Transport fuels face tough environmental standards

While crude feedstocks are becoming poorer in quality, regulation and market demand and clean air initiatives are leading transportation fuels in the opposite direction, writes David Wood.

This change has been led by OECD countries, with several countries in developing Asia still operating with 5,000-ppm sulphur in their diesel and gasoline (see **Figure 1**). As recently as 2004, 'clean' diesel around the world still contained between 350 ppm and 500 ppm sulphur, highlighting the magnitude of clean fuel advances in the last three years. Most of the OECD countries are now operating with 50 ppm or less sulphur (lower sulphur diesel – Worldwide Fuel Charter Category 3 fuel with maximum 50 ppm sulphur and 20% aromatics limits and minimum cetane number of 53) in their fuels. Only Hong Kong in developing Asia is operating at these standards in 2007.

Even in developed economies, there is still some way to go to achieve the 'sulphur-free' diesel (Worldwide Fuel Charter Category 4 fuel with maximum 10 ppm sulphur and 15% aromatics limits and minimum cetane number of 55) that is required by vehicle manufacturers to fit major advancements in emission control systems to new vehicles. The European Union (EU) has mandated sulphur-free diesel for on-road use by 2009, and Australia may follow by 2010. Japan is introducing an effective 10-ppm limit in road diesel fuels introduced in 2007. However, it is the US, with the introduction in October 2006 (September 2006 in California) of ultra-low sulphur diesel (ULSD), a 15-ppm sulphur on-road fuel, which has taken the largest step recently by replacing its 500-ppm limit. The US has also mandated the use of ULSD fuel in vehicle model year 2007 and newer diesel fuel engines designed for on-road use from June 2007.

Role of GTL diesel?

GTL (gas-to-liquids) diesel – diesel fuel derived from a natural gas feedstock – could play a significant role in the future in assisting refiners meet demand for diesel in terms of quantity and quality. Typically, the diesel yield of GTL plants is around 70% compared to 40% for an average oil refinery. In terms of quality, GTL diesel is 'sulphur-free' and, with very low aromatics and very high cetane number (>70), and exceeds the clean fuel specifications being introduced.

GTL diesel can be used as a neat fuel or as a fuel blend in existing diesel engines and future advanced diesel, diesel electric hybrid and some fuel cell technologies. It can also utilise existing fuel distribution infrastructure making it easy and cheap to introduce.

The current limitation on GTL is lack of capacity, with only a few small plants operating worldwide. The commissioning of the Oryx plant in Qatar in 2006 is a step in the right direction, but investment in many more, larger plants will be required before GTL diesel could have a significant impact on the global diesel fuel markets.

The Oryx GTL plant is able to process some 320mn cf/d (9.3mn cm/d) of lean natural gas from Qatar's North gas field to produce 34,000 b/d of liquids, comprising 24,000 b/d of GTL diesel, 9,000 b/d of naphtha and 1,000 b/d of LPG. This may be necessary in the future to compensate for trends to a heavier-sourer crude barrel (see *Petroleum Review*, April 2007) and continuing demand for high volumes of high quality road transportation fuels.

