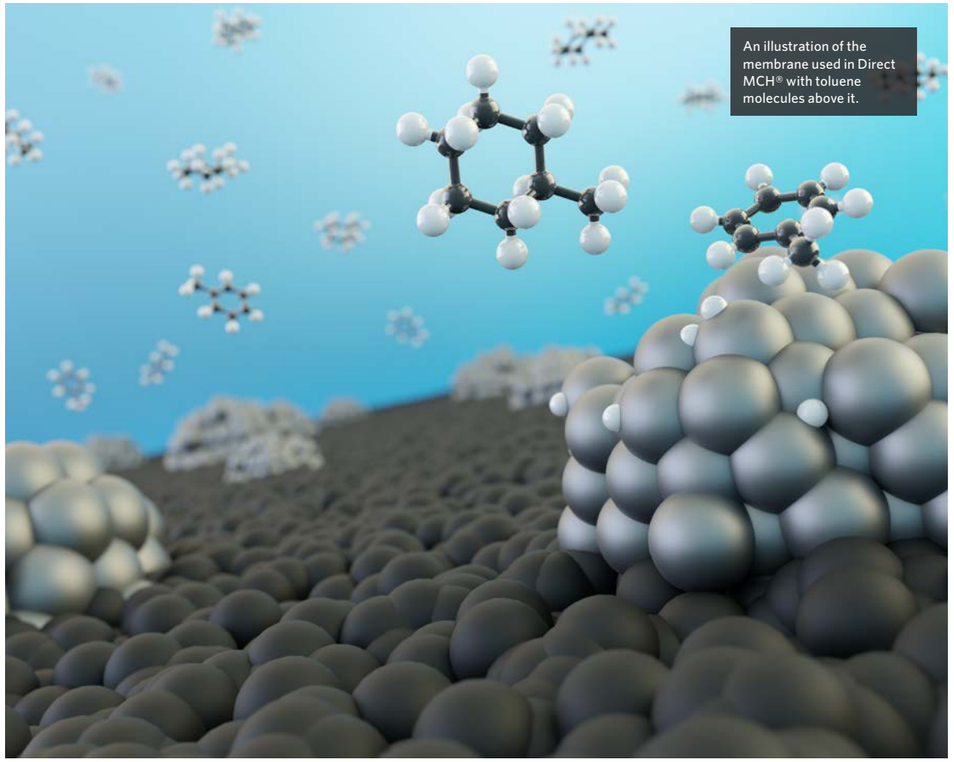
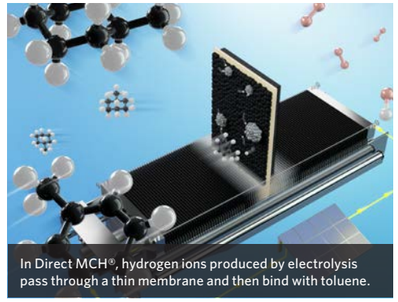
ADVERTISEMENT FEATURE

A hydrogen-powered society is around the corner

Hydrogen energy has a head start thanks to the existing INFRASTRUCTURE AND EXPERTISE in petroleum



An illustration of the membrane used in Direct MCH® with toluene molecules above it.



In Direct MCH®, hydrogen ions produced by electrolysis pass through a thin membrane and then bind with toluene.

ENEOS has 44 hydrogen refueling stations in operation as of early 2021.

Hydrogen imported by ship will be used for a range of applications.

The day will soon come when the most of the service stations operated by ENEOS, Japan's largest energy company, will offer carbon-free fuel to automobiles throughout Japan, according to Seiji Maeda, who leads ENEOS's carbon-free hydrogen initiatives. "There's a preconception that a society powered by hydrogen lies in the distant future," he says. "But the infrastructure and know-how for oil that we have accumulated over the years is helping us get there."

