



Combustion of hydrogen

Introduction

In Lesson 2 we learnt that hydrogen is a source of renewable, clean energy, which can be used in fuel cells to generate electricity. Hydrogen can also be used to provide power in another way - through a process known as **combustion**.

In this lesson you will learn how hydrogen combustion can provide a source of clean energy to power vehicles and how a hydrogen combustion engine works.

About the combustion of hydrogen

Hydrogen can provide power in two ways: **hydrogen fuel cells** can be used to create electricity or **hydrogen combustion engines** can be used to power vehicles.

Combustion means 'burning'. Combustion is a type of chemical reaction between a fuel and oxygen from the air which produces **heat** and **light energy**. Examples of combustion include burning natural gas in a cooker, striking a match, lighting a fire or burning petrol in the combustion engine of a car. Burning hydrogen is another example of combustion.

Combustion engines have been designed to burn hydrogen to power vehicles, instead of burning the **non-renewable** fuel petrol or diesel.

Traditional vehicles are powered by a mix of petrol or diesel and air that is ignited in a combustion engine. This releases energy that causes **pistons** in the engine to move, which in turn produces power to make the wheels go round.

However, when petrol and diesel are burnt they produce the greenhouse gas **carbon dioxide** (CO₂) which contributes to climate change.

Hydrogen powered vehicles have a type of combustion engine specifically designed to burn hydrogen. When hydrogen is burnt in the presence of air, energy is released that powers the car, in a similar way to petrol or diesel engines.

However, hydrogen has an advantage over petrol or diesel. When hydrogen is burnt it only produces pure **water**, whereas traditional engines give off CO₂ and other pollutants.



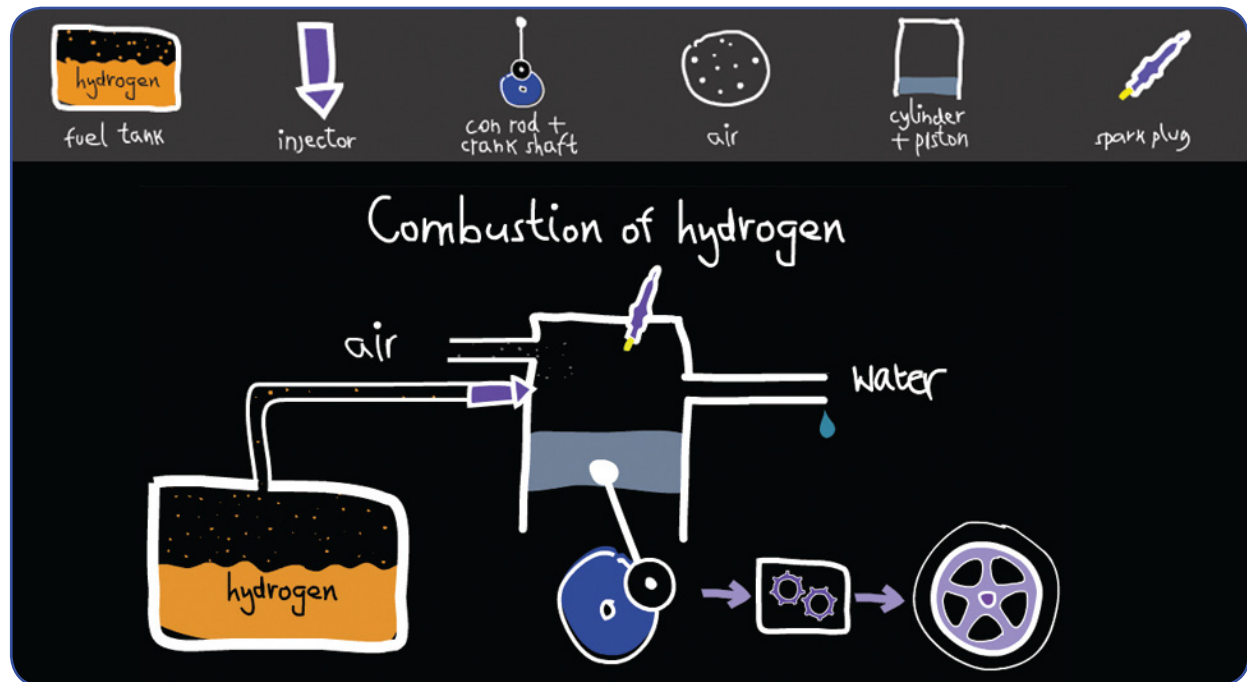
Hydrogen powered cars only give off water