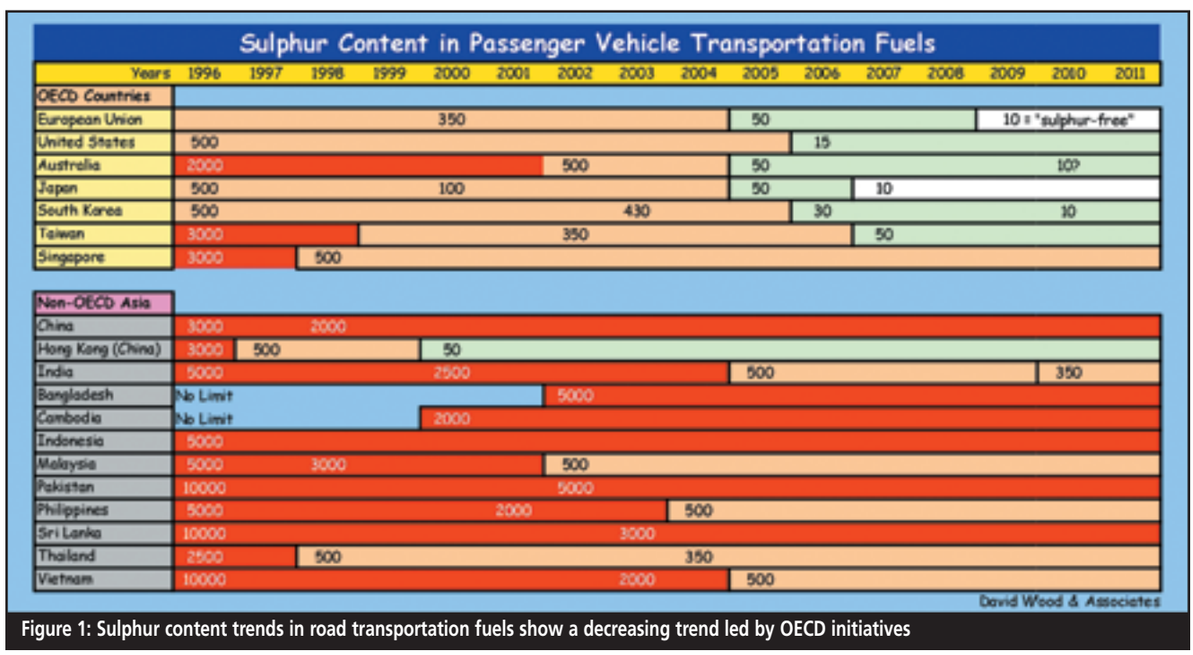

Figure 1: Sulphur content trends in road transportation fuels show a decreasing trend led by OECD initiatives

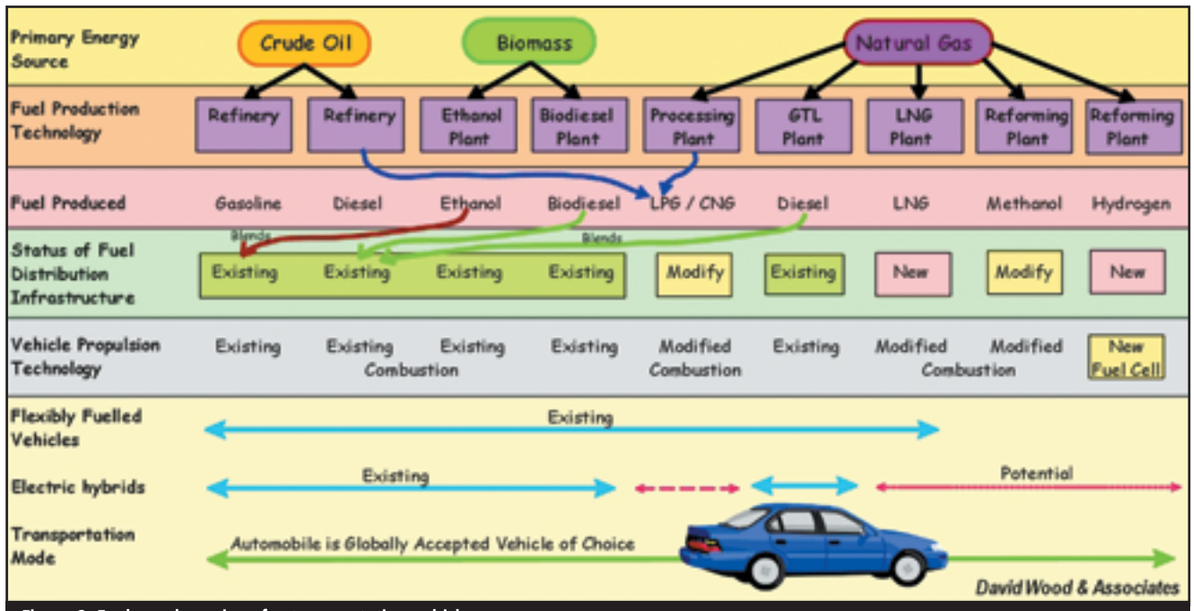

Figure 2: Fuel supply options for transportation vehicles

Alternative options

There are a number of other alternative fuels being developed to provide cleaner more efficient and flexible road fuel options with lower greenhouse gas emissions per km driven. These options are illustrated in **Figure 2**.

