Researchers from NUS have developed a device that can produce ethylene gas from carbon dioxide, water and sunlight in an eco-friendly and sustainable manner. Ethylene, a colourless gas, is vital in the manufacturing of plastics, rubbers and fibres, with production in 2015 reaching more than 170 million tonnes and global demand in 2020 expected to exceed 220 million tonnes.

The current method of ethylene production is by steam cracking of fossil fuels at temperatures between 750°C and 950°C; this involves breaking the bonds of longer chain hydrocarbons to form smaller hydrocarbons. It consumes large amounts of energy, puts a strain on natural fuel resources and emits twice the amount of carbon dioxide for every tonne of ethylene produced, leaving a significant carbon footprint.

The device developed by the NUS research team, led by NUS Chemistry Assistant Professor Boon Siang Jason Yeo, produces ethylene at room temperature and pressure using only benign chemicals and renewable energy. A copper catalyst was introduced into an artificial photosynthesis system containing water and carbon dioxide. A solar panel incorporated into the systems allows the whole process to be powered using only solar energy, which generates the electricity needed to convert the carbon dioxide and water into ethylene. The total energy efficiency achieved for this system is comparable to natural photosynthesis in plants.

To enable stable and continuous production of ethylene, a battery was incorporated into the device. This battery stores excess solar energy collected in the day to power the device at night or under low light, preventing interruptions in the device's operation.

Looking ahead, the team will continue to work on ways to scale up the production of ethylene in the device and look into commercialising the prototype. They also hope to develop similar systems for other liquid fuels such as ethanol and propanol.

The NUS invention is a significant breakthrough in the work towards a scalable artificial photosynthesis system for clean and sustainable production of important organic molecules such as ethylene.

The results were first published in the *ACS Sustainable Chemistry & Engineering* in August (ACS Sustainable Chem. Eng. 2017, 5, 9191-9199. DOI: 10.1021/acssuschemeng.7b02110.)

See us also in the Straits Times:

http://www.straitstimes.com/singapore/cleaning-up-the-plastic-making-process