Anaerobic digestion using hybrid reactor in low temperature

OJeong-Sun Park1), Tae-Kyu Eom*1), Ki-Hun Jang2), Seung-Jin Na2)
1) KyungSung university, 2)Eco solution
Department of Civil & Environmental Engineering
Busan Korea

INTRODUCTION
One of the major problems facing the industrialized world today is that of environmental contamina-
tion and the need to identify efficient treatments. Over the last few decades, anaerobic digestion
has been used for the effective treatment of organic wastes. Anaerobic digestion has many advanta-
ges over aerobic technologies, including a low space requirement, much less waste sludge produc-
tion, no need for aeration and most importantly, the production of biogas (50-80% methane), a use-
able fuel. The process usually has operated under mesophilic and thermophilic conditions (30-
55 °C). Currently, almost all full-scale treatment systems are operated at lower temperature, and this
can lower the treatment cost of wastewaters needed treatment. Therefore, the purpose of this study's deduction of optimum condition of HRT and pH that is most important item among all driving factors when operated anaerobic digester by 25 °C, and examina-
tion about maximum methanogenesis amount of each driving conditions.

MATERIAL AND METHOD
Materials
Sludge that use in this anaerobic digester used digester sludge of S sewage treatment plant which
is located in Korea's Busan, through period of adaptation of given period. Influent wastewater used
mixing livestock wastewater and food waste by 5:1 (from H processing plant located in Korea’s
Kyongsangnamdo and S processing plant of Busan).

TABLE 1. characteristics of the influent sludge used in experiments unit : mg/l

<table>
<thead>
<tr>
<th>pH</th>
<th>TCODcr</th>
<th>SCODcr</th>
<th>TS</th>
<th>VS</th>
<th>TSS</th>
<th>VSS</th>
<th>Alk. (mg/l as CaCO₃)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>~7.43</td>
<td>~14,000</td>
<td>~13,000</td>
<td>~22,563</td>
<td>~8,258</td>
<td>~4,933</td>
<td>~1,228</td>
</tr>
<tr>
<td>Average</td>
<td>7.28</td>
<td>18,667</td>
<td>13,667</td>
<td>27,536</td>
<td>16,242</td>
<td>11,059</td>
<td>7,638</td>
</tr>
</tbody>
</table>

Experimental units

The anaerobic digester had a volume of 45l, and its working volume was 40l. It was also equipped
with an influent system, gas recirculation system, effluent system and gas collection system. The tem-
perature of the influent sludge was monitored by a temperature maintenance system (cooling system), which was
set at 4±1 °C. Also, the influent sludge was equipped with invariable inlet with a pump (Masterflex pump)
in the reactor (anaerobic digestion reactor). The sludge was stirred in the digestion reactor using gas
from its own production. This reactor was incubated at 25 °C.
Experimental procedure

Initial temperature of seeding sludge was 35°C, and to search adaptation availability in 25°C that is temperature of this study, temperature decrease bases on range of 1 °C/week that is hardly change of microorganism's stallate. First, application possibility about optimum HRT was searched through batch test about effect that temperature change gets to anaerobic digestion efficiency for optimum HRT deduction. And experimented about digestion efficiency change, makes change gradual from HRT 30 to HRT 50.

Analysis

Standard methods were used for the estimation of CODcr, SCODcr(Soluble COD), TS(Total Solid), VS(Volatile Solid), TSS(Total Suspended Solid), VSS(Volatile Suspended Solid), Ammonia nitrogen(NH4+-N).

RESULTS AND DISCUSSION

Batch test

Decrease of removal efficiency by temperature change did not appear according to result of compare TCOD removal efficiency. In the case of Case 1, experimented doing volume comparison of digester sludge and influent wastewater by 1:1, and doing by 1:2 (digester sludge : influent wastewater) in the case of Case 2.

During 28 days which is driving period TCOD removal efficiency was 7-65%, with the exception of opening part period of adaptation most TCOD removal efficiency was more than 50%. Also, when we research SCOD efficiency as standard for pH, the efficiency is enlarged by 25-61% during 9 days which estimate acidogenesis steps. It is appeared that there is no decrease of removal efficiency according to temperature reduction by maximum 80% of SCOD removal efficiency at 27°C of reactor.

The removal efficiency of TCOD and SCOD, it was more than 50% according to change by more than pH 7, and this is not affected big impact by loading rate.

![Graphs showing COD removal efficiency](a) TCOD removal efficiency  (b) SCOD removal efficiency)

Fig. 2 COD removal efficiency according to temperature change.

During driving period, produced gas quantity was 20,850mL. Result in convert gas production into COD concentration utilizing Eq.1-1 by methane and CO2 fraction, it was 11,914 mg/L, and this mean that about 86.6% of gas is converted among total removal COD.

\[
C_aH_bO_c + \left( \frac{n - a}{4} - \frac{b}{2} \right) H_2O \rightarrow \left( \frac{n}{2} + \frac{a}{8} + \frac{b}{4} \right) CH_4 + \left( \frac{n}{2} - \frac{a}{8} + \frac{b}{4} \right) CO_2
\]

Continuous flow test

TCOD removal efficiency was 75%, 68% and 77% (HRT 30, HRT 40 and HRT 50), respectively. The maximum removal efficiency of SCOD was 83%, 88% and 88% (HRT 30, HRT 40 and HRT 50). COD removal efficiency that follow to HRT was not shown big difference.
CONCLUSIONS
1) In batch test, decrease of COD removal by temperature reduction was not appeared, removal rate by influent loading rate has not also changed.
2) Average of TCOD removal rate was up to 60%, there was no difference between removal rate according to HRT in continuous flow test. And high rate of removal was seen more than average 70% in SCOD removal rate.
3) Differences according to HRT appeared a little in the case of total gas production, and this estimates by influence about influent loading rate. Methane fraction was displayed fixed value that is irrelatively with HRT.

REFERENCE