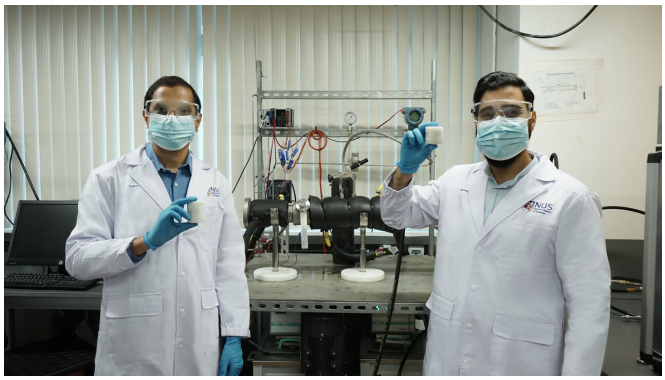
Engineers invent fast and safe way to store natural gas for useful applications

3 December 2020



Associate Professor Praveen Linga (left) and Dr Gaurav Bhattacharjee (right) from the National University of Singapore (NUS) holding solidified natural gas pellets. Behind them is a prototype of the machine they used in their patented conversion process. Credit: NUS

Natural gas is the cleanest of all fossil fuels, but storing it safely and affordably remains a challenge. Now, engineers from the National University of Singapore (NUS) have devised a method to convert natural gas into a non-explosive solid that can be easily stored and transported. Using a novel, low-toxicity additive mixture they formulated, the conversion can be completed in just 15 minutes—the fastest time so far.

The NUS team was led by Associate Professor Praveen Linga from the Department of Chemical and Biomolecular Engineering at the NUS Faculty of Engineering. Their paper was published in the journal *Energy & Environmental Science* on 27 October 2020.

Fast, safe and portable way to store natural gas

The NUS team worked on a process of converting natural gas into a solid form known as gas hydrates, or combustible ice, which consists of molecules of natural gas trapped in "cages" formed by water molecules. In fact, nature stores natural gas this way, but the process is extremely slow. Other researchers have previously managed to speed it up artificially, but they resorted to using highly toxic additives which are unsafe for both the environment and personnel involved.

The new additive mixture formulated by the NUS researchers contains L-tryptophan, well known as an essential amino acid in people's diet. This muscle-building amino acid can also greatly speed up the caging of natural gas into solid hydrate. The NUS formulation produces the fastest reaction rate to date—more than twice as fast as existing standards—while being less toxic and safer to handle.

Research Fellow Dr. Gaurav Bhattacharjee, who worked on the project, said, "Our breakthrough can really be put into perspective when you consider that it takes millions and millions of years for gas hydrates to form in nature, yet with our correct addition of secret ingredients to the system in small quantities, the same process can be effected in the laboratory in a matter of minutes."

Moreover, the end-product is very stable and can be stored at –5 degree Celsius and atmospheric pressure, similar to the conditions of a home freezer. This is impressive considering that the natural gas is reduced in volume by close to 90 times. Alternative ways to store natural gas include liquefying it at about –160 degree Celsius, or compressing it to almost 250 times atmospheric pressure. These approaches do not work at a large scale because either they are expensive or not so safe to store for long periods.

Scaling up for industrial use

The NUS researchers are now aiming to convert larger volumes of gas into smaller volumes of solid at a pilot scale of 100 kilogrammes per day. If successful, this will enable the commercial adoption

of the solidified natural gas technology and create a solid that is stable to store at atmospheric pressure. They hope to eventually scale it up for industrial use.

Assoc Prof Linga said, "This is especially relevant to natural gas importing countries like Singapore, where 95 percent of electricity is generated using natural gas. The development of such gas storage technologies would help enhance the country's energy security."

More information: Gaurav Bhattacharjee et al. Ultra-rapid uptake and the highly stable storage of methane as combustible ice, *Energy & Environmental Science* (2020). DOI: 10.1039/D0EE02315A

Provided by National University of Singapore