CHEMICAL ECONOMICS - THE NEW WORLD OF ELECTRIC CARS

In past editions of *Chemistry in Australia* I have reviewed several approaches to using different non fossil fuels for the propulsion of motor vehicles. In recent weeks there have been several major announcements of proposed electrification of passenger cars which may have long term consequences and implications for the Australian vehicle fleet.

In Europe there is increased level of concern with the use of diesel passenger cars especially in urban congested cities. This has not been helped by the behaviour of Volkswagen and their apparent deceptive conduct . VW claimed they could deliver both high performance passenger diesel engines and keep the level of pollution, particularly nitrogen oxides (NOx), to very low levels without resorting to injection of urea (blue additive used by other companies) . This claim now appears fraudulent with VW equipping their sophisticated computer controlled engines with software which could detect when the vehicle was undergoing regulatory performance testing and when it was being used by a VW customer. This was discovered inadvertently by a US research team testing emissions in real on-road conditions.

There have been several consequences of this, possibly the main one being that the claims of all the major vehicle companies on emissions are no longer believed. There has been increased research focused on real road emissions and this includes in Australia and early results are showing a significant disparity between real-life emission and manufacturer's claims for petrol engine vehicles as well as diesel fuelled vehicles.

Internationally, the inability of petrol and diesel vehicles to eliminate pollutants has led the French and British governments to propose the banning of all petrol and diesel engine vehicles and being replaced by all electric vehicles by 2040. However, proposals to electrify the passenger vehicle fleet have serious hurdles to overcome which are now starting to be realised.

The penny has started to drop with governments that electrification will require an enormous increase in charging points for this to be successful, possibly one in every parking bay. Furthermore, electrification will cost the government's treasuries by the loss of fuel excise duty. The solution to this would be to change the taxing point by means of a usage charge, possibly using satellite geo-positioning to determine the distance travelled by each road user and to develop a road user charge accordingly.

Moving a nations vehicle fleet to electricity will require a very large increase in power generation. At this point, in Europe this will almost certainly be by nuclear power, which will require further significant investment. For the UK this transition is estimated to require an additional 10,000 wind turbines or 10 nuclear power stations.

In line with this ambition, several vehicle manufacturers have announced further investments in electric vehicles. For instance Volvo has announced that it will soon stop production of diesel and petrol only vehicles. This has been widely interpreted has an announcement to build electric only vehicles but it is more likely to mean that fossil-fuel/hybrid vehicles would replace the present diesel and petrol vehicles.

One of the major issues with electrification is that, with present knowledge, the logistics and distribution fleet (trucks etc) are not amenable to electrification and some other source of motive power has to be found. For a zero emissions, the best option would be hydrogen propulsion on which I have commented in a previous article. Although there is much enthusiasm for this solution generation of hydrogen at a reasonable cost is currently beyond reach.

One issue currently missing from the discussion is what to do about jet-fuel. Again there has been a lot of media interest in an electric aeroplane but unfortunately although jet- engines in the form of gas-turbines are used to generate electricity, the process is irreversible and electricity cannot be used to drive a jet-engine. Rather electric driven aeroplanes would be stuck with propellers as the means of propulsion. This may be fine for a relatively short European journey but it means the end-of intercontinental jet-travel without an alternative approach. At this stage the solution seems to be to use renewable fuels from agricultural sources with the risk of on-going degradation of tropical rainforests to produce the fuel required.

The Australian demand for transport is different from the European major centres such as Paris and London. In Australia the use of very small cars, such as the *Smart Car*, is rare. Passenger Vehicles are larger and many are expected to be able to have a significant towing capacity. For instance in Europe, owning a boat is for the rich whereas boat ownership in Australia is more egalitarian with many boats parked in domestic driveways avoiding high mooring costs. Not only this, but many owners expect to be able to tow caravans and small trailers, again not as common in Europe. At this stage of development, electric vehicles do not offer any significant towing capacity if at all. It is a moot point if hybrid/electric vehicles could offer towing capacity to any significant degree. Another difference is that many vehicles in Australia are expected to travel long distances on a daily basis. Not only is this true for country dwellers but many trade-vehicles are travelling the breadth of the urban conurbations several times per day travelling distances well over 200km daily. This is also true of Europe and I am not sure if the proponents of electric only vehicles have fully taken this into account.

Fortunately for the chemist this unbounded enthusiasm for electric vehicles will bring significant amounts of cash for research to make utopia achievable. Electric vehicles themselves require significant improvements to battery technology to improve charge carrying capacity. This will probably require a move away from Li/Ni-Co systems and into Li metal technology and this move will require a significant level of chemical research and innovation in the chemistry fundamentals underpinning battery design. Another area is in the field of advanced material composites to further lower the weight of vehicles and thereby improving range. This demand should spur research into carbon fibre re-enforced plastic construction materials and light metal alloys. The major weight problem is the mass of copper to be carried in motor windings and it would be nice if an alternative based on carbon could be found - windings made of graphene fibres perhaps?

Another area is in the non-fossil fuel production of hydrogen. The present technology is poor and there are many opportunities for improvements from the chemistry standpoint.

Another area requiring new chemistry input is in the upgrading of lithium (and graphite) ores to reduce costs. Recently Rio Tinto have announce the timeframe for the development of their massive Serbian Jadarite (a lithium borate) prospect which may be cheaper to develop than the spodomene reserves currently used and under development in Australia. If Australia is to play a significant role in

this vehicle electrification then this field is the obvious one to make a significant investment to lower lithium production costs.

However, whatever the outcome it seems to me that electrification will cost a lot of money and it is not clear if the national governments promoting it can afford it.

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