

## The study of utilization of a fuel cell using digestion gas

Whole term

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### (Purpose)

The digestion gas generated in the sludge treatment process has high concentration of methane, which is a very useful source. According to the plan for enlargement of a high concentrated digestion process in Osaka city, the utilization of a fuel cell by digestion gas was focused on with respect to the effective use of digestion gas. The fuel cell is a power generator having small noise and vibration, and less polluted waste gas. Therefore, it is an eco-friendly equipment. In case that the digestion gas is used as a fuel cell, if the concentration of methane is high, it is necessary to remove toxic material such as CO<sub>2</sub> and H<sub>2</sub>S. Because of that, a test by wet alkali 2-bed adsorption was carried out since 1993, in order to remove toxic materials in Osaka City. The results showed that there was a possibility of using the purified digestion gas as a fuel of the fuel cell. Therefore, a treatment center with 200 kW scale was constructed in the Wastewater Science Center of Osaka City, and a study on utilization was conducted to focus on the investigation and the evaluation of the design-method.

### (Results)

#### 1) Principle and significance of the fuel cell

Fuel cell is composed of a single cell, in which there are 2 electrodes between electrolyte plates. Air and gas contained hydrogen, produced by improving methane and city gas, was blown to this single cell and direct electric energy was collected without incinerating the fuel by the reverse reaction of the electrolysis of water. Though, there are several types of fuel cells, the phosphoric acid fuel cell (PAFC), which would be developed for normal usage and commercial aspects, was the target.

#### 2) Evaluation of the purifying method of the digestion gas

Digestion gas is purified by an adsorption method to be used as the fuel of the fuel cell. Because the adsorption method is a simple system, initial cost as well as the necessary operation is less. And the recovery rate of methane is large and a stable operation is possible. In wet alkali 2 bed adsorption method - process, most of CO<sub>2</sub> and H<sub>2</sub>S are adsorbed using the treated water in the first bed, and the rest of CO<sub>2</sub> and H<sub>2</sub>S are adsorbed using NaOH in the second bed to inhibit the quantity of NaOH consumption and to get purified gas effectively.

#### 3) Comparison of the fuel cell with the gas engine

In comparison with the existing gas engine, the characteristic of the phosphoric acid fuel cell possesses good points such as (1) high energy efficiency (2) clear emission (3) low noise and vibration (4) easy to be maintained since a building is not necessary. However, the cost of the body is a little bit expensive and the short life is a problem. According to the results of the cost comparison between the two systems in case of consumed electricity, the overall cost of operation and the consumed electricity is less.

As per the aspects of effective use of sewage resources and the viewpoint of environmental conservation, the adopted fuel cell has significant meanings.

#### 4) Calculation of the generated energy

The average electrical energy consumed and the generated quantity of the digestion gas-fuel cell from the plant of self-supply in Osaka City, were calculated. 30 percent of the necessary electrical energy can be replaced by the digestion gas-fuel cell. On the other hand, considering the fluctuations of 30 % and 20 % of the self-consumed electrical energy and the generated quantity of digestion gas, respectively; the generated quantity of the digestion gas was not more than the self-consumed electrical energy in the plant.

#### 5) Plan for using the waste heat

The result of the investigation of the digestion tank-heating system using the waste heat

from the generation system of the fuel cell in the large scale facility, shows that the exchanged waste heat of the fuel gas with the energy of the waste sludge can replace the necessary energy of the digestion tank heating system.

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Keywords

Digestion gas, Fuel cell, Gas refining, Efficiency of power generation, Use of waste heat.