Beyond Freshwater

Unlocking Hydrogen Production with Hychor's Innovative Electrolysis

Join the green hydrogen revolution with Hychor.

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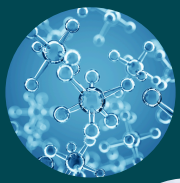
Electrolysis of Water

Hydrogen can be produced through many pathways, most commonly through dehydrogenation of methane through steam reforming which release CO_2. The most sustainable method of production, however, is through electrolysis, splitting of water (H_2O) into hydrogen (H_2) and oxygen (O_2) gases with electricity. When powered by renewable energy such as wind turbines or solar panels, it is called green hydrogen, which is a CO_2 free energy lifecycle and produced up to 840x less CO_2 than traditional methods.

Hydrogen Production – Electrochemistry



Electrochemistry is a surface science studying the interface of an electronically conductive electrode and electrolyte which is also conductive and supports transport of reactants and products.

Producing green hydrogen through electrolysis requires an external voltage (from renewables) which is applied to an electrochemical cell called an electrolyser. The minimum voltage to electrolyse water will be determined by the electrochemical potentials of the oxidation of water to oxygen and the reduction of water to hydrogen.

Where in standard conditions, the hydrogen evolution reaction (HER) occurs at the cathode (negative electrode):

$$2H_{(aq)} + 2e^- \rightarrow H_{2(g)},\ E^o = 0.00\ V\ vs\ SHE$$

And oxygen evolution reaction (OER) occurs at the anode (positive electrode):

$$2H_2O_{(aq)} + 4e^-_{(g)} \rightarrow O_2 + 4H^+(aq) +,\ E^o = 1.23\ V\ vs\ SHE$$

Total water electrolysis reaction:

$$H_2O_{(aq)} \rightarrow H_{2\,(g)} + \frac{1}{2}\ O_{2\,(g)},\ E^o = 1.23\ V$$

This is equal to a minimum energy input of 237 kJ mol^{-1} or 117 kJ g^{-1} (32.7 kWh g^{-1}) of hydrogen produced. However, typical electrolysers operate around 2 V, about 60% efficient to its lower heating value.

Where's the Water?

Though one of the most energy and water efficient methods of production, green hydrogen may withdraw up to 32.2 L of freshwater per kilogram of hydrogen. At the predicted 2050 scale of 460 TWh of hydrogen in the UK, that would equate to about 370 MT, just over 10% of UK's current domestic use. Globally, by 2050, green hydrogen may withdraw up to 11.5 GT of freshwater, or over 3x UK's supply. Relying on potable water will put a strain on the domestic water system so alternatives are necessary such as seawater.

To use seawater, it must first be desalinated which incurs additional costs and produces a polluting brine. Water input to PEM electrolysers must be of ultra-pure quality, with an inlet salinity of about 5 ppm total dissolved salts. Dependent on technology (reverse osmosis, thermal distillation, etc.), energy input of seawater electrolysis may be as low as 0.2%, marginal of the total cost of hydrogen production. Capital expenditure and balance of plant, however, incur a more significant cost, as well as, the considerations of brine production on the environment.

2050

Over 10% of UK's current domestic use

x3 times over UK's supply

Why not seawater?

Seawater can not be introduced into traditional electrolysers because of the dissolved salts present, most notably, chloride. Chloride can be electrochemically oxidised to chlorine gas, a highly corrosive, toxic gas which will destroy the electrolyser.

$$2Cl^-_{(aq)} \rightarrow Cl_{2\,(g)} + 2e^-, \quad E^o = 1.36\ V\ vs\ SHE$$

Though it's standard equilibrium potential is more positive than OER, the sluggish kinetics of OER cause an onset potential of about 200-500 mV (depending on catalyst). Coupled with ClER's facile kinetics, it will occur significantly before the onset of OER, producing chlorine on the anode rather than oxygen.

Chlorine is purposefully produced in the chloro-alkali process, however, these electrolysers require specialised materials, adding to cost, and would insist on having a chlorine market equal in size of the hydrogen market as they're produced at equal amounts.

Even if ClER in seawater can be avoided with a highly active OER catalyst, electrolysis of seawater will unavoidably generate by-products which not only makes ClER more facile but demands increased energy input. More products, more energy.

Hychor's Technology

Hychor does not take a material approach but a system one. We are rethinking electrolysis and are developing a novel electrolyser system to by-pass CIER through taking an alternative reaction pathway.

We don't avoid the salts present in seawater but use them to our advantage as they give seawater the necessary conductivity to facilitate electrolysis.

This system's approach allows does not require additives or produce by-products, only increasing the salt concentration by <1%, meaning the seawater can be returned back to it's source.

Hychor's Value

Our value is clear: facilitate the utilisation of the most abundant source of water available, seawater, while reducing costs. No desalination, no by-products, improved overall efficiency.

Though early-stage, our patent-pending technology may revolutionise the electrolyser industry, becoming a new branch of available technologies. By utilising seawater without desalination, we can directly reduce cost of hydrogen production and improve sustainability. Coupled with renewable energy, we can utilise any excess energy and convert it to hydrogen, maximising our energy system and avoiding constraint payments.

Ready to Revolutionise Your Hydrogen Production?

Discover how Hychor's groundbreaking seawater electrolysis technology can transform your hydrogen production process—reducing costs, minimising environmental impact, and maximising efficiency without the need for desalination.

Connect with Us

Want to learn more about our technology and its potential for your operations? Our team is here to answer your questions and explore how we can support your hydrogen production goals.

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