Managing future fuels complexity

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Linus Hakimattar, *Vice President Energy Business, Aspen Technology, assesses how the introduction of alternative fuels will increase the focus that petroleum companies need to place on optimising inventory management and distribution for their fuel retail sites.*

The introduction of alternative fuels for road transport will undoubtedly have significant repercussions for the petroleum industry. With targets suggested by the European Commission calling for as much as 20% of gasoline and diesel sales to be replaced by other fuels in 2020, it is clear that the average forecourt will see considerable change over the next couple of decades.

A shift in consumption of this magnitude will clearly require some quite structural changes in the way in which fuels are processed, sourced, stored, distributed and dispensed. This would be true if just one alternative fuel was being considered. However, with four or more different fuel types being advocated, each with its own unique advantages over fuels used commonly now, the potential for added complexity – with the associated costs – is enormous.

One of the major challenges for petroleum companies facing this scenario will be to manage the inventory and distribution of multiple different fuel types for their retail sites in the most efficient and cost-effective way. Even in the current situation, handling fairly stable demand for two main fuels, companies have learned that the retail (or 'secondary') distribution process can have a major impact on their margins. Those marketers able to eliminate wasteful practices while maintaining customer service levels have been able to gain a worthwhile competitive advantage.

Increased complexity

So, how will the widespread adoption of alternative fuels impact secondary distribution and the way it is managed? At a basic level, a greater number of fuel types will obviously lead to a corresponding increase in complexity. Many of the fuels under consideration, however, have characteristics that introduce additional requirements or constraints into the system. These include the need for specialist transportation vehicles, restricted sourcing from a small number of dedicated production and storage sites, and unique infrastructure at forecourts.

These factors each contribute to added complexity for managers seeking to keep the inventory management and retail distribution process under control. While this is a daunting prospect, there are already technologies available that companies can call upon to automate and optimise the secondary supply chain, and it is likely that the advent of new fuel types will help to focus attention on the value delivered by these systems. Indeed, companies that invest in the right solution now will be well placed to manage the more complex operational situations that come about when additional fuels are introduced.

While government policy, technological developments and regional availability will play a role in the rate and pattern of adoption, it is generally agreed that there are four main alternative transport fuel types which are likely to gain a significant market share over the next five to ten years. These are:

- natural gas
- hydrogen
- biofuels and biomass-to-liquid (BTL) fuels
- liquefied petroleum gas (LPG)

Each of these fuel types has different requirements in terms of inventory management and distribution, and, in the case of natural gas and hydrogen, there are a number of different options in the way the fuels are produced, stored, transported and used in vehicles. It is worth considering these various scenarios, since they have a major impact on the nature of the supply chain.

Natural gas

European Commission studies indicate that natural gas is the only alternative fuel with the potential for significant market share well above 5% by 2020 that could potentially compete with conventional fuels in terms of the economics of supply in

a mature market. A market share of around 10% could be feasible (equating to some 25% of forecourts carrying the fuel).

In most countries there is already a very extensive distribution network in place, allowing natural gas to be piped directly to the service stations from the existing grid. On-site compression facilities can then be used to create compressed natural gas (CNG) at the necessary pressure to fill vehicle tanks. This scenario is obviously very favourable in terms of distribution and inventory management, since it bypasses the need for road transportation and storage.

An alternative option is the delivery of liquefied natural gas (LNG) by road to the filling point – either for conversion to CNG or to be used directly in vehicles equipped for LNG. In this case, dedicated tankers would be required to transport the LNG from the liquefaction facilities and inventories would need to be managed in a similar way to conventional fuels.

Hydrogen

Hydrogen has considerable potential as a main energy carrier in the long-term future, and has broad feedstock flexibility in its favour. Research into hydrogen-powered vehicles (including fuel cell vehicles) is still at a comparatively early stage, however, and there is not a clear consensus about the most favourable production pathway to minimise overall emissions and energy usage. For these reasons, it is anticipated that hydrogen will achieve a market share of just a few percent by 2020.

In a similar way to natural gas, two main scenarios seem to be most likely for the production and distribution of hydrogen. At one extreme, liquid hydrogen will be produced in a small number of central production facilities, and transported by road using specialised cryogenic tankers to the service stations. The other alternative involves production of gaseous hydrogen directly at the retail site using natural gas steam reforming.

The implications for the supply chain are the same as those described for natural gas. Central production requires a dedicated transportation infrastructure in place, as well as precise management of demand and inventory levels. On-site production introduces significant additional flexibility, with the potential to respond quickly to variation in customer demand.

Biofuels and biomass-to-liquids

This category encompasses 'conventional' biofuels, including ethanol and biodiesel, which are based on the conventional agricultural crops such as plant oil, sugar or cereals, as well as BTL fuels, including methanol, dimethylether (DME) and BTL-diesel, which would primarily be produced on the basis of either waste products from agriculture (straw), forestry (thinning wood, residuals) or wood-based industries (sawdust, 'black liquor' from pulp and paper industry) or on energy plants specifically grown for the purpose (short rotation trees or other cellulose material).

The European Union has established a target market share of 6% for biofuels in 2010, so, with the addition of BTL fuels (which are less reliant on agricultural capacity being available), the potential total share could expand beyond 8% during the period 2010–2020.

Both biofuels and BTL fuels are likely to be produced in comparatively large dedicated process plants located close to the source of their raw materials in agricultural or forested areas. The overall supply chain would depend on whether the fuels would be used in their pure form (such as 100% biodiesel), or blended with conventional diesel or gasoline. In either case, there is potential to integrate these fuels more closely into the transportation infrastructure developed for conventional fuels, since traditional tanker trucks could be used for both. Similarly, the requirements for effective inventory management and distribution at the fuel retail site are the same as those for standard fuels.

