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Promotion of Utilization of Renewable Energy for Biogas/Natural Gas Dual Fuel Engine

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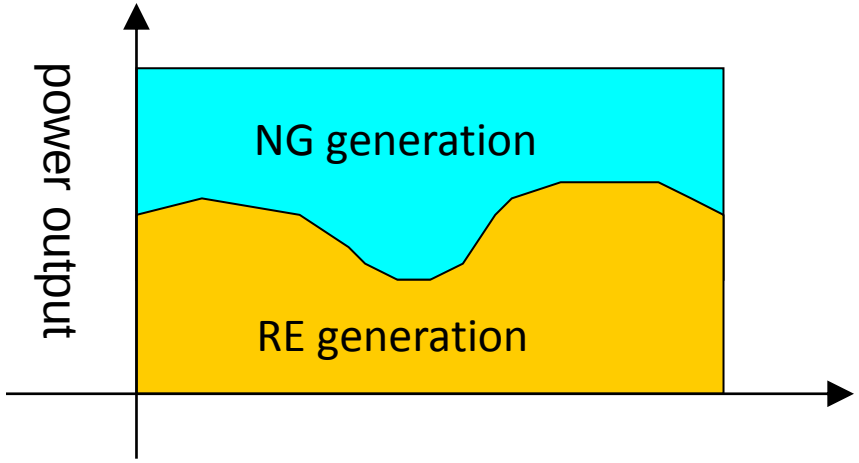
1. Introduction

- Renewable Energy(RE) such as
  - Solar energy
  - Wind energy
  - Biogas energy

⇒ Unstable power generation

- Serious influence on the grid
- Demand penalty in Japan



⇒ Stable power generation is desired, even when using RE

- Combination of RE and Natural Gas(NG)

