Fuels and engines need to be developed together

An essential, but difficult objective to meet.

Much discussion has taken place in Auto/Oil-I, Auto/Oil-II and many other forums on how to achieve air quality targets in a scientific and cost-effective way. The basis is sound science, starting with a thorough understanding of the adverse health effects of air pollution and the establishment of robust air quality standards. Reliable modelling of future air quality—taking account of already agreed abatement measures—can then identify the remaining gaps and the pollutants to be addressed. With this approach, the possible ways of solving the problems can be determined by combining available measures in an optimum manner.

Auto/Oil-I has been a good example of how to achieve the scientific basis for defining measures to meet air quality targets. Road transport has been the major area of possible improvements and engine/vehicle emission standards and fuel qualities were subsequently defined. With regard to fuel quality, the conclusions were based on an emissions test programme studying advanced engine technology and fuel properties. The programme not only showed the importance of vehicle technology and fuel quality on their own, but also demonstrated the importance of their interactions. A major outcome for current and future debate on both engine technology and fuel quality was that fuels and vehicle technology need to be developed together as a single system.

FUELS AND ENGINES—A COMMON SYSTEM

This very important message seems to have been lost over recent years. While vehicle and engine developments progress rapidly to meet the very stringent future emission levels of the next decade, the idea that both engine/vehicle technology and fuel quality have to be addressed as one design system and therefore developed together has not yet been adequately recognized. For example, worldwide fuel charters have been published by the automotive manufacturers' organizations tabling fuel properties for various technology categories. However, the oil industry was not involved in this exercise and no cooperative test programmes were conducted to generate information on interactions between fuels and advanced engines.

THE NEED FOR A COMMON APPROACH

CONCAWE felt the need to throw some light on the many aspects of importance when developing fuel specifications. Such aspects include vehicle emissions reduction, customer acceptance (e.g. driveability performance), fuel consumption, CO_2 and durability. It is essential that these issues should be well understood and adequately addressed. In order to complement the database, CONCAWE published a report on 'fuel quality, vehicle technology and their interactions' (report 99/55) to provide an understanding of the complexity of the task involved and an improved basis for developing fuel specifications. This is even more important since worldwide fuel specifications are suggested in an attempt at harmonization. The aspects of fuel and vehicle interaction reviewed in the report are illustrated in Table 1. In addition the report summarizes CONCAWE's information on the potential of vehicle technology to reduce emissions and the interaction with fuel consumption.

Aspects of fuel and vehicle interaction
• Vehicle technology trends • Vehicle and fuel effects on emissions of NO_x, particulates, HC, CO, unregulated emissions • Engine and fuel effects on CO_2 and fuel economy • Customer acceptability: driveability, diesel cold operability, noise, odour, smoke • Vehicle durability: after-treatment systems, engine deposits, diesel fuel pump wear • Implications of fuel changes for refineries

Table 1
Fuel and vehicle technology have many interactions to be addressed.

Since both the automotive and the oil industries have the common aims of reducing environmental impact whilst satisfying the same customers in the most cost effective way, there is a need to develop vehicle technology together with fuel quality as one system. Thus the report is intended to stimulate a discussion with the automotive industry and the legislator on the best way to make progress in the debate on fuel quality and emissions. Any later decisions should be based on scientific programmes.

MANY ASPECTS NEED ATTENTION, PRIORITIES CAN BE DIFFERENT

Since fuel changes alone have relatively small effects, any real benefits would come from synergy between fuel and vehicle technology, i.e. ‘enabling fuels’ which allow new technology to work effectively. Good examples are the introduction of unleaded gasoline to allow the use of catalyst equipped cars, and of low-sulphur diesel fuel (with lubricity additives where needed) to enable Euro 2 diesel engines to meet emission limits. Fuel quality and vehicle technology should therefore be treated as a design system and developed in cooperation.

Environmental needs depend on local circumstances. The goal is the achievement of good air quality, rather than the reduction of all emissions without regard to costs. The most critical pollutants and the degree of control required will vary depending on the local situation.

