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Principles

A fuel cell is a device that converts the chemical energy from a fuel, typically hydrogen, into electricity. Typically a fuel cell consists of two electrodes, the anode and the cathode. The input of a fuel source on the anodic side causes a migration of ions to the cathode, as well as flow of electrons (current) via an external circuit to the cathode, that can be utilised as a power source.

Fuel cells vs batteries

The major difference between batteries and fuel cells is that batteries internally store chemical energy by building up electrons on the anode, which are prevented from reaching the cathode by an electrolyte so upon introduction of the battery to a circuit the electrons will flow to the cathode via this external circuit thereby creating a current. A fuel cell on the other hand requires an external fuel source to enter the system in order to generate a current.

Fuel cells vs a thermodynamic system

Both are thermodynamic, open systems where fuel (hydrogen) reacts with the oxidant (air).

In a fuel cell, chemical energy is transformed directly into electricity via electrochemical reaction. In a thermodynamic (combustion) system, chemical energy is first transformed into heat via chemical reaction. Mechanical energy then has to be transformed into electricity.

A fuel cell's efficiency is not limited by the carnot limit whereas the efficiency of a thermodynamic (combustion) system is not.

The chemical reaction of a fuel cell is $\text{H}_2 + \frac{1}{2} \text{O}_2 \rightarrow \text{H}_2\text{O} + \text{Energy}$.

Note that there are many types of fuel cells, which require different fuels, electrode materials and operate under varying conditions (temperature etc.). The example of the Hydrogen PEM fuel cell is used as it is considered the most viable alternative to fossil fuel based combustion engines within the automotive industry.



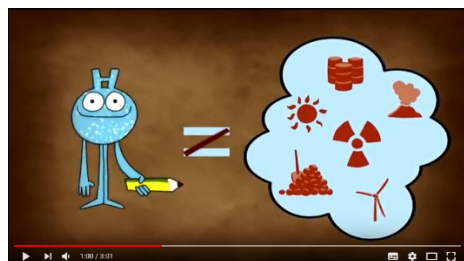
Links to additional resources for this topic

<p>Principles Student Powerpoint</p>	<p>Principles Extra Information for Teachers</p>	<p>Principles Additional Resource Loop Cards Chemical Cells AQA</p> <p>Principles Additional Resource Loop Cards Reactions in Cells</p>	<p>Kahoot Quiz</p>
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Principles videos with descriptions

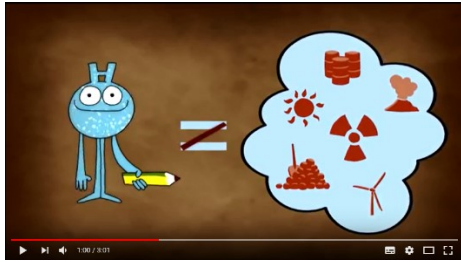
Principles - 1 – Animation - The World of Hydrogen in Italian 2.58 with all subs


<https://youtu.be/ee9cNHTdp9c>



in English 3.01 with all subs

<https://youtu.be/1R9PBNT5YL0>



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Principles - 2 – Animation - The return journey - Hydrogen to water In Italian 3.18
with all subs

https://youtu.be/eQs9ZHn_TGg



In English 3.19 with all subs

<https://youtu.be/wJ0jFPCu9Dc>



4.05 Fuel cells overview English with all subs

<https://youtu.be/QFQGXeI47c0>





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0.47 Video showing how a fuel cell stack is constructed English silent with captions

<https://youtu.be/XHj1LRJfLw>



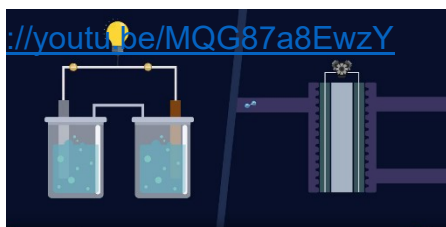
8.06 Video describing solid oxide fuel cell technology and how it can reduce truck emissions

https://youtu.be/zE_t5Lsyex8



7.08 Clear animation of a fuel cell English with all subs

<https://youtu.be/MQG87a8EwzY>





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