The appeal of biofuels is that they can be readily blended into traditional refinery gasoline or diesel and require no expensive vehicle engine modifications or infrastructure modifications to refuelling stations. However, some options require significant investment in engine modification technologies, fuel storage systems and/or specialised refuelling process infrastructure (eg hydrogen fuel cells, CNG and LNG).

The recent market appeal for flexibly fuelled and hybrid vehicles suggests that engine technologies and fuel storage systems are not major obstacles. It is, however, the massive infrastructure investment required worldwide to install alternative fuel refuelling and storage systems on existing gasoline/diesel fuel station sites (or new sites) that is the greatest hurdle that some alternative fuel systems have to overcome in order to significantly penetrate the global road fuel transportation market.

Fuel attributes plus the cost of engine modifications and additional refuelling infrastructure (**Figure 2**) have to be considered together in evaluating the potential of the various alternative fuel and vehicle options now available.

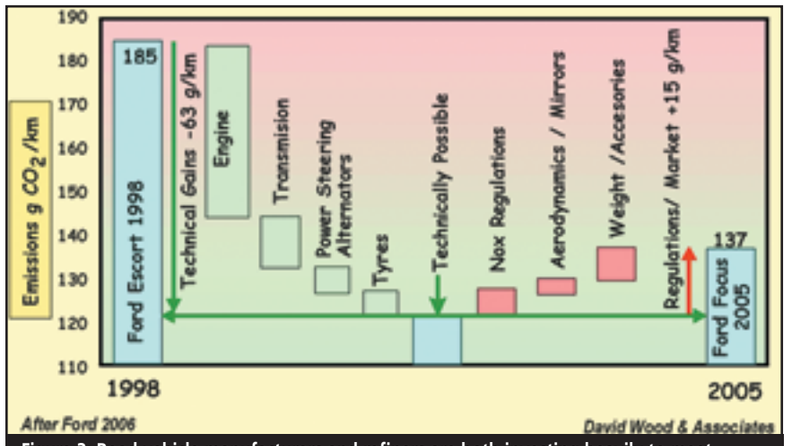

Figure 3: Road vehicle manufacturers and refiners are both investing heavily to meet tough emissions reduction targets, yet both are often portrayed by politicians and environmentalists to be the cause of the problem rather than the solution

Vehicle manufacturers under pressure

It is not just environmental regulations that are pushing fuels towards higher quality specifications, vehicle manufacturers, in order to achieve their emissions reduction targets in engines for new vehicles are also calling for higher specification fuels. Engine and vehicle technologies normally achieve improved performance and lower emissions with higher quality fuels. The ultra-low sulphur fuels not only reduce emissions of sulphur compounds (blamed for acid rain), but, in the case of diesel also allow advanced emission control systems to be fitted to new vehicles, comparable to catalytic converters in petrol (gasoline) engines, that would otherwise be poisoned by these compounds. These systems can greatly reduce emissions of oxides of nitrogen (NOx) and particulates (PMs)

It is carbon dioxide (CO_2), volumetrically the most significant greenhouse gas that vehicle manufacturers have targeted. **Figure 3** illustrates the gains in CO_2 emissions for a mid-range performance vehicle in Europe between 1998 and 2005. European car manufacturers should have:

- introduced cars emitting 120 g CO_2/km by 2000,
- with an average diesel car to emit 120 g CO_2/km from 2002,

and, have further agreed to the following targets:

- average new car to emit 140 g CO_2/km by 2008,
- 10% of all new cars to emit <100 g CO_2/km by 2012,
- average new UK car to emit <115 g CO_2/km by 2020.

These targets represent a gain in efficiency of 25% from 1995 on the new car fleet. However, the vehicle manufacturers are struggling to meet the 2008 target because of continued market demand for high-performance vehicles and their requirements for higher fuel quality to do so.

If growth forecasts for privately owned road passenger vehicles materialise, then significant growth in demand for transportation fuels should be expected over the next few decades, particularly in the developing world. No more so than in developing Asia, where road fuel specifications are currently of the lowest quality worldwide (see **Figure 1**).

Growth in car ownership and ever-tighter fuel specifications in OECD countries, coupled with heavier sourer crude feedstocks and premium prices for light-sweet crudes should promote investment in GTL developments. For Opec members, a rapidly growing medium-term market for their hard-to-market heavy-sour crude will be developing Asia, particularly India and China, with rapid demand growth and substantially less stringent road fuel specifications.