MIT Researchers Turn Waste Gas into Liquid Fuel

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Using waste gases from power stations to create low-carbon liquid fuels would be a major advance in the battle against global warming. Photograph: Jon Woo/REUTERS

Successful trial at a pilot plant in China using bacteria to convert exhaust emissions to oil will now be tested at a larger scale

Damian Carrington

Turning the emissions of power stations, steel mills and garbage dumps into liquid fuels has been demonstrated by MIT researchers using engineered microbes.

The process has been successfully trialled at a pilot plant in China and a much bigger facility is now planned.

Energy-dense liquids are vital to transport but are currently derived from oil, a fossil fuel, and transport produces about a quarter of the global carbon emissions driving climate change. Biofuels have been seen as possible replacement, but current biofuels compete with food production and have been blamed for driving up food prices.

Using waste gases to create low-carbon liquid fuels would be a major advance in the battle against global warming if they could be made at low cost and large scale. Another company

expects to be using different microbes to produce fuel from steel plants in Belgium and China in 2017.

The Massachusetts Institute of Technology (MIT) process uses bacteria to convert the waste gases into acetic acid – vinegar – then an engineered yeast to produce an oil. “It is quite an extraordinary story,” said Prof Gregory Stephanopoulos, an expert in chemical engineering and biotechnology at MIT in the US.

“It started just four to five years ago with a post-doctoral project funded by the US Energy Department. We are looking at a very fast timescale [of development],”, he said. “We have pieced the system together into an integrated system, where you put gas in one end and get a liquid fuel out of the other end.” The research was published on Monday in the journal Proceedings of the National Academy of Sciences.

The patents for the process are owned by MIT and have been licensed to GTL Biofuel Inc. Its pilot plant outside Shanghai ran successfully from September 2015 and a larger “semi-commercial’ demonstration plant, 20 times the size, is set to begin construction.

This will test if the process can be scaled up and evaluate its costs and carbon footprint, said Prof Stephanopoulos: “It is one thing to do it on a scale of 1-2 litres in the lab, but a different story to move up 1,000 litres and then 20,000 litres in the demonstration plant.”

“The bottom line, if one is aiming at making fuels from renewable resources, is we need to look very carefully at low-cost feed stocks,” he said. Garbage, along with manure and farm waste, is a particularly promising source of the “syngas” required, he said: “The volumes are staggering.”

Furthermore, using the gas from municipal waste reduces the carbon footprint of the liquid fuel, compared to exhaust gases from fossil fuel plants.

Prof Stephanopoulos said there are already thousands of biogas sites across Europe, but he argues the current practice of burning this gas to produce electricity is wasteful: “It is very costly and can only survive due to subsidies.” Better, he said, is to use the gas to produce fuels that can replace gasoline or diesel.

The MIT team are not the only people developing biotechnologies to turn exhaust gases into fuels. Like MIT, the US company Lanzatech uses microbes that can ferment gases into more complex molecules, a skill originally evolved so the bacteria could thrive at bubbling, hydrothermal vents on the ocean floor.

Lanzatech’s processes aim to produce either fuel or chemicals useful in industry. The company is currently building commercial units in Belgium with ArcelorMittal, the world’s largest steelmaker; in China with Capital Steel and in Taiwan with China Steel, with the first unit expected to enter service in 2017. Another US company, Catalysta, is working on converting methane into hydrocarbon fuels.