Separation Science and Engineering Group

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Anaerobic digestion is consisted series of complex metabolic interaction (Fig.1). The series of complex metabolic interaction can be classified into three major processes. The first process is the hydrolysis of polymer substrates such as carbohydrates, fat, and proteins into simpler soluble compounds. The second process is that hydrolyzed organic materials are converted to hydrogen and carbon dioxide, along with volatile fatty acids (VFAs) and alcohols. The third process is that intermediate metabolites are further degraded by methanogens and are then converted into methane with chemical oxygen demand (COD) reduction.The intermediate metabolites were only gotten a small amount in methane fermentation process since they were finally utilized by methanogens to produce only methane as valuable substances. However, there are many attractive intermediate metabolites in an anaerobic fermentation process. For example, hydrogen is a clean and efficient energy carrier because it produces only water after combustion and can be directly converted to electricity via fuel cells. Recently, environmental issues have come to the forefront, with global warming, regional air pollution and economic/ecological sustainability all being major driving forces behind the renewed interest in alternative energy sources. Therefore, hydrogen as a potential clean energy source of the future could be a possible alternative energy to fossil fuels. Hydrogen production through biological processes, such as photosynthesis and fermentation, has caught great attention recently since it is more environmentally friendly, sustainable, and less energy intensive when compared to conventional thermal/chemical processes. Attractive materials are in the intermediate metabolites in liquid phase too. For example, the 1,3-propanediol (1,3-PDO) produced through glycerol fermentation has a wide range of potential uses, in particular as a monomer for polycondensations to produce plastics with special properties, i.e. polyesters, polyethers and polyurethanes, as a monomer for cyclic compounds, as a polyglycol-type lubricant and it also may serve as a solvent.

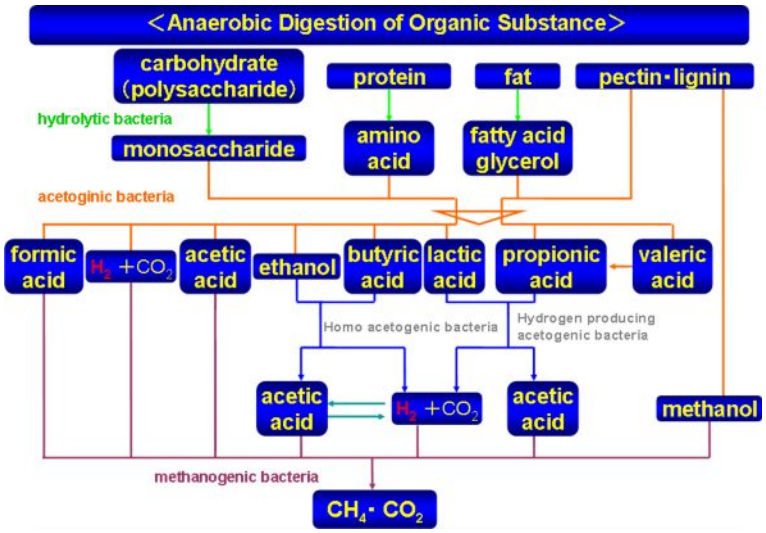

Fig.1 Methane fermentation scheme.

The two-phase anaerobic digestion system has several advantages over the traditional single-phase system, e.g., shorter detention time, higher gas conversion efficiency, and higher methane concentration in the produced gas (Fig. 2). Furthermore, it may allow a reduction in total reactor volume. The metabolic pathways of the two-phase anaerobic digestion process are the same as those of conventional digestion; however, they are physically separated in (i) hydrolytic and acetogenic phase and (ii) methanogenic phase. The first phase can be used as an independent hydrogen production unit but not as a pretreatment for the methanogenic reactor. The short hydraulic retention time (HRT) is applied in the first phase in order to separate acidogenesis from methanogenesis. The long HRT in the first phase is resulting in no effective separation of hydrogen production from methane production to convert hydrogen into methane.

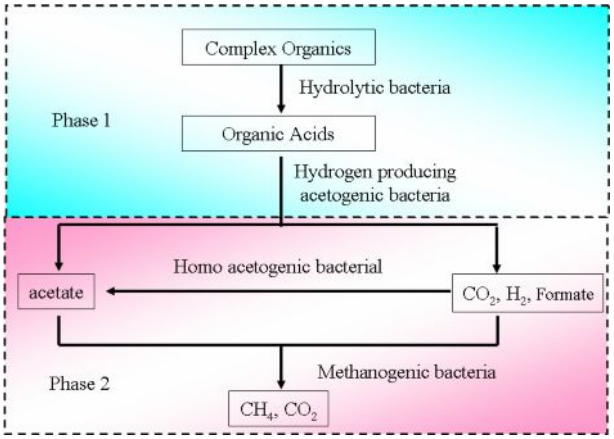

Fig. 2 The two-phase anaerobic digestion system.

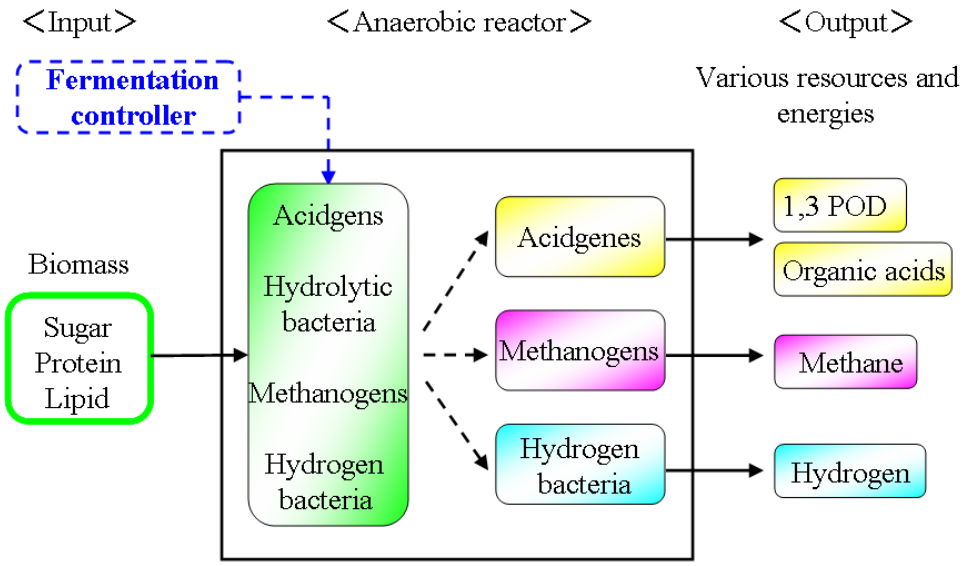

Fig. 3 Novel bioprocess concept. Various resources and energies production.

As shown in Fig. 3, if bacteria are inhibited with adding in small amounts fermentation controller to an anaerobic digestion process, there is a possibility that various resources and energies are obtained. The aim of our study was development of hydrogen and methane fermentation bioprocess in one reactor by controlled anaerobic digestion process such as divided acidogen and methanogen. In our reserach, anaerobic fermentation was carried out using glycerol as a biomass and bacteria or sugars as a fermentation controller.