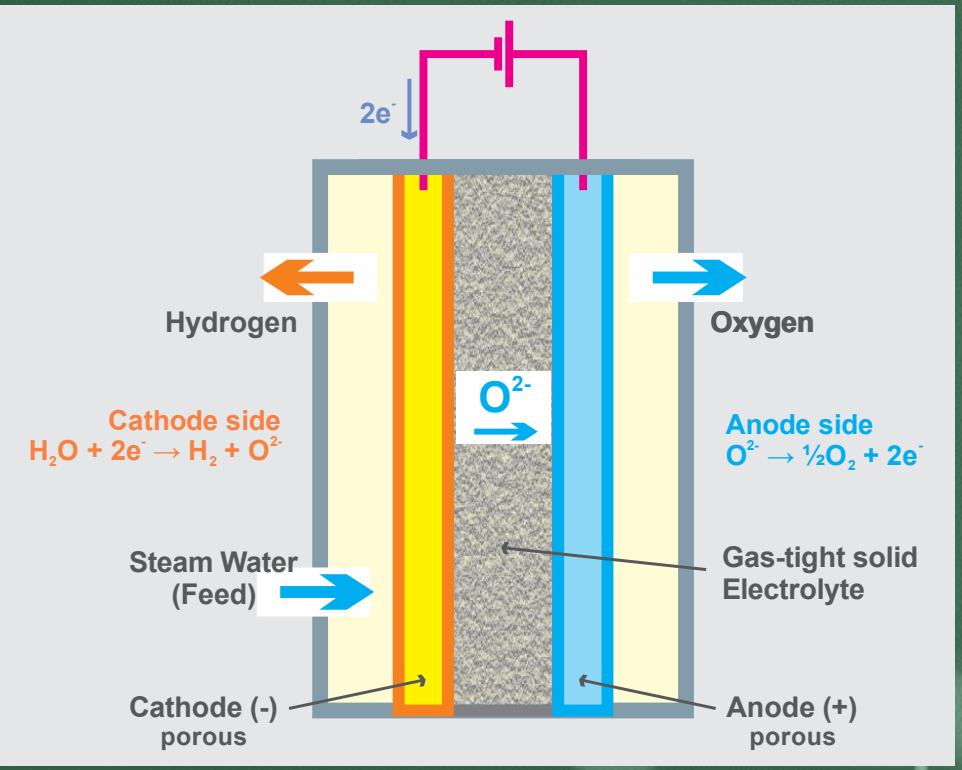
HIGH-TEMPERATURE WATER ELECTROLYSIS (HTWE) Principle



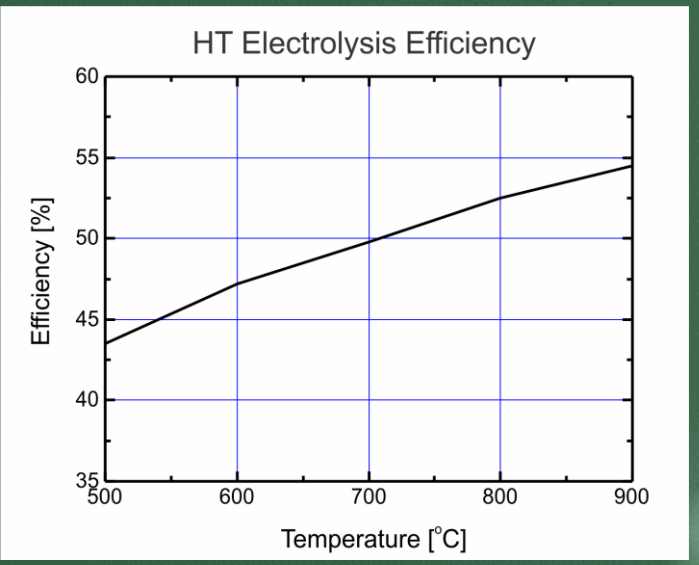
The principle of HTWE is as follows: At high temperature and with the help of an electric current, the feed water vapor is decomposed on the cathode side into H_2 and oxide ions (O^{2-}). The hydrogen leaves the system as a gas, while the oxide ions migrate through the electrolyte (see figure). They are neutralized on the anode side and released as gaseous oxygen.

As with any electrolysis process, the HTWE cell in which this occurs contains two **electrodes** (anode and cathode) connected to an **external power supply**, and a **solid electrolyte** positioned between them. The electrolyte enables the transfer of charged particles (ions) from one electrode to the other.

The operating temperature of such a device ranges from **700 °C to 1000 °C**. Because of these high temperatures, the materials used to construct the cell must remain stable both electrochemically and physically. Therefore, special ceramic materials that exhibit high-temperature conductivity are used. Noble metals are not required. A high-temperature electrolytic cell of this type is commonly referred to as a **Solid Oxide Electrolysis Cell (SOEC)**.

More details: https://en.wikipedia.org/wiki/High-temperature_electrolysis#:~:text=High%2Dtemperature%20electrolysis%20(also%20HTE,new%2C%20potentially%20better%20electrolytes%20like

HTWE
Energy Efficiency



The efficiency of HTWE **can exceed 50%,** depending on the operating temperature, as shown in the figure. This value is calculated under the assumption that the electricity used for electrolysis is generated in a thermal power plant—although this does not have to be the case—where the efficiency of converting heat into electricity is about 30%. At the same time, the efficiency of heat production is significantly higher, as is the efficiency of the electrolysis process itself, both typically above 80%. Taken together, these three efficiencies determine the overall efficiency of the system.

Using the same principle—but without heat energy and without the efficiency of its generation—it is calculated that the efficiency of **alkaline electrolysis** is around **27%**, which is the product of the efficiency of electricity generation and the efficiency of the electrolysis.

The energy efficiency of HTWE is significantly higher than that of low-temperature water electrolysis for at least two reasons. First, the feed material in this electrolysis is **water vapor**, which requires thermal energy to produce. This thermal energy is considerably cheaper than electricity, and it typically accounts for at least **30%** of the total energy input. Second, the efficiency of water decomposition increases with rising temperature (see figure), because elevated temperatures increase electrode activity and accelerate all chemical reactions, which consequently increases the hydrogen production rate. Moreover, as already noted, at sufficiently high temperatures water can be decomposed even without an electric current.

The drawbacks of HTWE are its limited operational stability and system durability.