

PROVINCIAL WORKSHOP TOPIC FOR 2017

A large portion of global air pollution is generated through transportation and the automotive sector. Hydrogen and Fuel Cell Technologies (HFCT) are attractive technologies as they may reduce greenhouse gas emissions. Are HFCT powered motor vehicles sustainable and viable alternatives to conventional motor vehicles in South Africa?

Greenhouse gases

Greenhouse gases are gases, which when released into the atmosphere, do not break down and settle into a layer which acts like a blanket around the earth. This “blanket” traps heat from the sun, causing changes to earth’s climate (www.nasa.gov). Greenhouse gases include carbon dioxide, nitrous oxide, methane and chlorofluorocarbons (CFCs). The Intergovernmental Panel on Climate Change, which was made up of 1300 independent scientists, has agreed that human activities have raised the concentration of carbon dioxide in the atmosphere from 280 parts per million to 400 parts per million over the last 150 years (www.ipcc.ch)

According to the Union of Concerned scientists in the United States, cars produce about 20% of greenhouse gas emissions in the United States. Vehicles which have engines which combust fossil fuels such as petrol and coal produce greenhouse gases in the form of carbon dioxide and nitrous oxide. Carbon dioxide is released into the atmosphere during the burning of fossil fuels when carbon combines with oxygen. The transportation sector which includes air and rail transport, as well as road vehicles, accounts for nearly one third of carbon dioxide emissions making it the second biggest single source of greenhouse gasses after electricity production (www.ucsusa.org). The United States Environmental Protection Agency recommends switching to alternative and renewable fuels and advanced technologies in order

to decrease the level of greenhouse gases and curb climate change (www.epa.gov). One such technology is hydrogen fuel cells.

Hydrogen fuel cells

In all batteries redox reactions at the anode and cathode convert chemical energy into electrical energy. Redox reactions are those in which transfer electrons to or from atoms take place. In hydrogen fuel cells, hydrogen is separated into electrons and protons on the platinum surface of the anode. Fuel cells are batteries which receive a continuous flow of fuel from outside the battery, unlike the battery in your phone or watch. Hydrogen fuel cells convert hydrogen fuel into electricity and water (Refer to Figure 1).

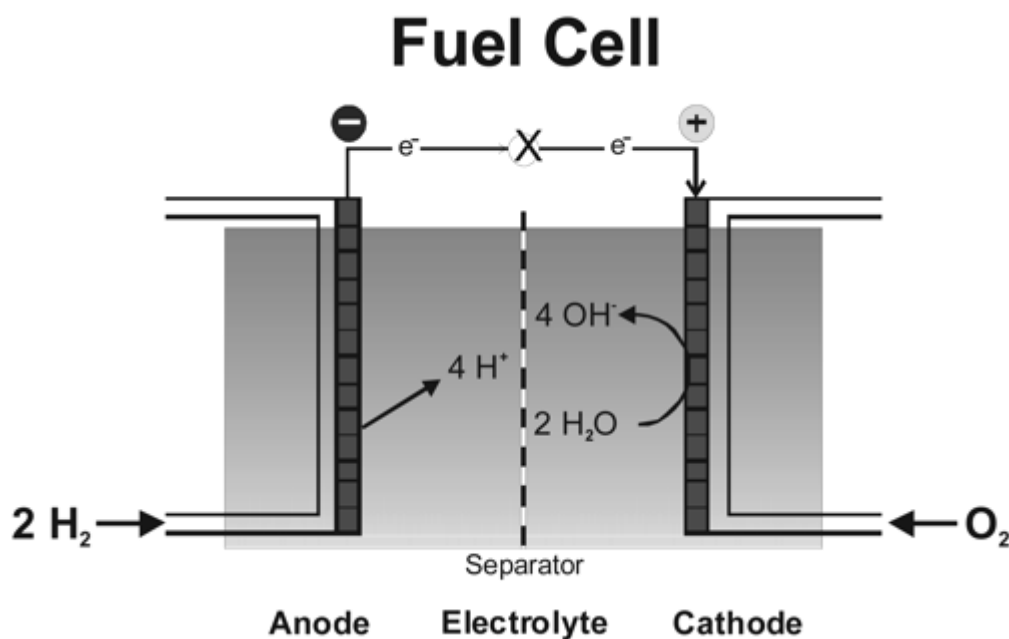
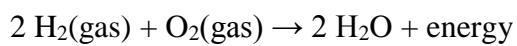


Figure 1: A schematic representation of a hydrogen fuel cell (Taken from Winter and Brodd, 2004).

