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Evaluation of Anaerobic Wastewater Treatment and Simultaneous Biogas Generation Potential from the Bangladesh Military Savar Dairy Farm

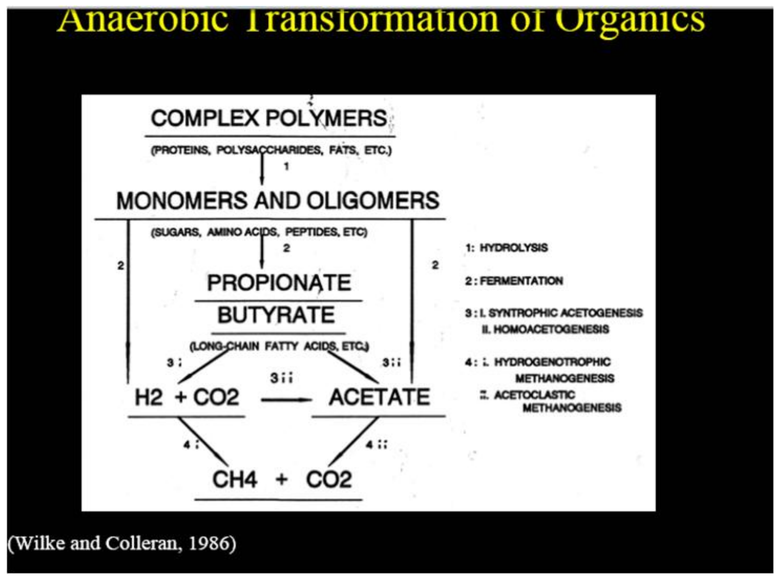
N. R. Khandaker , S. R. Sarker, and P. Dey
World Energy and Environment Technology
Coventry, CV3 1PG, UK; Email: conference@weentech.co.uk

1.Introduction

Although the application of anaerobic waste stabilization to low solids wastewater is well established in more developed economies in Bangladesh there has not been any application to date. Sadly we are missing out on a source of renewable energy, and low cost energy efficient effective method of wastewater treatment. In this paper we will introduce the effectiveness of anaerobic wastewater treatment by looking at three different wastewaters from three different sources with different waste characterization. Biological waste stabilization under aerobic condition calls for continuous oxidation that requires energy to run the blowers which in turn calls for the burning of fossil fuel with its added cost and also the generation of added green house gas produced during power generation. In contrast anaerobic processes require no aeration thus more economical and produce as a byproduct of wastewater treatment methane and hydrogen gas which are renewable fuels; both points are of value to Bangladesh with its scarcity of energy, especially in rural environments. The three sources of the wastewater we used in this study are: Case Study I: A moderate strength low solids wastewater from Akij Food and Beverage Factory in Manikganj, Case Study II: A high strength moderate solids wastewater from a dairy farm in Savar, and Case Study III: A low strength low solids wastewater from a milk processing Factory in Savar attached with the dairy farm in Case Study II.

2.Methodology

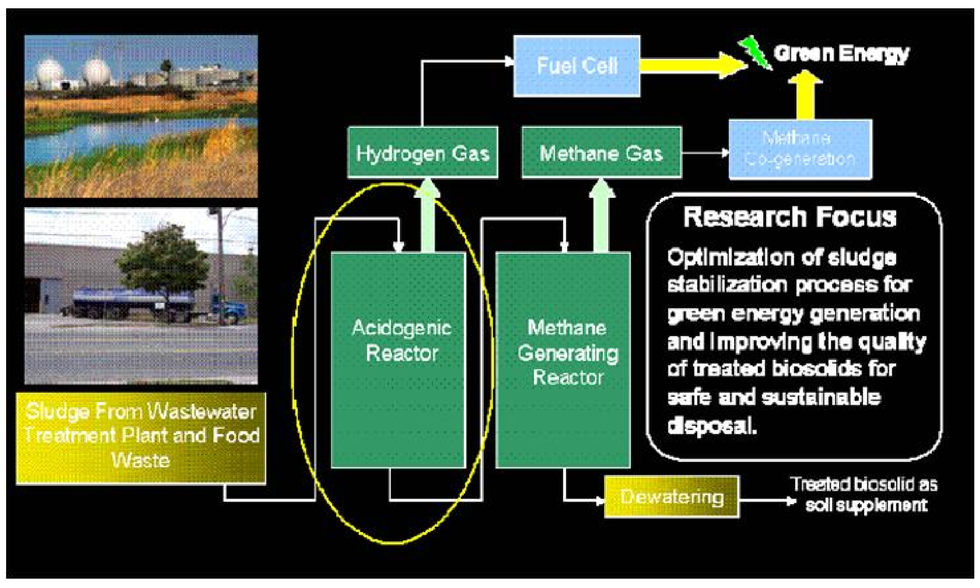
Time proportioned samples were obtained from each of the industries of concern in this paper and characterized in the laboratory as per Standard Methods with regards to the analytical procedure (Standard Methods, 1989). The parameters which were analyzed for the characterization of the composite samples were chemical oxygen demand, total solids, total suspended solids, ammonia nitrites, and nitrates, and phosphates. Statistical analysis was done by means of Excel spread sheet and all data reported as mean and standard deviation. To plot graphics Excel spreadsheet was used.