"INDUSTRIAL USE NEEDS TO KICK OFF FIRST, SO WE CAN TAKE ADVANTAGE OF SCALE"

ENEOS began operating hydrogen stations in 2014, the year when the Japanese government stated its commitment to accelerate moves towards a hydrogen-powered society. As of early 2021, ENEOS operates 44 hydrogen stations, the largest network in Japan. With a technology a decade in the making nearing completion, ENEOS is working to bring a society based on carbon-free hydrogen closer to reality.

HYDROGEN WITHOUT CARBON

There are two main ways to produce hydrogen gas without releasing carbon. One is to reform fossil fuels such as brown coal and natural gas and eliminate carbon dioxide emissions with carbon capture and storage technology. Another is to electrolyze water using electricity generated from renewable energy — now a point of focus for ENEOS.

Resource-poor Japan has relied heavily on imports for hydrogen derived from fossil fuels. This will also be the case for energy derived from renewable resources. "It costs about three to five times more to produce electricity from renewable energy in Japan than in countries rich in renewable resources, like Australia or Norway. Even after accounting for additional costs like transportation, importing is still more economical," explains Maeda. "The right strategy for Japan, then, is to focus on lowering costs for hydrogen produced and transported from abroad. And we have — Japan has been leading research into hydrogen supply chains since the early 2000s."

ELIMINATING THE MIDDLE STEP

A technology known as Direct MCH® is expected to reduce the cost of transporting carbon-free hydrogen. It can store hydrogen from renewable resources in liquid form. "The technology is an enhanced version of a method involving toluene, a flammable liquid like petroleum," says Yasushi Sato, who leads the engineering team that developed Direct MCH®. "It involves dissolving hydrogen into toluene to produce methylcyclohexane (MCH), which is a liquid at normal temperature and pressure." In addition to saving space, these properties make it much easier to transport. The alternative is liquid hydrogen, which must be stored at −253 degrees Celsius.

In the original MCH method, gaseous hydrogen had to be stored in tanks and later reacted in toluene in chemical reactors. In contrast, Direct MCH® converts renewable energy directly into MCH. "With Direct MCH®, the hydrogen ions produced from electrolysis pass through a thin membrane and bind with toluene directly inside the same apparatus," explains Sato. Since it doesn't require storage tanks or chemical reactors, Direct MCH® is expected to cut facility costs by up to 50%.

In a pilot run in early 2019, Sato's team succeeded in powering a model vehicle in Japan with hydrogen made from Australian solar power. "Preparations for the next pilot are currently underway," says Sato. "The plan is to charge customers' fuel-cell vehicles at one of our stations with hydrogen produced through Direct MCH® in Australia."

USING PRE-EXISTING INFRASTRUCTURE

"To supply carbon-free hydrogen to consumers at affordable prices, industrial use needs to kick off first, so we can take advantage of scale," says Maeda.

"An immediate use is in extracting sulfur out of crude oil — we can replace the fossil-fuel-derived hydrogen currently used for this process with carbon-free hydrogen," he says. "Additionally, electricity generation and steel manufacture are thought to be the largest industrial-scale opportunities in Japan. Power plants and ironworks are in the same industrial complex as refineries, and are already connected by pipes for supplying oil and gas directly. It makes sense to use the same infrastructure to quickly supply hydrogen in bulk."

The size of refineries and associated facilities are also practical for receiving vessels carrying MCH. "To import massive amounts of hydrogen, we need ports large enough to accommodate tanker ships," says Maeda. "While it would be extremely costly to build a new facility of that size in Japan, our refineries already have ports that can accommodate very large carriers." Furthermore, the refineries are equipped with oil tanks that can be modified to store MCH.

NEARER THAN WE THINK

By combining pre-existing infrastructures and new innovations, ENEOS is continuing to push towards a future society based on carbon-free energy. "People tend to speak of a society based on hydrogen energy as though it was a long way off. But part of that ideal world already exists in today's world," says Maeda. "We don't need brand-new infrastructure for new energy; the infrastructure we already have for petroleum refineries are valuable assets that bring a carbon-free society closer to reality — this is exactly where energy companies like ENEOS can contribute." ■

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