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A COMPARISON OF SINGLE PHASE AND TWO PHASE
ANAEROBIC DIGESTION AT LOWER TEMPERATUREBy Sithamparappillai JEYASEELAN *, Toshiya KOMATSU**,
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Introduction

It was learned that phase separation in anaerobic digestion is not an advantage for carbohydrates¹ and different components of the substrates have different digestion rates in two phase digestion². Effectiveness of phase separation is experimented for substrates with lipids comparing stabilization for single and two phase operations.

Materials and Methods

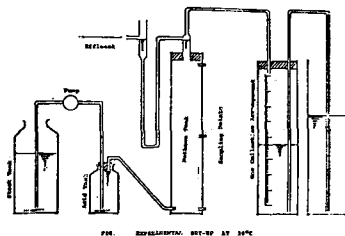
The experimental arrangement used for experimentation is schemetically given in the figure for two phase experiments and the same system was used for single phase operations without the acid tank. The acid tank was operated as a completely mixed continuously stirred reactor and methane tank was filled with plastic media and functioned as an upflow anaerobic filter at 20°C and their volume ratio is 1:5 respectively. The constituents of substrates used and nutrients added to them are given in table 1 and 2. The details of operation are given in table 3.

Table.1 Constituents of Substrates

Component	Baby milk(%)	Skimmed milk(%)
Carbohydrate	40.2	52.99
Protein	6.3	34.36
Lipids	53.5	0.70
Ash	--	8.15
Water	--	3.80

Table.2 Nutrients Added.
To the Substrates

Nutrients	Concentration (g/g.milk/l)
NH ₄ HCO ₃	0.30
K ₂ HPO ₄	0.20
Na ₂ HPO ₄	0.40
KH ₂ PO ₄	0.05



Results and Discussions

A comparison of properties calculated from chemical oxygen demand of samples from acid tank and methane tank and gas composition of gas samples at steady conditions for various single phase and two phase operations are tabulated in table 3. The destruction and stabilization of the wastes are reflected in two parameters, namely the overall process efficiency based on COD measurements (EFLR) and gas production rate (GPRT). The gas production per COD reduction (GPL) is also included. When one looks at the efficiency the single phase operations seems efficient and for gas production rate the two phase operations efficient. Due to the fact that the floating materials are not accounted in evaluation of efficiencies based on effluent COD values, the gas production rate is more reliable than the process efficiency evaluation. Gas production in two phase are more than corresponding single phase operation supports this explanation indicating more waste stabilization. The GPL values are almost same for skimmed milk and large variation for baby milk indicating better stabilization. As such two phase operation definitely gives better stabilization especially in the case of baby milk and for wastes having more lipids in general.

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Table.3. Comparison of Single Phase and Two Phase Operations

Substrate	COD (mg/l)	Total DT(day)	Property	Unit	Single phase	Two phase
Skim-milk	200	3.0	EFLR	%	84.6	72.5
			GPL	m3/kg	0.13	0.21
			GPRT/RV	ml/day/l	9.5	15.2
		2.0	EFLR	%	76.5	78.1
			GPL	m3/kg	0.22	0.21
			GPRT/RV	ml/day/l	23.0	22.2
		1.5	EFLR	%	83.1	80.9
			GPL	m3/kg	0.13	0.21
			GPRT/RV	ml/day/l	29.6	39.5
		1.0	EFLR	%	78.4	80.9
			GPL	m3/kg	0.16	0.15
			GPRT/RV	ml/day/l	34.6	39.7
		0.75	EFLR	%	85.1	77.4
			GPL	m3/kg	0.13	0.12
			GPRT/RV	ml/day/l	36.8	40.6
Skim-milk	1500	2.0	EFLR	%	86.3	87.4
			GPL	m3/kg	0.23	0.24
			GPRT/RV	ml/day/l	184.5	229.9
Baby-milk	200	2.0	EFLR	%	81.0	75.8
			GPL	m3/kg	0.07	0.18
			GPRT/RV	ml/day/l	7.7	22.4
		1.0	EFLR	%	78.9	80.3
			GPL	m3/kg	0.07	0.14
Baby-milk	1500	2.0	GPRT/RV	ml/day/l	14.8	35.3
			EFLR	%	92.0	89.9
			GPL	m3/kg	0.17	0.28
			GPRT/RV	ml/day/l	138.8	250.7

When the substrates are compared for the same concentrations and detention times, for skimmed milk which constitutes very little percentage of lipids (0.70%) the process efficiencies are close and even though the gas productions in two phase operations are more they are only by a little amount. Whereas for all the cases for the baby milk which constitutes 53.5 percent of lipids the difference in process efficiency is higher in comparison and the gas production rates in two phase operations are more than double of that of single phase operations for the same substrate at the same total detention time in all three cases experimented. It is a clear indication of the fact that the destruction of lipids and stabilization of wastes in the case of two phase operations is much more than that of single phase operations and is supported by the GPL values. Considering 1500 mgCOD/l, the floating property is well understood by comparing skimmed milk and baby milk at this concentrations which have 86.6% and 92.0% efficiencies in single operations respectively and 87.4% and 89.9% respectively in two phase operations which are close. In two phase operations lipids get broken and change forms. As such the volatile acids and other forms which soluble can contribute to TCOD and therefore EFLR is less in efficiency evaluation in the case of two phase operations.

Conclusions

These experiments showed that it is possible to achieve two phase anaerobic digestion at lower concentrations as low as 200 mgCOD/l wastes even at temperatures as low as 20° using two phase system with anaerobic filter as methane phase reactor. Comparison of single phase operation and two phase operation showed that separation of phases in waste stabilization is definitely an advantage especially where there is presence of lipids.

References

1. Hanaki, K., Matsuo, T., Nagase, M., and Tabata, Y., (1986), IAWPRC's conference, Brazil.
2. Tanaka, S. and Matsuo, T. (1985), IAWPRC's conference, Tokyo, Japan.