(Wilke and Colleran, 1986)

3.Challenges

In Bangladesh we are very familiar on the application of anaerobic digester to stabilization of cow dung to produce biogas known as gobor-gas. Grameen Shakti has been extremely successful in introducing biogas production to rural Bangladesh using micro-financing. Unfortunately the application is limited to cow dung stabilization or chicken excrement stabilization in poultry farms. In pilot scale some municipalities in Bangladesh are attempting to introduce anaerobic stabilization of municipal solid waste to generate biogas. Although the application of anaerobic waste stabilization to low solids wastewater is well established in more developed economies in Bangladesh there has not been any application to date. Sadly we are missing out on a source of renewable energy, and low cost energy efficient effective method of wastewater treatment.



4. Results

Table 1. Wastewater characterization from Akej Food and Beverage Factory Twelve Month Average.

Parameter	Mean	Standard Deviation
pH	5.2	0.5
COD (mg/L)	857	274
TDS (mg/L)	411.3	37.1
TS (%)	0.14	.02

Table 2. Barn wash Wastewater Characterization from a Dairy Farm in Sabar.

Parameter	Mean	Standard Deviation
TSS	673.0	113.50
Ammonia	2.1	0.00
Nitrite	0.6	0.02
Nitrate	5.4	0.35
Phosphate	20.0	0.25
TCOD	1412.0	104.75
SCOD	664.7	95.97

Table 3. Milk Processing Wastewater Characterization from a Dairy Farm in Savar.

Parameter	Mean	Standard Deviation
TSS	40.3	1.53
Ammonia	0.2	0.01
Nitrite	0.1	0.00
Nitrate	0.8	0.06
Phosphate	12.6	0.42
TCOD	340.0	60.56

5.Impressions

Case Study I

The characterization data for the Akij wastewater is shown in Table 1. The Akij is a moderate to high strength wastewater. Based on the operational data of the existing aerobic wastewater treatment plant in Akj the Chemical Oxygen Demand (COD) removal efficiency is 93%. Thus we can assume that the ultimate BOD would be 93 percent of the twelve months average COD value of 857 mg/L. What this implies is that the wastewater is moderately strong and can be a candidate for anaerobic pretreatment to remove 93% of the wastewater COD. According to McCarty (McCarty, 1964-Part I, McCarty, 1964-Part II, and McCarty, 1964-Part III)., for every pound of biodegradable COD the methane generation potential is 56.2 cubic feet at Standard Temperature and Pressure. At the average wastewater flow are of 1.7 cubic meters per hour the mass balance yields 6.75 cubic feet of methane per hour. This is a substantial potential for renewable energy generation which Akij can use to operate their existing boilers for stem generation which they use for sterilization of their food products.

Case Study II

The wastewater characterization high strength moderate solids wastewater from a dairy farm in Savar is listed in Table 2. The wastewater is generated from the barn where 1800 castles are kept and if we assume that 50 L of water per cattle head are required to wash down the cows and the barn then in average 3750 liters per hour of wastewater is generated. This wastewater has COD value of 1412 mg/L making it an ideal candidate for anaerobic wastewater treatment for the generation of methane gas. At the specified flow rate and wastewater strength and at 93% COD removal efficiency, the theory to the methane production would be 60.88 ft^3/hr. The wastewater is also not deficient in phosphate although we may have to admit with nitrogen. The solids content of the wastewater is moderately high calling for low loading rate reactor with the hydraulic retention time of around 10-15 days. Ideal reactor for this particular application would be an engineered anaerobic lagoon.

Case Study III:

Is a wastewater with low strength and low solids from milk processing Factory in Savar attached with the dairy farm in Case Study II. The wastewater characterization is listed in Table 3. The wastewater is generated from a milk processing plant where they package pasteurized milk along with making butter. The processing plant generates in average 6735 liters per hour of wastewater from the whole processing activity which includes wash down water from all there reactor vessels along with the production floor .This wastewater has COD value of 340 mg/L making it a low strength wastewater possibly not ideal source for methane generation. This is still an excellent candidate for anaerobic low strength application. Application of anaerobic treatment for low strength wastewater is in the vanguard of technology application with the benefit that it is a cheaper energy efficient alternative to aerobic wastewater treatment that requires aeration. A cutting age application is the use of sequential batch anaerobic reactors to treat low strength wastewater and simultaneously generate hydrogen gas instead of methane gas. Sequential batch reactors (refer to Figure 3) in theory would have infinite solids retention time and would follow zero order kinetics independent of substrate concentration for substrate stabilization and the reactor waste stabilization efficiency would only be dependent on the residence time of the reactor. Optimal hydrogen generation calls for a short retention time along with periodic shock treatment of the biomass to curtail the growth of the methanogenic microorganisms and thus optimize for hydrogen generation. Table 3 also shows that there is sufficient phosphate and nitrogen present not to require addition augmentation for microbial metabolic needs.

6.Scope

In this paper we will introduce the effectiveness of anaerobic wastewater treatment by looking at three different wastewaters from three different sources with different waste characterization. The three sources of the wastewater we used in this study are: Case Study I: A moderate strength low solids wastewater from Akij Food and Beverage Factory in Manikganj, Case Study II: A high strength moderate solids wastewater from a dairy farm in Savar, and Case Study III: A low strength low solids wastewater from a milk processing Factory in Savar attached with the dairy farm in Case Study II.