

# Refining the oil fired approach

UK company Quadrise has developed a fuel that it says will not only boost refinery profits but is also a more economic and cleaner alternative to heavy fuel oil. Junior Isles, reports.

The idea of using an oil-in-water emulsion as a substitute for heavy fuel oil (HFO) is not a new one. Back in the late 1980s and 1990s, the production and use of Orimulsion was gaining traction in South America before being brought to an end by a change of government in Venezuela.

Now UK company Quadrise, started by ex-BP employees involved in the original Orimulsion sector, looks set to commercialise a new oil-emulsion fuel which can be used as a low cost and much cleaner substitute for HFO in marine diesel engines (two- and four-stroke) and for thermal power and steam generation.

The fuel known as MSAR<sup>®</sup> (Multi-phase Superfine Atomised Residue) is described by Quadrise as a "potential game-changer" for oil refiners as it frees up valuable distillates used for HFO manufacture, thus increasing profitability without incurring significant expenditure.

For the power sector, the technology is centred around displacing HFO so that boilers are instead fired on what the company says is a "far superior" fuel in terms of combustion. Quadrise is convinced it could save owners of oil fired power boilers millions of dollars a year as well as significantly cut emissions of air pollutants.

Sam Saimbi, General Manager Power at Quadrise described the thinking behind the technology. "To produce HFO, refiners take the 'bottoms' off their process. This residue has a high viscosity, so they use high value distillates, such as diesel, to lower the viscosity so it's ready for transportation. Sometimes it can be up to a 50:50 split to create HFO. Instead of using premium distillate fuels to do this, we can use a combination of water and a few chemicals.

This produces a far better fuel that is easier to handle and store; in addition the residue has comparable calorific value. Overall it offers the end user an economic solution as well as a saving for the refinery."

Quadrise has been developing the technology since around 2004, when it partnered with AzkoNobel to further develop MSAR using the company's proprietary emulsification technology.

MSAR production is a fairly simple and proven process.

In the first stage, oil residues are taken from refinery rundowns and cooled to under 200°C to achieve the required viscosity (typically 300-400 centistokes). Water (about 30 per cent), which can be derived from several utility or wastewater sources, is then added to the residue. In the third step, special surfactants and chemicals are added to stabilise the emulsion for long term storage and transport, and to promote complete combustion. Finally, the mixture is processed in a proprietary MSAR unit to a high hydrocarbon content (typically 70 per cent) stable oil-in-water emulsion (100-500cSt at 50°C depending on client specification).

"The key to this technology," said Saimbi, "is after you have emulsified this residue with the water and the surfactants, you end up with a fuel that has a far smaller particle size distribution than can ever be achieved with HFO. In a furnace, where you have a fixed geometry and there is a fixed residence time for the fuel to burn, a smaller particle means complete combustion."

He noted that part of the problem with HFO is that even after atomisation, particle size is in the range of 80-100 microns. This compares with 5-10 microns in MSAR fuel. In addition to complete combustion, less

oxygen is needed. This all leads to minimal unburned carbon in the ash and hence significantly less particulates. Not only does this save fuel, it also produces less ash and therefore saves on the cost of ash disposal.

In terms of storage and handling, MSAR is very similar to HFO. However, since the viscosity is lower, it is stored at a lower temperature (25-50°C). It has similar flame characteristics to HFO but has a lower peak flame temperature by about 100°C due to the water content. Notably, this cooling effect should typically result in 20-50 per cent less thermal NOx, while the smaller particle size means there is less than 5 per cent carbon in ash compared to HFO.

According to Quadrise, making the advance from Orimulsion to MSAR production is very easy and a proven and secure process. "In essence, Orimulsion was produced in some fairly big capacities, so all we've done is optimise that solution. We would simply provide – and install if necessary – the refinery with a blending plant and a technology licence."

The first use of MSAR fuel will likely be in the marine sector, where Quadrise has been working with shipping giant Maersk to use MSAR in large diesel engines.

