EDISON

Edison Explains

Hydrogen from oil reservoirs

Utilising in-situ combustion to exclusively produce hydrogen

Hydrogen and the energy transition

Edison believes that hydrogen will play a key role in the decarbonisation of the energy system, with supply expected to be met with the production of a combination of green hydrogen (from electrolysers powered by electricity from renewable sources) and blue hydrogen (created from fossil fuels where the CO_2 is captured and stored), see also Edison Explains: Low-carbon hydrogen. Here we look at the adaptation of in-situ combustion in oil reservoirs to produce only hydrogen to surface.

What is in-situ combustion?

In-situ combustion (ISC) is one of the oldest methods of thermal recovery from oil reservoirs, and has been successfully used for decades in the oil industry. Gas, containing oxygen, most commonly air, is injected into a reservoir, where it reacts with the crude oil to create a high-temperature combustion zone, generating combustion gases and creating a heated front that moves through the reservoir. The technique has typically been used in heavy oil reservoirs that cannot be produced by conventional methods due to the high viscosity of the oil. The increase in temperature created near the combustion zone results in a reduction in the oil viscosity, allowing an increase in production.

How can ISC be adapted to produce hydrogen?

Hydrogen is a by-product of the reactions occurring during the in-situ combustion process, so the goal would be to only recover the hydrogen from the reservoir. If proven, this technique could deliver an alternative source of hydrogen without producing CO_2 to surface.

The key processes are gasification and the water gas shift, which also occur in steam methane reforming, used to create blue hydrogen. At temperatures above 500°C, the carbon dioxide produced during the combustion process reacts with steam to produce syngas, a mixture of carbon monoxide and hydrogen, and this is known as gasification. In the water gas shift, the carbon monoxide then reacts with steam to produce carbon dioxide and more hydrogen. Any reservoir where oil and water are present is suitable, opening up a potential use for many mature, end of life fields.

What are the key challenges?

The two key challenges to successfully producing only hydrogen to surface using ISC are:

- Successfully separating the hydrogen from the other produced gases downhole.
- Achieving a high temperature in the reservoir.

Palladium-based membranes have been developed for hydrogen separation. These decompose hydrogen into individual atoms which diffuse through a metal lattice and recombine to hydrogen on the other side. While used successfully at surface in steam reforming, palladium alloy membranes are known to be fragile, so their use underground, where control would be more difficult, is more challenging and would need to be successfully demonstrated.

To achieve high temperatures, injecting pure oxygen instead of air should make the downhole reactions hotter and more efficient.

Where is this happening in practice?

Since February 2020, private company **Proton Technologies** has been trialling this technology in its Superb heavy oil field in Saskatchewan in Canada. The company is successfully producing hydrogen, although for now it is separating out the hydrogen at surface with the palladium membranes. In early tests, the membrane extracted a 99.9% stream of hydrogen. The next step will be to test the membranes deep in the wells.

In addition to producing its own hydrogen, the company has sold at least 15 licences to other companies, believed to be a mix of oil and gas operators and renewable energy companies. One of these is **Whitecap Resources**, a company that currently produces c 116,000boepd from its operations in Western Canada and has been involved in CO_2 sequestration for over 20 years. In January 2021, Whitecap Resources secured a hydrogen production licence of up to 500 metric tons/day from Proton.

Edison insight
'If successfully demonstrated, in-situ combustion offers a path to generating hydrogen that avoids greenhouse gas emissions.'
Elaine Reynolds, energy analyst.

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