Evaluation Study on Performance of Fuel Cell System with an energy source of digestion gas

Whole term	2003. 4 ～2005. 3	Text P.147～P.153

(Purpose)

Digestion gas produced in the process of sludge treatment of sewage disposal plant contains much methane and is one of the useful energy sources. Since Osaka City has a policy to adopt High concentration digestion process for the sludge digestion in the sewage treatment plants owned by the City, total sludge volume put into digestion tanks is decreasing, and as the results energy needs for the sludge treatment purpose are also decreasing. Due to the above, the volume of surplus gas after utilized for sludge treatment is increasing. Now, therefore, it is recognized as one of the important issues how to expand the uses of the said surplus gas.

Fuel cell is one of the effective uses of this digestion gas, which is, however, including various chemical substances other than methane useful for fuel cell. Among the above contaminations, high Carbon dioxide (CO_2) density relates with the decrease of methane density and it cause decrease of fuel cell output. Hydrogen sulfide (H_2S) is a hazardous substance against fuel cell and such contamination accelerates consumption of fuel cell. Osaka City, therefore, aiming at simultaneous elimination of both CO_2 and H_2S, has performed substantial experiments since FY1993 based on the Water and alkali two-step purification system and, as the results, obtained the prospects for the purification of digestion gas for the purpose of fuel cell production.

In FY1996 Osaka City performed technical experiment for actual utilization jointly with JIWET (Japan Institute of Wastewater Engineering Technology) as the functional highly advanced promotion enterprise (new technical practical use type) in the new generation sewer support enterprise system. In FY1997 construction of fuel cell pilot plant with an energy source of digestion gas ("Fuel Cell System") was commenced and completed in FY2003.

This evaluation study was made during two years of FY2003 and FY2004 on the usefulness of Fuel Cell System, maintenance, economical effects, etc. by using the completed pilot plant.

(Results)

1. Performance and capacity of the system

Performance of the 1st purification process depends on the liquid volume (L) and the digestion gas volume (G), and it was found that purified gas of target methane density (about 85vol%-DG) could be obtained under the adequate L/G operation. The more L/G ratio, however, the higher methane density was recognized, and the density of nitrogen, which is hazardous to fuel cell, may exceed the fuel cell ceiling of ($N_2 \leqq 4\%$). In order to obtain stable performance of the system, it is necessary to establish an operation management method considering liquid (L) temperature.

Although target power generation efficiency (39%) was mostly attained about the performance of a fuel cell, heat recovery efficiency might not have satisfied 73～80% and a processing target value. In a low-temperature side, the design value of pumps is larger than real operation, and since this was performing intermittent operation for 30 minutes in 1 hour, it is because it became in the direction to which heat recovery efficiency falls.

2. Environmental impacts

In case of fuel cell, digestion gas is not burned directly and the Nitrogen oxides' discharge is quite little compared with fossil fuel. Moreover, as its energy is generated through a chemical reaction, noises are low. It was confirmed that Fuel Cell System was excellent from the viewpoint of reduction of environmental load as well.

3．Operation and maintenance

For the operation of the gas purification process, an adequate L/G operation is necessary based on the temperature of the liquid (L) to be purified. Therefore, as well as daily central monitoring and patrol, seasonal check/review of the density of digestion gas ingredients are essential. On the other hand, since fuel cell system contains no driving device in it, the system keeps high endurance and the system is operated automatically, it can be said no maintenance required, except the periodical exchanges of purification devices and exchange of fuel cell itself (cell portion) may become necessary.

4．Economic evaluation

Power generation cost of fuel cell system on the utility consumption basis is 3 to 4 yen per kW and it is cheap, however, from the total cost basis including construction cost, it becomes 36 yen or around (about 26 yen/kW when heat reuse considered) and it became more expensive than the present electric power purchase price (12 yen/(kW)). Maintenance expense is large as an item, the spread of fuel cell systems will take for progressing from now on, and it will be thought by improving construction costs and maintenance expense that power costs become cheap.

(Conclusion)

In this performance assessment study, operation of the performance target of digestive gas refining equipment and fuel cell equipment mostly satisfied except for all chlorine in part was completed. Although the subject that power costs are high merely remains, spread is considered that it takes for progressing and cost is improved.

Co-researcher：Osaka City, Japan Institute of Wastewater Engineering Technology
Researchers：Nobuyuki Horie, Atsushi Komai, Hiroshi Uchida

key words	Utilization of digestion gas,Water and alkali two-step purification system,Fuel cell, Phosphoric acid type