-spec fuel. Of these, 44% classified the issue as 'serious'.

The greatest complaint was filter clogging – reported by 64% of respondents. This was followed by excessive sludge issues from 48%, fuel pump sticking and seizures from 40%, and broken ring problems from 19%.

Speaking before the *International Bunker Conference* in Copenhagen in April, Tore Morten Wetterhaus, Managing Director of DNVPS, warned of more problems ahead. 'Over the next two or three years, we are expecting more fuel quality cases due to increased blending activities in the supply chain to meet the greater need for low sulphur fuel oil (LSFO) products. Unregulated blend components will remain a key cause to such problems.'

As a supplier of chemical fuel treatments to more than 150 shipowners worldwide, **Power Research Inc.** (**PRI**) has experienced a heightened demand for fuel treatment chemicals specifically formulated to address these issues.

'Our focus has always been to keep ahead of these problems – and make absolutely certain that we formulate with the optimum solutions in mind,' says Blake Davidson, PRI Chief Financial Officer. 'Foremost in our thinking is the safety of onboard personnel. Unexpected engine failures at sea associated with poor quality bunkers are wholly avoidable in most cases. Our job is to work closely with shipboard and onshore personnel to do everything we can to ensure operational reliability.'

PRI manufactures three fuel treatments for heavy fuel, *PRI-RS*, *PRI-27* and *PRI-SOLV*. The first two incorporate PRI's exclusive thermal stability technology – a chemistry verified by **MAN Diesel** under the strict MARPOL Annex VI emissions testing protocol to reduce particulate, unburned hydrocarbon and carbon monoxide emissions. All three chemistries are formulated with effective dispersant technologies that have shown to not only increase reserve stability, but to also reduce shipboard sludge generation in a range of 30%-50%, depending on initial fuel quality.

'You could say we have taken a holistic approach,' says Davidson. 'We look at every possible thing that can go wrong with fuel, and formulate accordingly.'

A pioneer in lubricity technology born with the company's founding in California in 1985, PRI also manufacturers *PRI-D* lubricity/stability treatment for low sulphur gasoil. Favoured by major vessel operators worldwide for application to 0.1% gasoil, PRI-D has for many years been applied to fuel storage tanks at a wide range of onshore power generation plants, including emergency standby generators at nuclear power operations.