Hydrogen Combustion And Fuel Cells

Intro

If a long-term goal of the United States is to reduce greenhouse gas emissions, one factor that must inevitably be worked on is the greenhouse gas emissions from cars burning gasoline. While it would be impractical to suggest that people stop using cars altogether, there are ways to create cars that would either drastically reduce or eliminate the emissions of greenhouse gases from cars. This can be achieved through the means of using hydrogen fuel instead of gasoline. There are two main ways this could be done. First through the use of hydrogen in an internal combustion engine, or the use of hydrogen fuel cells. For this paper, both options will be explored further.

Process

Hydrogen Combustion

Using hydrogen in a combustion engine works in pretty much the same way as using gasoline in an internal combustion engine. The majority of cars use a four-stroke combustion engine, meaning that energy is created in a four-step cycle that repeats. These engines have four main parts: the crankshaft (moves in a circular motion and moves the piston, creating the cycle), the spark plug (what ignites the fuel), the intake valve (where the fuel enters the combustion chamber), and the exhaust valve (where the products of the reaction leave the chamber). In this cycle, the first step is the intake step. In this step the piston moves from down from the top, letting air and fuel into the chamber. The second step is compression. As the crankshaft continues to turn the piston is pushed back up, compressing the gas and air together (which makes the explosion more powerful). The third step is combustion. As the piston reaches the top, the spark plug ignites the gas and air (which explodes and produces energy) and drives the piston back down. The last step is the exhaust step. In this step, the exhaust valve is opened and all the byproducts of the reaction are released. Then the cycle repeats. For hydrogens, some adjustments need to be kept in mind, but they will be discussed in the limitations section below.

Hydrogen Fuel Cells

Unlike combustion engines, fuel cells don’t have moving parts. Hydrogen fuel cells are called PEM cells (Proton Exchange Membrane). PEM cells also have four parts: the anode, the cathode, the electrolyte, and the catalyst. The anode conducts electrons released from the hydrogen molecules into an electrical circuit and disperses the hydrogen molecules evenly onto the catalyst. The cathode distributes oxygen onto the catalyst and conducts electrons back into the catalyst to recombine with hydrogen and oxygen to make water. The electrolyte is the Proton Exchange Membrane. This allows protons to pass through it from the Anode side to the Cathode side while forcing the electrons to go through an external circuit (because the PEM blocks the electrons from passing through). This flow of electrons creates the energy needed to run an object (like a car). Lastly, the catalyst is normally made of platinum nanoparticles. When hydrogen comes into contact with these particles, it splits the atoms into two H+ ions and two

electrons. The ions pass through the PEM to the cathode side, while the electrons pass through the circuit of the vehicle, powering it before re-entering the fuel cell on the cathode side.

Benefits

Hydrogen Combustion

Hydrogen Combustion has the potential to be both cleaner (in emissions) and efficient (can produce 15% of the maximum output of a gasoline engine) than gasoline. However, this is only if the engine design is created with hydrogen in mind. Hydrogen Internal Combustion Engines are often bigger than gasoline engines because they require more air to create enough energy to effectively fuel the car.

Hydrogen Fuel Cells

Hydrogen Fuel Cells produce no greenhouse gasses at all. Just water and a bit of heat (however much less than that produced in a combustion engine). This reduction in heat produced makes the fuel cell less susceptible to energy loss. This “engine” doesn’t have moving parts either, which makes it more reliable than a combustion engine and less likely to… well… explode. And because of Selloni’s research into catalysts, it can be produced domestically as the products needed to make the catalyst from their research are abundant and inexpensive, like Iron.

Limitations: Can only be produced using excess renewable energy (because otherwise greenhouse gasses would be created, the cost would be quite high as it takes $4.50 per Kg (around a gallon of gas) to produce

Hydrogen Combustion

The main issue with Hydrogen Combustion engines is the engine design itself. First, the idea of a combustion engine means using a high-density fuel to maximize an explosion. This is an issue with hydrogen because hydrogen has a low density, meaning you need much more of it to drive a car an adequate distance. Second, hydrogen takes a lot less energy to ignite. This can also be an issue because if the engine is designed poorly and the chamber gets to warm, the hydrogen can blow up too early, which at the very least would ruin the engine and has the potential to hurt or kill someone. And if the reaction in the engine doesn’t have pure oxygen, but air (which also includes nitrogen), then the emissions from the hydrogen vehicles will include nitrogen oxides which have the potential to be hazardous greenhouse gasses (NO and NO2)

Hydrogen Fuel Cells

The main issue with Hydrogen Fuel Cells is the cost. Hydrogen is expensive to produce, and even using electrolysis to split steam into hydrogen and oxygen will cost around $4.50 a kg to make (a kg of hydrogen is the equivalent of a gallon of gas). This means hydrogen will always cost more than gasoline ever will. However, because they’re more efficient, you’re getting much better mileage to a kg of hydrogen, but in the end, that won’t matter because of the sticker shock of having a fuel that costs around $8 per kg. There will be many people who will straight up refuse to use hydrogen because they think it’s more expensive and they don’t care

about the environment because they think climate change is a hoax.

Impact

Hydrogen cars (especially the Fuel Cells) have the potential to have a significant impact on car emissions (if not eliminate it). However, even if hydrogen-fueled cars are way more efficient than gasoline, as long as the sticker price remains higher than regular gas, it will never be effective at eliminating gas usage. People will rarely do something unless they have an incentive to do so (especially if this thing is a change from a habit that has worked well for so long), so without some sort of technological advancement that allows it to be cheaper to make or without a government subsidy, it will unlikely do any good, which is a shame.C

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