Notation

D	Dilution rate, 1/d
K_s	Half velocity coefficient, g /L
S	Residual substrate concentration at steady state, g /L
S_0	Substrate concentration in medium, g /L
t	Time in day, d
μ	Specific growth rate, 1/d
μ_{max}	Maximal specific growth rate, 1/d
X	Biomass concentration, g/ L
X_0	Initial input biomass concentration, g/ L
$Y_{X/S}$	Growth yield, g-cells/ mmol H_2/CO_2

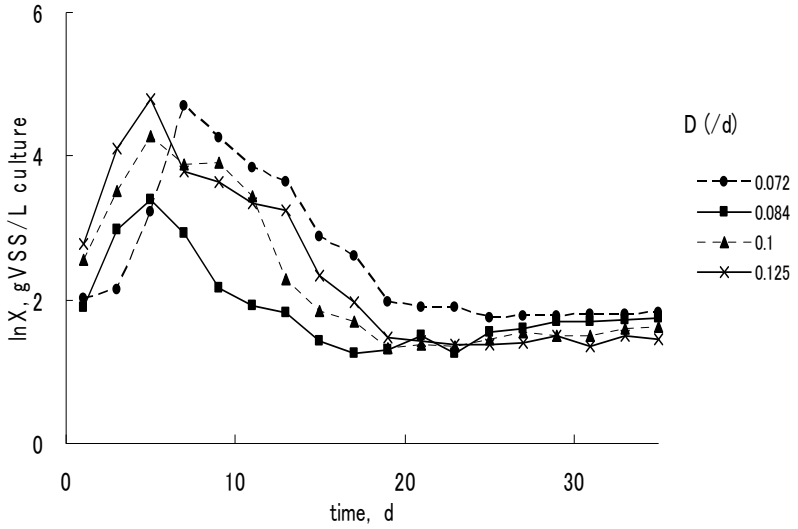

Fig.1. Time course of Bacteria growth during the experiment at different dilution rate

1

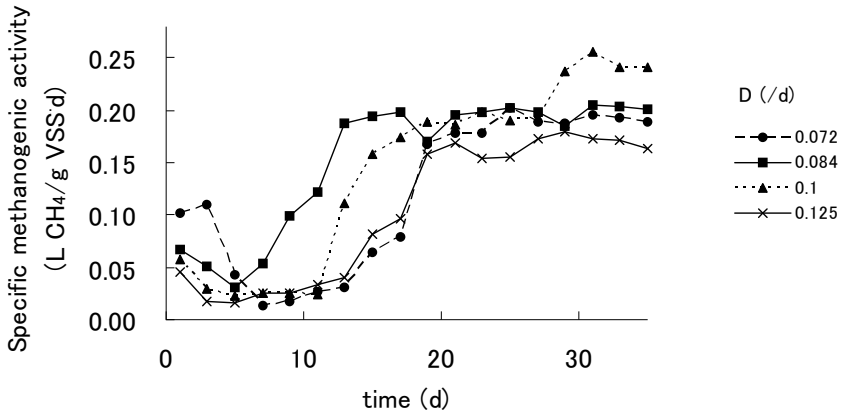

Fig.2. Time course of the Specific Methanogenic Activity (SMA) during the experiment time (days) at different dilution rate; the SMA was obtained from the relation between the bacteria growth rate and the methane production rate at mesophilic temperature (37 ± 2ºC).

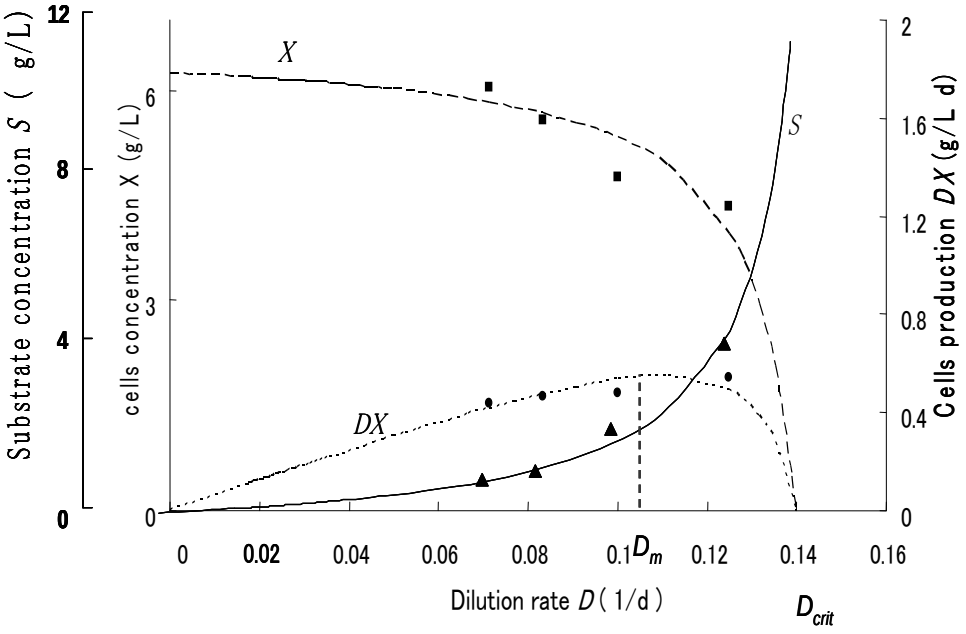

Fig.3. Dependence of cells concentration *X*, cells production rate *DX* and supply substrate concentration on continuous culture dilution rate *D* as simulated from Monod chemostat model. ■ cells concentration *X*; ▲ H_2/CO_2 concentration *S*; •cells production rate *DX*; (—) model prediction. D_{crit} (0.14 /d).

Table 1
Characteristics of acclimated methanogens under H_2/CO_2 as sole substrate after 7months acclimation representing the average of the duplicate reactors

Parameters	Values average	Standard deviation
COD (g/ L)[a]	9.4	0.387
TS (g/L)[b]	120.7	4.0
VSS (g/L)[c]	116.6	0.55
Total N (g/L)	2.2	0.243
pH	7.7	0.2
Acetic acid (mg/L)	0.0	0.0
Methane production (%)	56.6	1.7

[a] COD, chemical oxygen demand.

[b] TS, total solids.

[c] VSS, volatiles suspended solids.

Values are averages of five determinations; the obtained data differences were less than 3 %.

Table 2

Experimental consumption rate of H_2 and CO_2 calculated when assumed that the gases are perfect (means ± variance coefficients of data from triplicate sampling trials)

Reactor		Input substrate S_0 (g/L)	Output substrate average S (g/L) after 24 hrs	Variance coefficients (%)	Consumption rate (%)
I	H_2	1.71	0.13	2.3	92.0
	CO_2	9.43	0.71	1.8	92.0
II	H_2	1.71	0.15	5.5	91.2
	CO_2	9.43	0.83	6.1	91.0
III	H_2	1.71	0.29	3.7	83.0
	CO_2	9.43	1.69	4.1	82.0
IV	H_2	1.71	0.52	3.2	70.0
	CO_2	9.43	3.14	4.4	67.0

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Table 3
Proposed operational condition using hydrogenotrophic methanogens

Parameters	*Proposed values*
Dilution (*D*), 1/d	0.10
Hydrogenotrophic methanogens concentration (*X*), g VSS/ L culture	5±0.12
pH	Controlled at 6.40-7.67
H_2/CO_2 gas supply, L/d	12.00
Temperature, ºC	37 ± 2
mixing	1min interval at 0.08 MPa
Methane production, L/d	1.21