Hydrogen Storage

The safe storage of Hydrogen is the main concern regarding the gas's potential to become the fuel of the future, a fuel on which the whole 'Hydrogen Economy' will obviously be based. If Hydrogen cannot be stored safely then how can we consider it for use as a fuel? Currently there is much research and investigation into safe methods of storage.

One such method of storage involves compressed Hydrogen being kept in tanks. These tanks have been vigorously tested and have proved to be remarkably durable. The research and development that has been undertaken into the storing of pressurized Hydrogen in tanks has led to many advances in the field. New materials have been discovered and developed enabling Hydrogen to be stored in these tanks. Substantial tests including detonating a stick of dynamite next to the tank and subjecting the tank to temperatures approaching 1500ºF[1] has been undertaken to establish the tanks safety. Presently the cost of the tanks and compressing the gas is high but tanks do provide an established method of Hydrogen storage that appears to pass the stringent safety requirements.

Condensing the Hydrogen into a dense liquid form enables larger quantities of Hydrogen to be stored and transported. To liquefy Hydrogen the temperature must be reduced to -253ºC. This is a process that is time consuming and can require a large amount of energy. It is also a process with a number of inherent dangers. Low temperatures can cause cold burns and can be just as dangerous at hot temperatures. Substances that are cryogenically stored can cause oxygen deficiency that results in asphyxiation when they evaporate. The toxic nature of some cryogens can also be a danger. There desirability of liquid Hydrogen is based in it's energy:mass ratio. Excluding nuclear reactions it is the most energy dense fuel in use. There are still a variety of problems with storing Hydrogen in a liquid form. The tank it must be stored in would be large and require substantial insulation. This storage system is being investigated for use in motor vehicles due to the energy:mass ratio that would allow the vehicle to travel further than if pressurized Hydrogen was used.

Perhaps the safest storage method presently known for storing Hydrogen is achieved by combining it with certain alloyed or pure metals. When these various metals combine with Hydrogen they produce metal hydrides. The Hydrogen is bonded to the surface of the material. Large volumes of Hydrogen are stored by using small granules, therefore increasing the surface area that the Hydrogen has to bond with. The process of bonding the Hydrogen to the metal is known as 'charging' and is fulfilled by injecting the Hydrogen at high pressure into a container enclosing small metal particles.

Chemical Hydrides allow the Hydrogen to be stored at higher densities than are achievable though compression. One development that has been made into this technology is the discovery of carbon nanofibre technology. They are similar to chemical hydrides in the methods they use for sorting and releasing Hydrogen. If this technology is proved correct then it could be possible to store up to 70% of Hydrogen by weight compared to a mere 2 – 4% using the chemical hydrides technology that is presently available.

Glass micro-spheres are another technology that is being investigated as a storage system for Hydrogen. They are made up of tiny hollow glass spheres. When these spheres are warmed the permeability of their walls increase. The glass micro-spheres are they immersed in high

[1] Hydrogen Now (2002) **www.hydrogennow.org**

pressure Hydrogen gas. When the spheres cool the Hydrogen is trapped inside. Potentially this storage method could be very safe as they resist contamination and store the Hydrogen at a low temperature.

Presently there is no Hydrogen storage system that can be considered as completely hazard free but it could be argued that no technology is completely without its hazards. A case could be made to suggest that using Hydrogen as a fuel is as safe as many other substances. Hydrogen can be less flammable than petrol. It is also the lightest element so if a leak occurs it becomes dispersed in the atmosphere and will not burn. Even if Hydrogen does ignite the light nature of the element means that it burns upwards unlike petrol vapours that are heavier than air and therefore remain a flammable threat for a greater period of time. Hydrogen is a non-toxic gas unlike petroleum fuels that when burnt produce a number of toxic compounds including carbon monoxide and nitrogen oxide. Would it not be a reasonable and substantiated argument that suggested that using Hydrogen as a fuel is safer than the current use of petroleum fuels?

It has been established that Hydrogen has many potential benefits as a fuel. However a problem that has been recognized through the development of Hydrogen as a fuel is that there is currently no established distribution network. Often we take for granted the distribution networks that are in place presently. We drive the car to the petrol station and simply refuel the vehicle. Alternatively we switch on the boiler to heat the house.

Motor vehicle manufacturers are developing fuel cell vehicles. How are the fuel cells in these vehicles going to be provided with the Hydrogen required? One option is to build Hydrogen fuel stations. These would have to rely on the same infrastructure as the petroleum industry currently uses.