Vehicles that run on hydrogen are already in existence although they are not yet in general production. One of the main problems associated with hydrogen powered vehicles is the availability of **fuelling stations**. However, there have been several hydrogen fuelling stations operating in Europe since 1999 and more are opening.

Hydrogen is known as **clean energy** as it does not produce CO₂. The **benefits** of liquid hydrogen make it an important source of fuel for the future.



How do hydrogen combustion engines work?



Combustion engines have been designed which burn hydrogen to release its stored energy, instead of burning the non-renewable fuel petrol or diesel. Unlike petrol and diesel, when hydrogen is burnt only heat and water are produced so no carbon dioxide or other pollutants are given off into the atmosphere.

Hydrogen

Stored chemical energy can be released from hydrogen to create power for vehicles using a hydrogen combustion engine.

Hydrogen is stored in a **fuel tank** in the form of liquid hydrogen. By cooling hydrogen gas to a very low temperature hydrogen gas turns into a liquid.

In traditional cars, combustion engines burn the non-renewable fuel petrol or diesel. However, when petrol and diesel are burnt they produce the greenhouse gas carbon dioxide (CO_2), which is released into the atmosphere and contributes to climate change.

When hydrogen is used to generate energy the only by-product is pure water.

Discussion points:

- Where does the hydrogen used in hydrogen combustion engines come from?
- What is the difference between hydrogen gas and liquid hydrogen?

Air

The air that surrounds us is an invisible substance made up of lots of different gases. One of the gases is **oxygen**. The chemical formula for the element oxygen is O .

Oxygen from the air is needed for combustion to take place.

Air and hydrogen are mixed together in the cylinder, before they are **ignited**.



Injector

The injector is responsible for releasing an even and measured supply of hydrogen into the cylinder, where it is mixed with air.

Cylinder and piston

The cylinder is where the combustion reaction takes place. Air and hydrogen are mixed together before they are ignited. Once this happens, the high pressure produced from the ignited fuel forces the piston to move down inside the cylinder. The movement of the piston is transferred via the con rod to the crank shaft which turns in a clockwise motion. When the crank shaft completes a rotation the connecting rod is forced back into its original position, moving the piston upwards.

The movement of the piston is **transferred** through a series of steps to ultimately make the wheels of a vehicle turn.

Spark plug

The spark plug is responsible for igniting the hydrogen and air mixture. It produces a spark that causes the hydrogen and oxygen to burn.

Con rod and crank shaft

The con rod connects the piston to the crank shaft, so when the piston moves it causes the crank shaft to rotate.

In this way, stored **chemical energy** from hydrogen is transformed into movement or **kinetic energy**. The kinetic energy is transferred from the crank shaft to the gear box and onto the wheels to make the vehicle move.

Water

Water forms when two hydrogen atoms are joined together with one oxygen atom.

When hydrogen is burnt in a combustion engine in the presence of oxygen from the air water is the only chemical that is given off. This makes hydrogen a clean source of energy.

Water that is produced by a hydrogen combustion engine is released through the exhaust of a vehicle.

Remember! Water was one of the sources of hydrogen we learnt about in Lesson 1.

Gear box

The speed of the wheels is controlled by the gear box. The more energy that is transferred, the faster the wheels of a vehicle will turn (depending on the gear selected).

Wheel

The purpose of a combustion engine is to transform stored chemical energy from hydrogen into kinetic (movement) energy to turn the wheels of a vehicle.

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Discussion points:

- What are the benefits of hydrogen powered vehicles compared to a traditional combustion engine that burns petrol or diesel?

Summary

In Lesson 3 we have learnt how hydrogen can provide a source of clean energy to power vehicles using a hydrogen combustion engine.