Hydrogen fuel cells do not release any harmful emissions because the fuel source does not contain carbon. This means that no carbon dioxide is produced during energy production. The only by-product of hydrogen fuel cells is pure water which can be collected and used for other applications

Hydrogen fuel cells powered vehicles

Hydrogen fuel cells are lightweight and have quick start up times, making them ideal for use in vehicles (Alaswad, Baroutaji and Olabi, 2015). Hydrogen fuel cells can be used in all types of vehicles including cars, buses, trucks, scooters and forklifts. Hydrogen fuel cell powered vehicles have many advantages over conventional vehicles. They do not produce any harmful emissions and therefore do not contribute to greenhouse gasses in the atmosphere. The price of hydrogen is stable when compared to the volatile oil market. Hydrogen is a renewable resource and can be produced anywhere in the world without mining.

Application and Benefits Perspective

Through Hydrogen South Africa (HySA) numerous hydrogen fuel technologies are being developed locally. This has led to an increase in local research capacity, including the training of scientists, as well as the development of technologies which can be used all over the world. Research into the design and production of more efficient fuel cells will be beneficial to many industries, not only the automotive sector. For instance large hydrogen fuel cells can be used to power buildings as has been done at the Chamber of Mines in Johannesburg by the International Development Corporation (www.idc.co.za). One of the technologies currently being worked on is the efficient storage of hydrogen using metal hydrides (Lototsky *et al.*, 2015). This research is collaboration between HySA, the University of the Western Cape and Impala Platinum and is an example of how government and private industry can work together for the benefit of society.

Socio-Cultural Perspective

One of the limiting factors to social inclusion of many people both in rural and urban environments is inadequate transport. This means that many sectors of society including the economic and educational sectors are lacking in cultural diversity. A study conducted by the Department of Transport showed that “transport poverty” is an unrecognized burden to poor South Africans (Lucas, 2011). Hydrogen fuel cell powered vehicles have the potential to increase transport infrastructure through both public and private transport.

In large cities rapid bus transport systems such as Rea Vaya in Johannesburg and MiCiti busses in Cape Town could be expanded using large hydrogen fuel cell powered busses. Hydrogen fuel cells may also be used to power bicycles and\ scooters in areas with fewer infrastructures.

Economic Perspective

South Africa has the capacity to design and manufacture both hydrogen fuel cells and hydrogen fuel cell powered vehicles. The large scale manufacturing of these items would stimulate the automotive sector and would lead to growth in the economy, as well as job creation and skills development. Hydrogen fuel cells typically require a platinum catalyst. South Africa is one of the world's largest platinum producers with the world's largest platinum resource (Junge *et al.*, 2014). The use of hydrogen fuel cell technology would increase the demand and therefore the price of platinum leading to growth in the mining sector. Use of this technology would also decrease South Africa's import of oil as discussed in the next section.

Political Perspective

In 2014 the South African government warned that the country was becoming increasingly reliant on petrol imports. In 2013 4 billion litres of diesel and 1.2 billion litres of petrol were imported. Nearly half of this oil comes from Saudi Arabia, while Nigeria provides almost a quarter (Maqubela quoted in Fin24). Being heavily reliant on these countries can influence political policies. This was seen when Western nations, as well as South Africa, were forced to stop using Iran as a supplier for oil when UN sanctions were imposed on that country. Political instability in Nigeria often threatens South Africa's supply of oil. The use of hydrogen fuel cells will allow South Africa to become more politically autonomous from countries like Saudi Arabia and Nigeria.

References:

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