Fuel-efficient cars, planes cheaper with magnesium drawn from ocean

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Credit: PNNL

A lightweight metal that reduces fuel use in cars and planes could be extracted from the ocean through a unique process being developed at the Department of Energy's Pacific Northwest National Laboratory. The process could ultimately make fuel-efficient transportation more affordable and expand the American magnesium market.

PNNL is leading a $2.7 million, three-year project to develop a novel method that removes naturally occurring magnesium from seawater. The project was announced today (pdf) by DOE's Advanced Research Projects Agency-Energy, also known as ARPA-E.

"Demand for lightweight metals such as magnesium is growing, but it's expensive and energy-intensive to produce them," said the project's lead researcher, PNNL Laboratory Fellow Pete McGrail. "We expect our method will be 50 percent more energy efficient than the United States' current magnesium production process. This will also decrease carbon emissions and the cost."

Among the lightest of metals, magnesium is used in alloys that decrease weight and increase strength of key parts used in vehicles, airplanes, power generation equipment, industrial processes and buildings. But magnesium is about seven times more expensive to produce than the steel traditionally used in those applications. Producing lightweight metals also requires a lot of energy, the generation of which creates carbon emissions. A cheaper and more efficient production process is needed to enable the broader use of lightweight metals, leading ARPA-E to announce $32 million in funding today for new projects that will develop new processing and recycling methods.

The United States is home to just one bulk magnesium plant in Utah, where brine from the Great Salt Lake region is put through a chemical reaction called electrolysis to extract the metal from a molten salt. About a third of the nation's magnesium is imported, and China is the world's largest producer. China uses another method called the Pidgeon process, which requires significantly more energy and creates substantially more carbon emissions than the method used in Utah.

"Reinventing the magnesium production process so it's more affordable can also help grow the American magnesium market and decrease U.S.

reliance on foreign-made materials," McGrail said.

New catalyst key to energy-efficient conversion

PNNL is developing a new, titanium-based catalyst that regenerates an important chemical used in the magnesium extraction process. The catalyst will enable a more efficient process and use less energy. PNNL's process will require temperatures of no more than 300 degrees Celsius, which is much lower than the 900 degrees Celsius required by the current U.S. process.

PNNL will draw on its expertise in catalyst development, molecular simulation, powder metallurgy and metal-organic chemistry for the project. Detailed computer modeling and follow-up lab tests will be used to pinpoint the catalyst's specific chemical makeup.

The project team plans to develop a prototype system that uses the new process. Commercial-scale magnesium production with the new process is expected to halve the current U.S. production cost. It should cost less than $1.50 and require only 25 kilowatt-hours of energy per kilogram.

PNNL is partnering with Global Seawater Extraction Technologies and Utah magnesium plant owner U.S. Magnesium, LLC. The new production method will use a crystallization process developed by Global Seawater Extraction Technologies and tap electrolysis and practical magnesium production experience from U.S. Magnesium.

ARPA-E is providing $2.4 million for the project, while PNNL's project partners will provide the following cost-share matching: $210,000 from Global Seawater Extraction Technologies and $60,000 from U.S. Magnesium.

More information: www.arpa-e.energy.gov/sites/de …

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%26REMOTE_Project_Descriptions_091913.pdf

Provided by Pacific Northwest National Laboratory