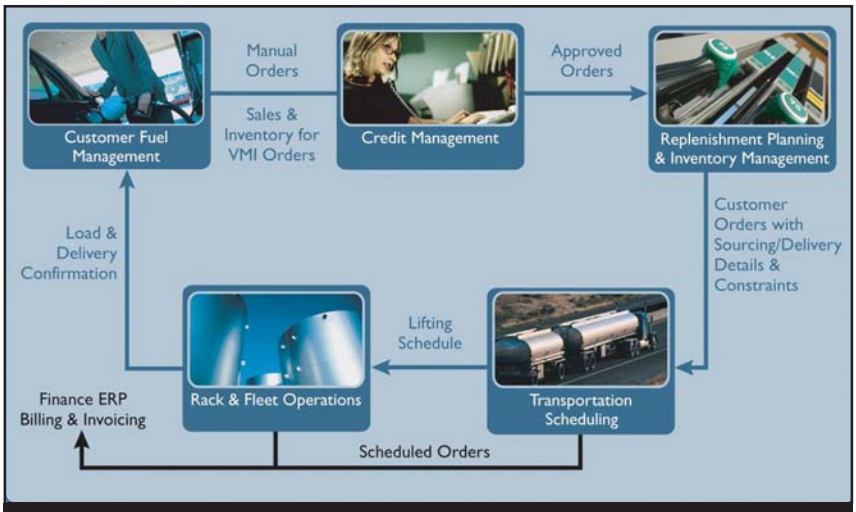

Figure 1: Additional fuel types will require companies to automate and optimise their secondary supply chain business processes

Source: AspenTech

Liquefied petroleum gas

LPG is already a well established alternative motor vehicle fuel and has potential for additional market share, possibly up to 5% by 2010. The fuel (which primarily consists of propane gas) is a by-product of natural gas processing or petroleum refining and is transported and stored in its compressed liquid form using specialised tanker vehicles.

The transportation infrastructure for LPG is already in place in many countries, including regional distribution centres serving the major concentrations of population. Although it requires dedicated tankers, LPG requires similar processes for distribution and inventory management as conventional fuels.

Managing the supply chain

As the descriptions above highlight, companies offering a range of alternative fuels from their forecourts will need to manage the supply chain complexity created by fuels that are sourced from multiple different production sites and distribution terminals, and the requirements for expensive, dedicated vehicles to handle the more specialised products like liquid hydrogen.

In the case where sourcing is limited to a smaller number of regional locations, companies will need to adapt to longer trip times and distances, with, for example, each truck only being able to make two deliveries per day rather than five. In such circumstances it may also be more economic to use two drivers per truck so that vehicle utilisation is not restricted by driver's hours regulations. The need for specialised vehicles will also significantly reduce flexibility, with no capability for multi-product distribution using the same truck.

Since few, if any, petroleum companies will produce a full range of alternative fuels directly, this will place a greater emphasis on exchange or outsourcing agreements with other suppliers. Third-party logistics providers are likely to play a bigger role, particularly where products require unique vehicles.

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Supply chain systems

While the complexity of the secondary distribution process will undoubtedly increase with additional products, the fundamental needs of managing inventory, forecasting run-out times, sequencing deliveries and optimising the utilisation of transport remain the same. As a result, software solutions developed to help companies manage and optimise today's inventory and distribution activities will still be valid in the future – as long as they are sophisticated enough to incorporate a larger number of products and operating constraints.

Over the past decade, these supply chain systems have evolved to make use of the investments in IT infrastructure that took place over that period, providing petroleum companies with a set of capabilities carefully aligned with the needs of the fuel retail business. Two key concepts that have emerged as best practices are automated stock replenishment (ASR, also known as vendor managed inventory), and transport scheduling optimisation (TSO).

ASR enables companies to automatically create a demand forecast for each site based on information from automatic tank gauges and point-of-sale (POS) devices, so that deliveries can be scheduled to prevent run-outs and avoid high inventory or delivery costs. 'Proportional' inventory management can be used to increase the benefits of this approach significantly, by ensuring that inventories are maintained at a level which is balanced to match the ongoing demand for each unique product at each site. In this methodology, the highest selling product is known as the 'controlling product' and determines how often you must deliver to that site. Balancing deliveries of all products in proportion to demand helps to eliminate excess inventory, while also maximising the payload and minimising the number of deliveries to each site.

TSO uses sophisticated optimisation techniques to make optimum use of transportation resources to fulfil the required delivery schedule that has been generated using ASR. This ensures that trucks are utilised as effectively as possible, and follow the most efficient journey routes to replenish the sites requiring new deliveries.

By populating the system with the appropriate data and operating constraints, both ASR and TSO can be applied to any kind of fuel and any combination of transportation resources, whether they are standard tanker trucks belonging to an in-house fleet or specialised vehicles operated by third-party suppliers. Thus these concepts are fully applicable for use with a range of alternative fuels.

Photo: AspenTech

The latest generation of software solutions are taking the concept of ASR/TSO to the next level, by providing a 'real-time' capability and by using Internet technologies to enable multiple users to access the system from any location, including hand-held devices or truck-based mobile computers. By using real-time sales, inventory and delivery data, companies can continually re-optimise their delivery schedules, providing the latest instructions to the drivers and terminals for execution. Flexible 'thin client' Internet access permits any authorised user to view the current system performance and to collaborate with other partners to ensure forecasts and plans are as accurate as possible.

Companies that start to invest now in these innovative technologies and business processes will have a significant advantage when it comes to making the transition to marketing additional types of alternative fuels. These new fuels will inevitably place new demands on the retail supply chain, but by integrating, automating and optimising their processes the leaders will be able to minimise their costs and maintain high levels of control and efficiency. ●