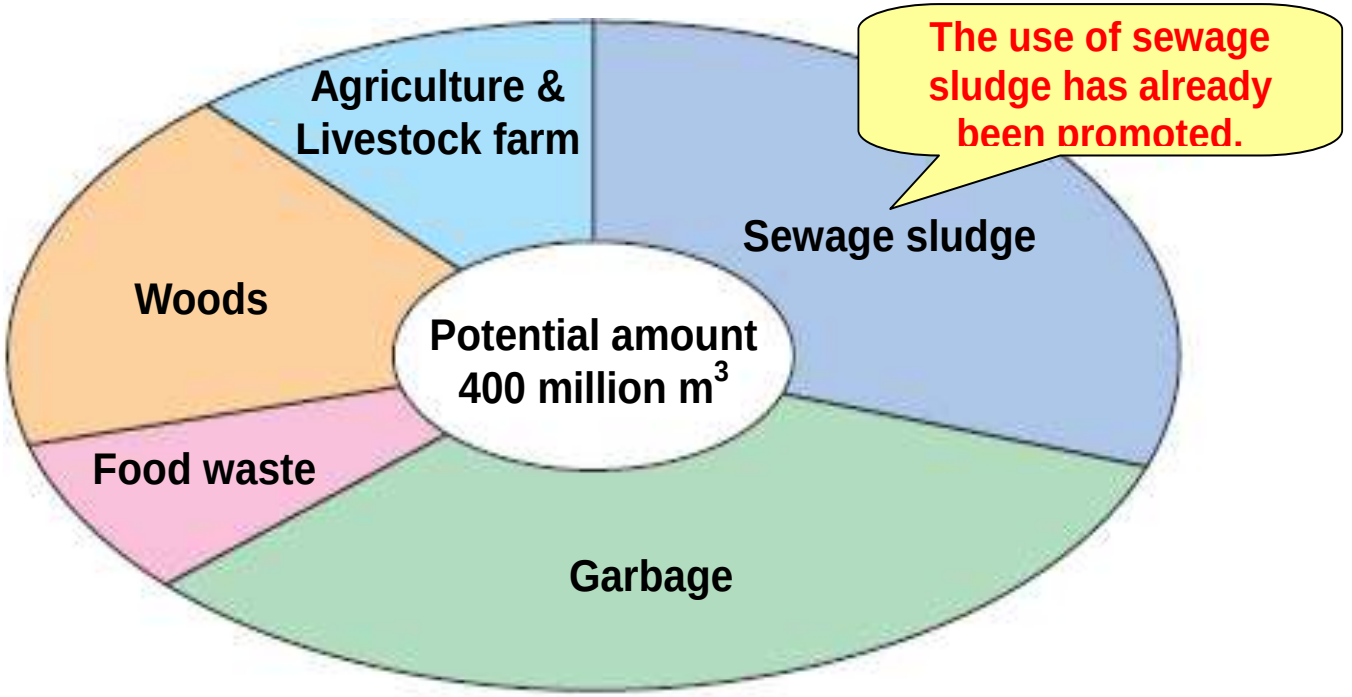
  ⇒ Enables constant power generation

- To promote effective use of Biogas energy

  ⇒ Biogas/NG dual fuel engine generation is smart solution

2. Potential amount of biogas in Osaka Gas location

Biogas Potential Amount: 400 M m^3/y ⇒ CO_2 900,000 ton/y
⇒ only a few % is used now



cf. Osaka gas - NG sales : 8.5 B m^3/y to 7.0 M customers
in Kansai area (Osaka, Kyoto, Nara, Kobe, etc)
- Pipeline network : total 59,500km length

3. Biogas utilization by dual fuel GE generator

Tab. Dual fuel GE modules installed by Osaka Gas

site	kW	number	CH_4 conc. in Biogas
food factory A	520	1	72%
food factory B	520	1	71%
beverage factory A	730	1	78%
beverage factory B	2100	1	84–90%
sewage plant A	520	2	57–59%
total	4910	6	–

Biogas 3 M m^3/y + Natural Gas 3 M m^3/y consumed by 6 GE gen.

⇒ Conventional dual fuel system was complex and expensive

⇒ To spread the use of biogas,

Low-cost dual fuel engine system is desired

(cf. Osaka Gas has installed >600 NG gen. in these 20years)

4. Dual fuel system by JFE eng. and Osaka Gas

JFE Eng. and Osaka Gas have jointly developed the simple biogas/NG dual fuel engine system.