HARMONIZATION, A DIFFICULT TASK

Given the interactive nature of engine technology, engine calibration and fuels, a worldwide approach to harmonization needs, by definition, to consider many aspects and is a complex task.

While an initiative is progressing to harmonize heavy-duty engine emissions cycles worldwide, harmonization of vehicle test cycles will be required as well. Worldwide fuel specifications could be a beneficial contribution, but only in conjunction with simultaneous harmonization of reference fuels and emission limits. In this context, the question of whether common worldwide advanced emission control requirements could be based on a common technology strategy would have to be investigated.

The expectations of the vehicle owner/driver need also to be taken into account, e.g. smooth and reliable operation under all operating conditions. Changes to reduce emissions may conflict with this objective. Customers around the world may place quite different values upon fuel economy, specific performance features and overall vehicle/operation costs.

AIR QUALITY INFLUENCED BY LOCAL NEEDS

It is vital to consider the underlying causes of the air quality problem: in individual situations, different technical/non-technical approaches will give the most cost-effective and practical solutions. Climatic or geographical conditions, customer driving patterns and expectations, the profile of the vehicle parc (size, diesel/gasoline, LD/HD, age), social demographics, public transport infrastructure, the impact of stationary emission sources and the scale of the problem (e.g. inner city versus regional) can be extremely varied.

ECONOMICAL USE OF FUEL PARAMETERS

Fuel properties should only be specified to control specific critical aspects of vehicle performance or emissions, where clear fuel effects are demonstrated and the specification parameters should be linked directly to vehicle effects. Long-term, unnecessary limits on fuel composition will restrict the ability of refineries to produce sufficient quantities of future fuels. This restriction in flexibility will translate into increased processing requirements and energy use.

CO_2 ISSUES MOVE TO THE FRONT (A 'WELL-TO-WHEELS' APPROACH)

CO_2 reduction is a further challenging objective for vehicle design. The extent to which moves to improve fuel economy align with customer expectations will vary across the regions.

Possible options to reduce CO_2 emissions/fuel consumption include vehicle size and/or weight reduction, gasoline direct injection, lean-burn technology, increasing the proportion of the diesel share, optimized (linked) engine-transmissions systems and hybrid vehicles.

To extend diesel and gasoline lean-burn applications to their full potential, breakthroughs are still required in development of exhaust gas de-NO_x technology. For such technology very low sulphur fuels are seen as enablers, but this has not yet been demonstrated. Cooperation in this area of complex and rapidly developing technology should be a priority for the industries involved, since only technically mature and cost-effective solutions can be the basis for a sound approach in meeting both air quality objectives and the customers' needs.

Changes to fuel specifications in order to reduce exhaust emissions inevitably require more processing in the refinery and hence generate more CO_2. As a consequence, CO_2 emissions must always be evaluated on a 'well-to-wheels' basis. Overlooking this principle may lead to incorrect conclusions. Any further reduction in fuel sulphur is such an example. Therefore a joint approach would have to take this into account, since increased refinery emissions could outweigh any benefits of supplying the new fuels to the vehicle fleet.

CONCLUSION—WORK IN COOPERATION

In CONCAWE report no. 99/55 the principles and the specific issues which are key to the development of fuel specifications are outlined. Cooperation between the industries involved is essential in such developments, since fuel and vehicle technology need to be developed together as a common technical system.

The US AQIRP[1], the European Auto/Oil/EPEFE[2] and JCAP[3] programmes demonstrate how the oil and auto industries can work together towards a common goal. Such programmes develop sound technical information, but more work is needed to expand the knowledge gained from these programmes to cover new technologies.

CONCAWE has, on various occasions, stated their willingness to join programmes contributing to a better understanding of future vehicle and fuel requirements for customer satisfaction and environmental needs.

[1] *US Auto/Air Quality Improvement Research Programme*
[2] *European Programme on Emissions, Fuels and Engine technologies*
[3] *Japanese Clean Air Programme*