"We have been working with Maersk since 2010 to de-risk every element in terms of the production, distribution, bunkering and finally firing MSAR in the engine of a commercial ship," advised Sam Saimbi. "We are now planning the final validation – a LONO (Letter of No Objection) test. On success, we anticipate commercial rollout."

Saimbi joined Quadrise in January this year to spearhead the effort in the power sector, where he believes there are significant opportunities.

Quadrise is in discussions with Singapore utility Power Seraya, which was a customer for Orimulsion and is therefore already adapted to accept the fuel. MSAR, however, is also well suited to oil fired plants that have never burned Orimulsion, says the company.

One of the effects of having 30 per cent water in the fuel is that there will be an increase in flue gas weights compared to fuel oil, similar to the impact of firing natural gas. This is not a problem for a new boiler installation, which would be designed according to the fuel. For a retrofit, however, the effects on the boiler still need to be considered.

"Generally, there will be a 3-5 per cent increase in gas weight but this can be mitigated by reducing the oxygen for combustion, due to the smaller particle size. But each retrofit is different, so you have to undertake a due-diligence and review of the boiler margins" said Saimbi.

"We don't foresee any modifications to the boiler pressure parts but new atomisers would be needed to cater for the increase in fuel volume going into the boiler. This would be at minimal cost."

The development with Power Seraya is still in the early stages. Quadrise needs to find a refinery that is prepared to adopt the technology and deliver the fuel to the utility at a competitive price, with the required quality and reliability.

Saimbi says this is a complex

process. "You can imagine the challenge to the business. Not only do you have to find a refinery to adopt the technology, you also have to find and an off-taker for the fuel. You need to find and align all the stakeholders, which naturally takes time."

The initial focus is therefore on the Kingdom of Saudi Arabia (KSA), which is a big oil refiner and user of oil for power production. "With these being in the same country, logistics become a bit easier. For us, it's a huge market," said Saimbi.

Although profits will be on a case-by-case basis and will depend on what distillate the refinery is mixing with the residue, Quadrise believes it makes economic sense for a number of KSA's refineries to adopt MSAR.

One case study for a Middle East refinery showed that the installation of MSAR technology would enable an increase in distillate production of more than 30 000 barrels/day, resulting in a net profit of \$100 million/year. This was for a capital outlay of well under \$50 million.

Such an installation could be executed with very little downtime. "It would be installed while the refinery is in operation. It is just a case of installing the blending plant and then carrying out the final tie-ins, which could be done in a couple weeks. Overall, with installation and commissioning, it's a 12-month programme," said Saimbi.

For power plants, again the economics will vary case-by-case. "It's difficult to give figures – every plant is different; it also depends on what distillates are being replaced," stated Saimbi.

He added: "Every boiler is different. For example at some oil fired plants in KSA, unburned carbon in ash is more than 80 per cent. We believe we can get this down to less than 5 per cent but you don't know until you have carried out the tests. This would save on fuel as well as on the cost of removing the fly ash. In one example we are reviewing, it's costing the plant a lot of money to transport and dispose of the fly ash. If you add all the benefits, you could save millions of dollars a year."

Quadrise's current business model would see any profit margin split between itself, the power plant owner and the refinery. "The power plant would have an incentive because they would be purchasing a less expensive fuel," noted Saimbi.

With a clear economic case, at least in Saudi Arabia, plans are moving forward. A utility scale demonstration in KSA is targeted to produce and fire MSAR fuel in the first half of 2016. Saimbi says commercial rollout will follow, once this is proven.

With discussions also under way in Latin America, prospects look promising but Quadrise is taking it one step at a time.

Saimbi summed up: "For us the challenge right now is to get the product to the market. We are all working hard and are focused to make this happen. We know it will take time, so we are taking it step-by-step. The focus is first to have one of our current prospects working as highlighted, and then there will be a domino effect."

**MSAR technology frees up valuable distillates traditionally used for HFO blending, replacing them with low cost water and a small amount of additives**