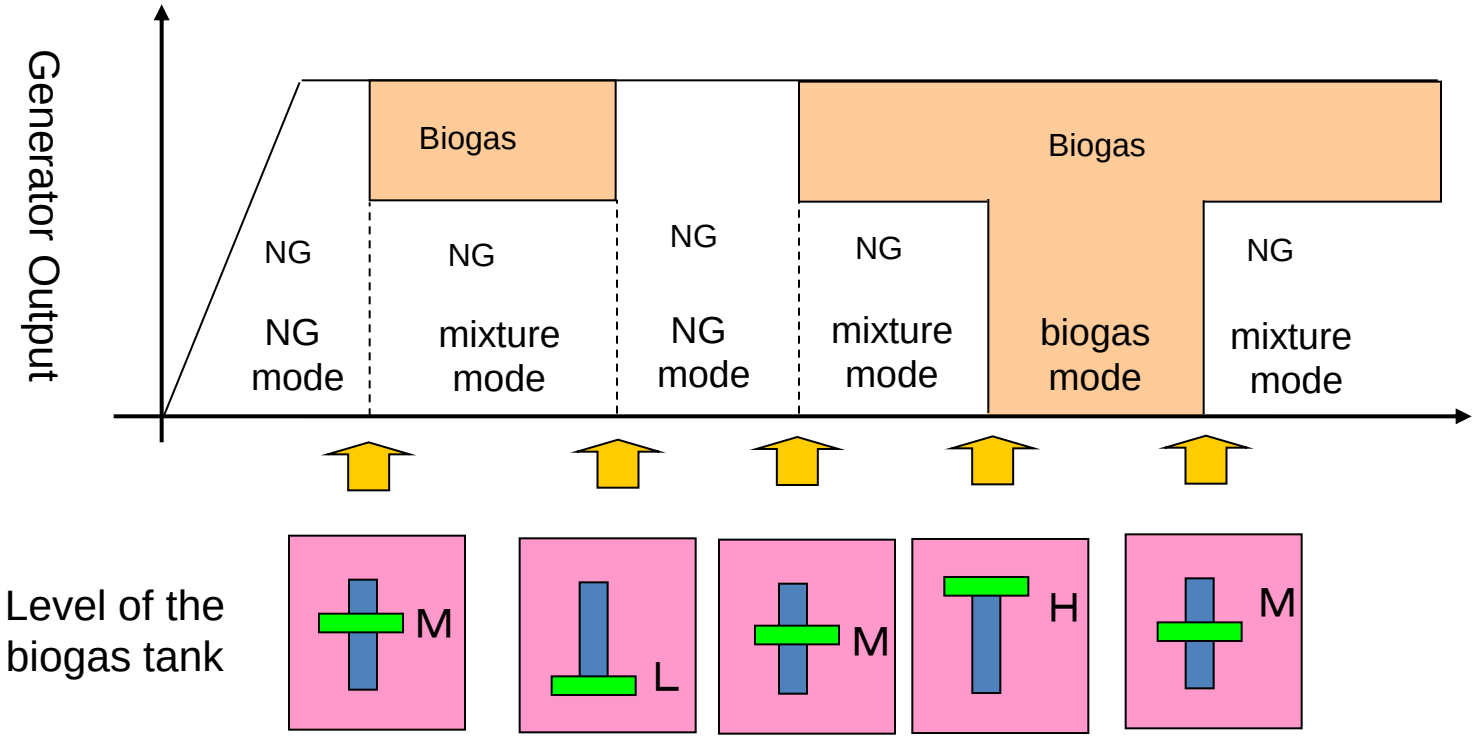


Fig. Basic function of the the developed system.
Operation mode is switched due to the level of the biogas tank.

