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Professor In Seop Chang's research team presents a hybrid process to economically recover low concentrations of bio-ethanol

☐ GIST (President Kiseon Kim) – A research team led by Professor In Seop Chang of the School of Earth Sciences and Environmental Engineering has presented an energy efficient hybrid process to recover and purify low-concentrations of bio-ethanol * which was based on a technical and economic evaluation **.

* Bio-ethanal: C-2 alcohol made by microbial fermentation, mostly from carbohydrates produced in sugar- or starch-bearing plants such as corn, sugarcane, sweet sorghum

** Technical and economic evaluation: calculating the theoretical costs used to separate and purify ethanol to the target concentration based on infrastructure and operating costs of the processing technology

☐ Synthetic gas is a mixture composed of carbon monoxide, carbon dioxide, hydrogen, and other impurities. It is produced by the gasification of organic substances such as waste wood generated by the paper industry or by biogenic urban waste. Converting synthetic gas to fuel such as bio-ethanol through microbial fermentation processes can reuse waste resources and reduce greenhouse gas emissions by replacing some usage of fossil fuels.

- However, bioethanol is mixed at a low concentration of 2% or less in the fermentation broth * produced through the synthesis gas fermentation process. To use bioethanol as a feedstock for energy fuels and chemicals, it is necessary to have a high concentration of 99% or more. If the initial bio-ethanol concentration is low, then the separation and purification costs are higher. Therefore, an economical recovery method is needed to increase the low concentrations of bio-ethanol derived from synthetic gas.

  * Fermentation broth: after the fermentation process, a liquid phase containing bio-ethanol produced from the synthetic gas

□ The synthetic gas fermentation process is a new technology that can convert gaseous substrates into liquid products such as ethanol, and it is emerging as a new technology that can replace the production of bio-ethanol from traditional food sources and can be used as ethanol fuel.

- However, the bio-ethanol concentration of the fermentation broth produced by the synthetic gas fermentation process is about 5 to 10 times lower than that of the sugar fermentation process. As a result, the energy demand for distillation-based bio-ethanol recovery and refining process operation, which is currently being used, is greatly increased. Therefore, an optimal and economical hybrid technology for low-concentration bio-ethanol recovery is required.

□ Professor In Seop Chang's research team compared and analyzed optimal hybrid technology combinations by conducting a technical review of systems for water-ethanol separation and a technical/economic evaluation based on ethanol concentrations.

- The researchers found that the hybrid pathway, in which low concentration ethanol of about 2% was first purified to about 85% level through distillation process and then purified with high concentration ethanol of about 99.7% using membrane-based pervaporation process was the most economically efficient production process.

□ Professor In Seop Chang said, "Given the importance of a variety of new renewable energy and technologies to reduce carbon dioxide emissions worldwide, it is expected that the low-concentration bioethanol separation and refining hybrid technology presented in this study can accelerate commercialization of the synthetic gas fermentation process in the future."

□ This research was led by Professor In Seop Chang (joint co-corresponding author), COMSATS University Islamabad Professor Muhammad Yasin (joint co-corresponding author who received Ph.D. from GIST), and Nulee Jang as co-author and was funded by the New & Renewable Energy Core Technology Program of the Korea Institute of Energy Technology Evaluation and Planning grants from the Ministry of Trade, Industry and Energy and the Priority Research Centers Program through the National Research Foundation of Korea funded by the Ministry of Education, the Basic Science Research Program Foundation of Korea funded by the Ministry of Education and Basic Science Research Program through the National Research Foundation of Korea funded by the Ministry of Science and ICT. The results were published in *Renewable and Sustainable Energy Reviews* (IF 9.184) on February 21, 2019.

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