RSC | Advancing the Chemical Sciences

Transport: RSC position statement

- **Introduction**

The transport sector accounts for around 30% of total UK energy consumption and 25% of UK Greenhouse gas emissions (2001 DTI figures). Worldwide, the demand for fuels and the number of cars is increasing. Trends in vehicle design are being driven by the need to increase efficiency and reduce CO_2 emissions. However, it is generally accepted that the customer is unprepared to compromise his or her expectation of vehicle performance, reliability or cost, so technological improvements are necessary alongside environmental developments.

The chemical sciences are pivotal in the development of systems that offer significant improvements to fuel and exhaust systems in vehicles; this has been demonstrated through the development of unleaded petrol (eradicating harmful lead additives), detergent additives (that have increased fuel economy and increased engine lifetime), oxygenated fuels (that improve fuel efficiency) and catalytic converters (to reduce harmful carbon monoxide, volatile organic compounds and NO_x emissions).

- **Reducing vehicle weight**

Vehicle performance can be considerably improved by reducing weight through the use of lighter construction materials. The challenge to polymer and synthetic chemists is to create new structural materials and designs that radically reduce vehicle weight without compromising safety.

- **Systems engineering approach**

Personal mobility can be considered a systems engineering problem consisting of the engine and fuel, the transmission system, the vehicle itself including the wheels, the road surface and construction, the refuelling infrastructure and the eventual recycling of the components. This requires a deep understanding of the chemistry and the chemical engineering aspects of the fuels, their combustion characteristics, the engine and vehicle shell materials, the control systems and sensor required.

- **Hybrid and electric vehicles**

Recently hybrid vehicles have been introduced to the market place. Further improvements to hybrid vehicles will require lightweight construction materials and technology, efficient low emission engines and improved battery or alternative energy storage technology. Energy storage is a key issue to which chemists and materials scientists have much to contribute. All of these points are equally applicable to electric vehicles.

- **Biofuels**

In early 2003, the European Commission issued a directive promoting the use of biofuels for transport, setting out to indicative targets for EU member states – 2% biofuels inclusion in the fuel pool by December 2005, and 5.75% by December 2010. The UK is currently <u>not</u> on track to meet the 2010 target.

Biofuels have great potential for reducing carbon emissions but it is vitally important that energy used in their production is minimised or derived from renewable resources.

First generation biofuels, such as biodiesel (made from vegetable oil) and bioethanol (from carbohydrate fermentation) are key biofuels that need to be exploited to meet the 2010 target. The chemical sciences and engineering disciplines are critical in developing efficient catalysts, separation processes, high throughput systems and additives to maximise the effectiveness and efficiency of biofuels.

It is the belief of the RSC that second generation biofuels (that is those derived from lignocellulosic biomass such as trees and cereal straw) offer far greater potential for reducing cost and environmental impact than first generation biofuels. Furthermore, second generation biofuels do not necessarily compete with food production unlike first generation biofuels. There are a number of key technological barriers that must be overcome before second generation biofuels are realised but with significant effort second generation biofuels will have substantial market impact by 2015.

It is important to accept that biofuels alone cannot mitigate the environmental impact of transportation, but that they can play a significant role alongside other measures.

- **Hydrogen fuel cell**

On-board storage of hydrogen is posing significant obstacles to delivering hydrogen-powered vehicles. The development of materials for hydrogen storage is a key challenge for chemical scientists.

The cost of fuel cells versus that of the internal combustion engine is also a problem, with the latter typically costing $30 for each kilowatt of power it produces while fuel cells cost a hundred times more. Technical challenges such as making fuel cells rugged enough to withstand the stress of driving, reducing their size and weight while increasing power density, fuel flexibility and fuel cell poisoning still exist.

- **Air travel**

Air transport is receiving increasing attention because of environmental concerns linked to CO_2 emissions, air quality and noise. Further atmospheric chemistry research into the impact of aircraft emissions in the upper troposphere (extends from about 14 to 18 km) and lower stratosphere (extends from the troposphere to about 50 km) are required. Whilst technology can reduce the emissions per flight, it is much more important to reduce the overall number of flights. To reduce emissions, designs with reduced weight will benefit fuel economy and efficiency. Embedded sensors and controls (in intelligent gas turbine engines) could reduce noise, emissions and costs through more effective diagnosis and maintenance processes. New materials are required (e.g. low-cost composites, corrosion-resistant, damage-tolerant alloys and smart materials) to reduce manufacturing, life-cycle costs and reduce travel time, whilst advanced coatings for the next generation of gas turbine engines are required for improved fuel efficiencies and emission reductions. Multidisciplinary teams of chemists, materials scientists and engineers are needed to develop viable solutions.

RSC | Advancing the Chemical Sciences

References (www.rsc.org/policy):

- RSC report – Chemical Science Priorities for Sustainable Energy Solutions
- RSC response to DTI Energy Review
- RSC response to Environmental Audit Committee inquiry into Reducing Carbon Emissions from Transport
- RSC and Bioscience Federation to the Environment, Food and Rural Affairs Committee inquiry into Bioenergy
- RSC response to Royal Society call for evidence into biofuels