5. Flow daigram of the developed system

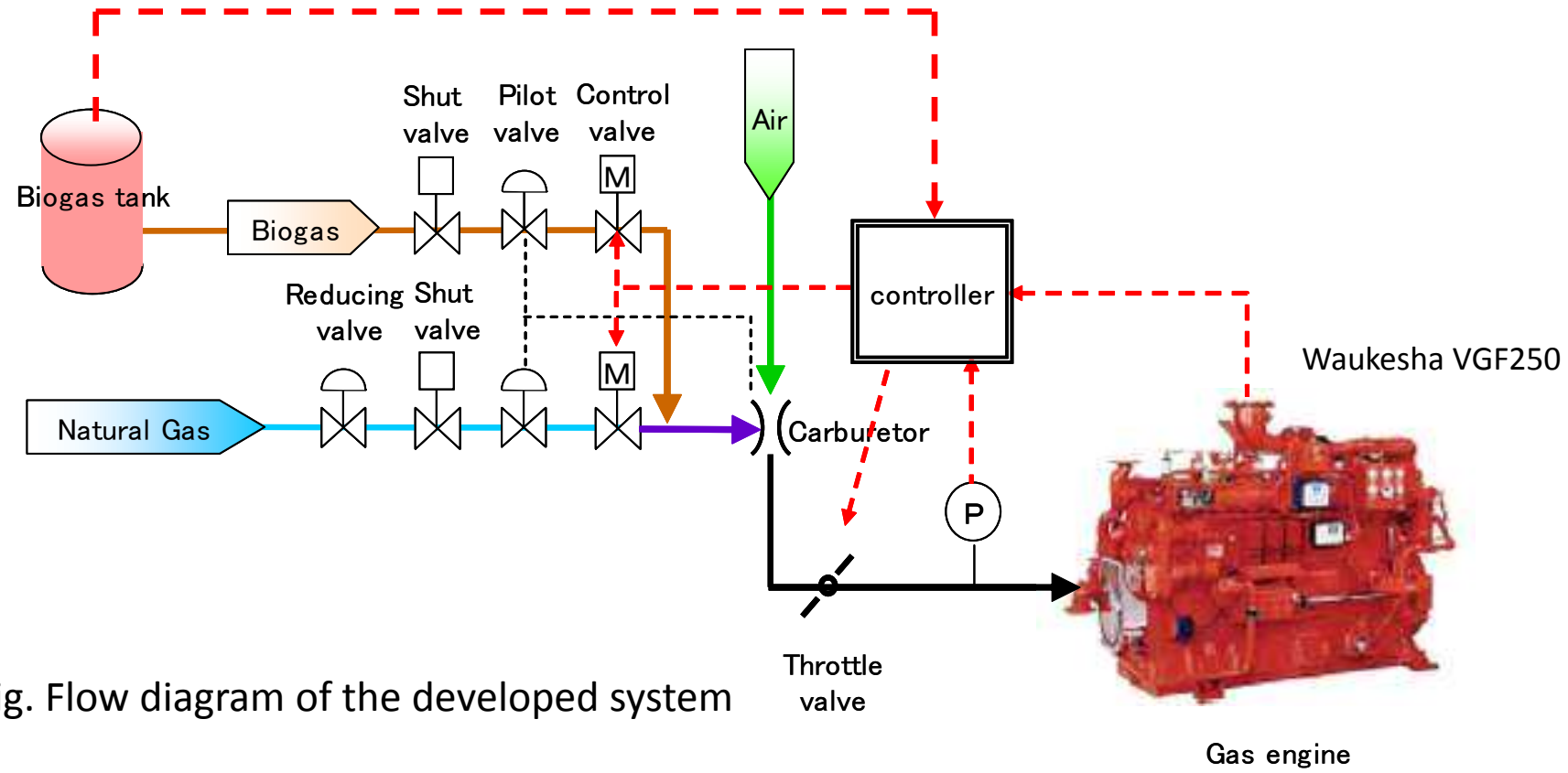


Fig. Flow diagram of the developed system

- Gas switching control:fuel control valve (due to biogas tank level)
- Output control :throttle valve
- Air ratio control :fuel control valve (due to intake pressure)

6. Fundamental property of the developed system

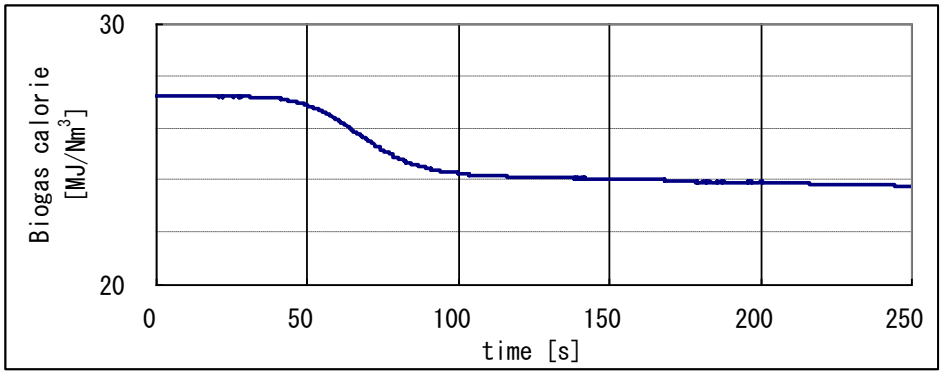
Tab. Fundamental property of 250kW gas engine generator

