Formic Acid Bus Pulling In

Compared with private cars, public transportation is ushering in the era of clean energy at a higher speed. According to statistics from Ministry of Transport of China, bus ownership has been about 500,000 in China, in which new energy bus has exceeded 160,000. The market penetration of new energy bus is estimated to reach about 50 percent by 2020.

Most new energy buses at present are electric or hybrids vehicles, but scientists are still exploring for more choices. A young research team from Eindhoven University of Technology in the Netherlands, has found a new kind of fuel for the bus from the secretion of ants.

Formic acid, systematically named methanoic acid, is common in the secretion of insects such as ants and bees in daily life. It has been widely used in the production of organic chemical raw material as cleaning agents, solvents or pesticides.

Team Fast, a Dutch research group, has developed a catalyst capable of transforming carbon dioxide and water into formic acid. "This founding inspired us to make a prototype to prove that the formic acid can actually power vehicles." Vera Pijnenburg, the marketing director of Team Fast, told CBN Weekly. "The Earth is warming up at an unprecedented speed because of the excessive emission of greenhouse gas. We have to take actions to stop it."

By using the particular catalyst, Team Fast synthesized formic acid, dissolve it in solvents, and produced the new fuel named Hydrozine which contains 99% of formic acid. Being stored in containers, this new fuel can be decomposed into hydrogen and carbon dioxide by using specific catalysts. Added into fuel cells, hydrogen will react with oxygen and generate electric power, which further powers the vehicles, and expels environmental friendly carbon dioxide and water while the traditional buses usually exhale harmful gases including carbon monoxide, and sulfur oxide.

Also, Hydrozine can easily transported and replenished. "Its liquidness enables the fuel to be stored and ‘refueling vehicles' as petroleum," said Pijnenburg.

Recently, Team Fast is cooperating with VDL group, a Dutch bus manufacturer, in developing the first sample formic acid-fueled bus, which has several advantages over the electric bus according to the research group.

"Battery has made it convenient to travel in short distance, but when it comes to heavy vehicles such as buses, trunks and steamers, it is obvious to see the limitation of having electric drive system." In Pijnenburg's opinion, the limitation of electric vehicles in long-distance and heavy transport can be addressed for formic acid has triple energy density as battery (about 2.1 kW·h in every liter).

Still, Hydrozine is not perfect. Its energy density is lower than diesel, so it has to be stored in bigger containers. The prototype of the fuel tank made by Team Fast recently can accommodate 300 liters, which means the cruising ability of a bus is about 200 km. The first prototype bus primarily uses electric power system developed by its partner, the VDL group, and receives extra electricity by formic acid fuel battery system suspended on the rear trailer. The team plans to improve its cruising ability to 400 km by enlarging the fuel tank.

It will cost approximately €35,000 to adapt a general gas station into a Hydrozine filling one, which is much cheaper than directly constructing a new station, estimated by Team Fast. The price of Hydrozine is €0.5 per liter. It is more expensive than diesel, but according to Pijnenburg, it's cheaper than gasoline and is likely to be the cheapest among the three fuels in the future as research goes further.

"We're still in the infancy of the production, so it's hard to estimate the ultimate cost. There are some over-engineered problems that we have to tackle: Some functions exceed actual demands, and that increased the difficulty of budget estimation," Pijnenburg said to CBN Weekly.

Team Fast, the university based research team, mainly focuses on fuel innovation. It includes 35 teachers and students from different majors. Having three general leaders, they are divided into seven branches, carrying

different duties in security, electronic hardware, electronic software, chemistry, mechanical engineering, public relation, and marketing.

The structure is what distinguishes itself. "It has a flat management with no superiors and subordinates on the whole, with small branches work closely. Full-time members are responsible for internal management, coordination and communication with public affairs. The others, like me, are part-time workers, focusing on their professions with a clear division of work," Zhang Huiyi, a member of the team, told CBN Weekly.

Zhang Huiyi is a member of the chemistry team and is the only Chinese. During her graduate study at Eindhoven University of Technology, she accidentally came across recruitment information and applied for it. The official language of Team Fast has changed from Dutch to English because of her joining in.

Chemistry team is mainly responsible for the research and development (R&D) in the laboratory, including basic R&D test. Zhang believes the key of her department is "the transformation of formic acid".

"The transformation involves several academic details related to reactors like catalysts and reagents," Zhang explained, "The first problem I encountered was the purity and formula of the catalyst. We couldn't afford the best raw materials, meanwhile we have to improve the instability of the reaction system, which hasn't been thoroughly proved in previous researches."

Many members in Team Fast are part-time, resulting in the errors to different extent. To verify and ensure the purity of the generated hydrogen, they have done abundant trials and analysis, and requested helps from outside engineers. "I even tried to contact Chinese raw material suppliers," Zhang said.

Undoubtedly, the limitation of R&D conditions is the biggest obstacle that Team Fast has ever met. "We need more funds to buy or rent expensive equipment if we want to make big promotion," Pijnenburg said.

At present, the research of "formic acid bus" is primarily financed by Eindhoven University of Technology and some major companies are interested as well. Besides VDL, Burkert, a fluid control system manufacturer, other companies are also discussing cooperation and future financing.

Team Fast is targeted in making Hydrozine the fuel for most heavy vehicles in the future and applying it to engines in construction sites and greenhouse gardening.

In fact, it has cooperated with Van Rooij, a horticultural company, and built the first gardening system driven by Hydrozine in the world. They're planning to make a greenhouse system capable of the fully sustainable cycle: to transform the oxygen and carbon dioxide in the greenhouse into Hydrozine first, and to turn the Hydrozine into electric power later, releasing water and carbon dioxide which are needed by plants in their energy cycle in return.