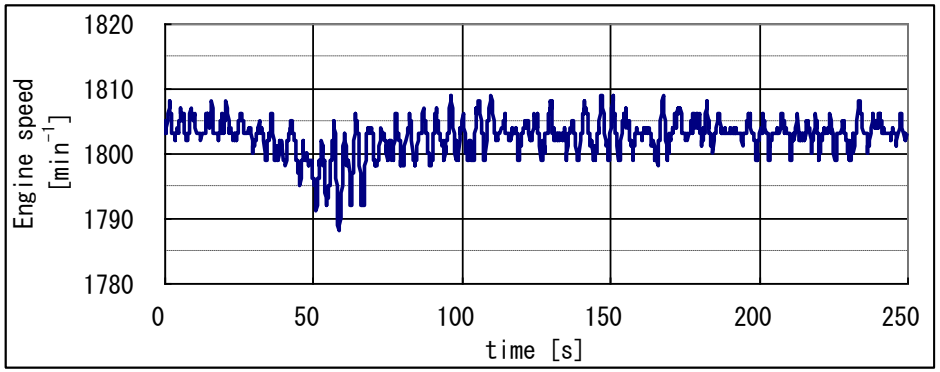
item	unit	natural gas	50/50	biogas	notes
speed deviation	1/min	2	5	4	ave. speed 1800/min
electrical effic.	%	33.4	33.2	32.0	
NOx conc. at O2=0%	ppm	443	517	478	national reg. <600 ppm
O2 conc.	%	8.4	7.4	6.8	

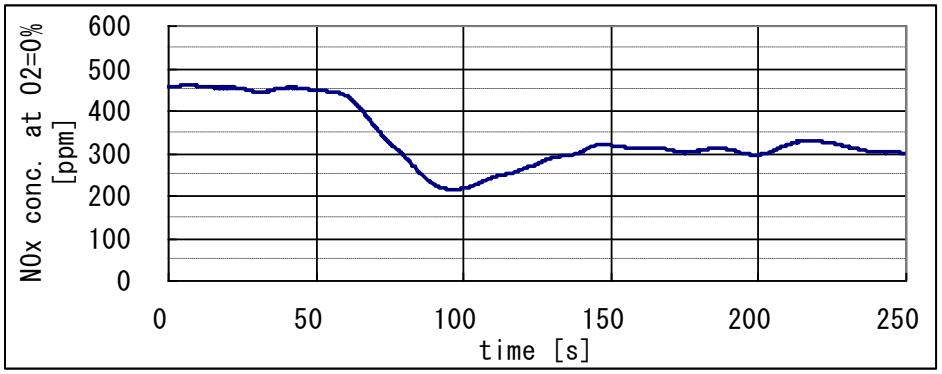
- Operation mode: Island mode
- Load : Heater

Results:
- Speed control : Stable
- Ele. Effic. : 32.0-33.4 %
- NOx conc. : <600 ppm

7. Test for rapid change of biogas heat value







Test for rapid change of biogas heat value at biogas mode:

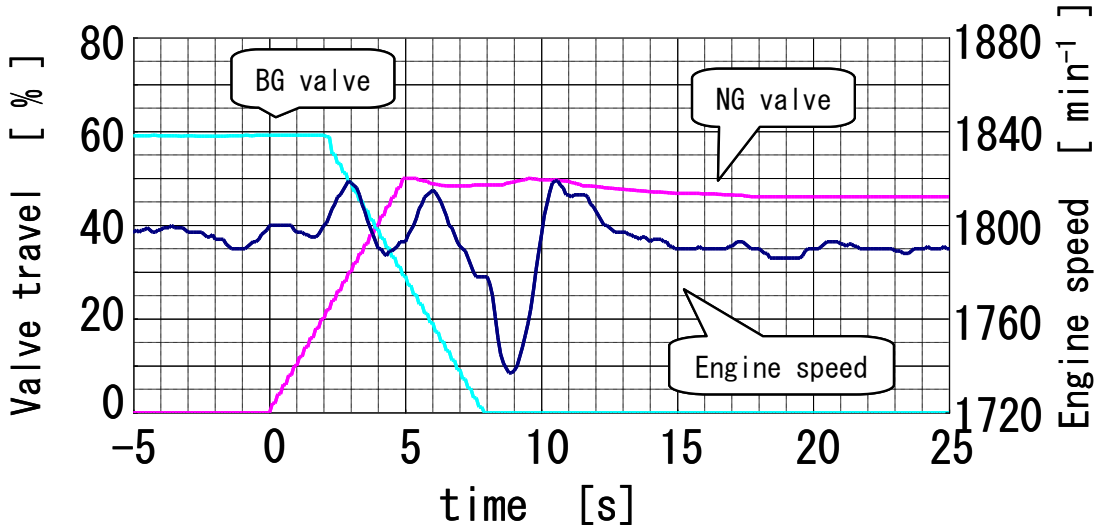
- Heat value: 27.2 to 24.0 MJ/m3
- Transition period: 60 sec

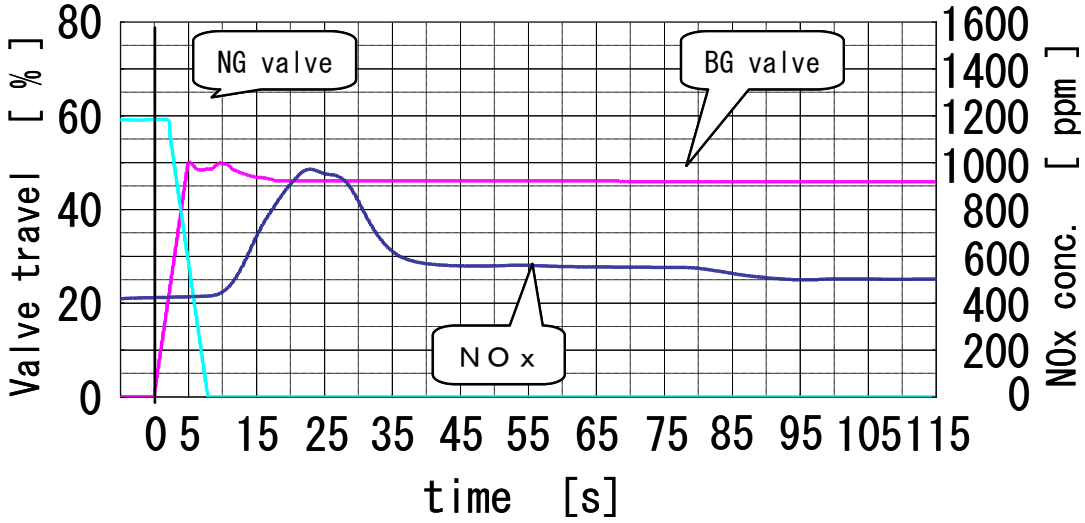
Results:

Engine speed was stable (deviation <20 /min)

This system was proved to work well when biogas heat value changes rapidly.

8. Test for fast fuel switching





Test for fast fuel switching:

- Fuel: Biogas to Natural gas
- Valve operation :pre-programmed
  (transition period set to 10 sec)
- Speed control :automatic
- Air ratio control : automatic

Results:

Gas switching of only 10 sec was Succeeded.

This made it possible to reduce the capacity of a biogas tank and tank cost.

9. Conclusions

1) Combination of Renewable Energy(RE) and Natural Gas(NG) is effective to promote RE utilization. Biogas/NG dual fuel engine generation is smart solution for Biogas utilization.

2) Osaka Gas has installed 6 dual fuel gas engines at 5 sites.

   Biogas of 3 M m^3/y and Natural Gas of 3 M m^3/y are consumed.

3) JFE Eng. and Osaka Gas have newly developed the simple dual fuel gas engine system. We are confident about the high performance of this system. This will contribute to the further promotion of Biogas/Natural Gas utilization in near future.