EVALUATION OF ANAEROBIC PROCESSES FOR URBAN WASTEWATER TREATMENTS UNDER VARIOUS TEMPERATURE CONDITIONS

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Abstract

The study investigated the effect of temperature on the performance of the anaerob digestion process applied to wastewater collected across Oradea. The substrate was formed of the effluent from a mechanical stage which has been subjected to a treatment in an anaerobic digestion system which consisted of two digesters joined in series. We opted for the operation of the working area in mesophilic environment (35°C, 40°C respectively) compared with the thermophilic environment (55 or 60°C) for a hydraulic retention time of 7 days. The results showed that the operating temperature of 55 °C is most suitable for reducing in the greatest proportion the pollutant load, expressed as COD, of urban wastewater.

Keywords: mesophilic, thermophilic, urban wastewater

INTRODUCTION

Temperature is considered one of the decisive factors for the proper functioning of anaerobic processes, on it depends both the metabolism and the capacity of reproduction of methanogenic bacteria and also the fermentation time, quantity and quality of the gas produced (Ahn, et.al., 2002).

Depending on the operating temperature in the anaerobic treatment tanks three distinct areas have been found:

- the low temperatures areas (below 15°C), in which the cryophilic bacteria develops and operates;
- the moderate temperatures areas (15 - 43°C), in which mesophilic bacteria are present;
- the high temperature areas (44 - 60°C), in which thermophilic bacteria are present.

The sensitivity to ambient temperature depends on various factors, in particular the degree of adaptation of culture, the mode of operation and the type of bioreactor (Masse et. al., 2001).

The optimum temperature for the development of thermophilic bacteria is considered 55°C and 37°C for the mesophilic bacteria; a temperature below 5° C paralyzes the methanogenic bacteria activity.

The time required for the cryophilic fermentation is over 90 days, for the mesophilic fermentation is 20-25 days and for the thermophilic one is of

5-7 days. In the thermophilic environment a sharp increase in temperature leads to a significant decrease in gas production (Choorit, 2007).

The metabolism and the rate of production of methanogenic bacteria are influenced by the abrupt decreases of temperature, so that it is indicated that during the anaerobic treatment to maintain a constant or almost constant temperature.

Studying the data obtained from different bibliographic sources in mesophilic and thermophilic systems, regarding the affinity that the bacterial population has for using different types of substrate the following were noticed:

Table 1.

The preference of microorganisms for mesophilic and thermophilic anaerobic digestion by using different types of substrate (Solera et.al, 2002)

Substrate	**Mesophilic digestion**			**Thermophilic digestion**		
	increase	% CH_4	%CO_2	increase	%CH_4	%CO_2
1% α-cellulose	+	48,5±4,1	37,5±5,0	+	60,1±2,0	30,5±5,1
1% starch	+	32,3 ±2,6	61,0± 7,0	+	20,5±3,1	79,5±3,1
1% xylan	+	33,8± 13,7	55,4 ±8,6	+	10,0±1,3	85,7±4,5
1% casein	+	60,6± 5,0	39,4± 3,8	+	57,1±11,7	42,9±7,2
0,1 % glucose	+	67,5±0,5	14,3±1,7	+	48,7±2,1	35,1±2,6
0,1% xylose	+	47,1±3,9	48,9±1,2	+	19,7±5,6	62,2±4,8
0,1% formic acid	+	41,3±3,8	38,1±4,1	+	20,9±2,9	38,1±1,8
0,1% acetic acid	+	79,0±5,0	5,0±1,4	+	50,0±10,3	22,3±3,4
0,1% propionic acid	+	68,9±6,3	21,3±3,2	-	0	0
0,1% butyric acid	+	81,1±12,1	17,9±4,9	+	68,4±3,8	9,7±1,6
0,1% lactic acid	+	52,1±5,2	11,3±3,7	+	47,3±5,6	7,4±2,9
0,1% methanol	+	20,0±1,9	52,3±2,6	+	50,0±2,7	28,5±4,6
0,1% ethanol	+	50,6±6,3	40±1,1	+	43,2±3,3	37±4,2
0,1% propanol	+	22,3±4,2	30,6±2,4	-	0	0
0,1% butanol	+	80,6±6,1	10,0±2,2	+	45,0±8,9	28,2±1,3

MATERIAL AND METHODS

This study focused on the influence of temperature in the waste water coming from the waste water treatment plant Oradea city. The effluent from the mechanical stage was collected and was processed in the laboratory in an installation for anaerobic digestion with a capacity of 11 l, consisting of two reactors connected in series (see Figure 1)

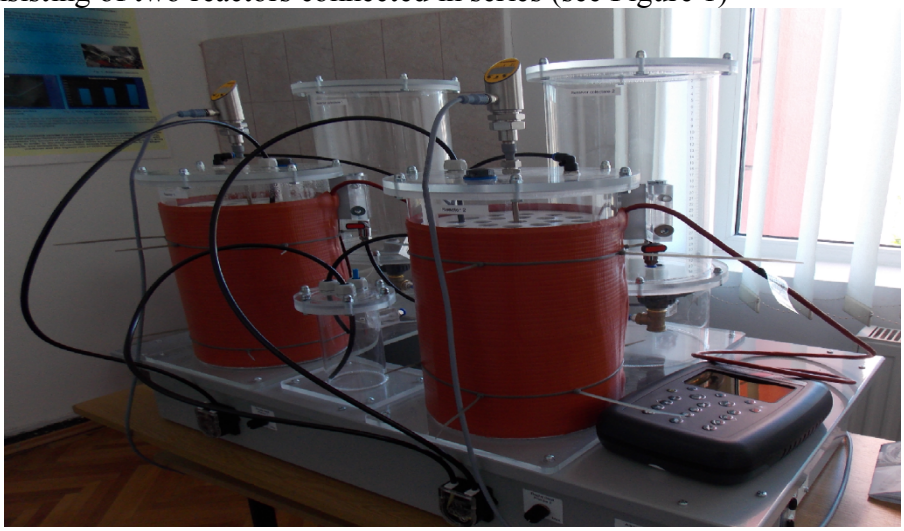

Fig.1. The installation of anaerobic digestion

Working temperatures were specific to the mesophilic (35 - 40^{o}C) and thermophilic (55 - 60^{o}C), respectively, and the hydraulic retention time was of 7 days. Determinations of the chemical demand of oxygen (COD), were made, in initial substrate, after 7 days of monitoring respectively. Chemical demand of oxygen was determined by Photometric Hanna HI 83224. The initial substrate had an organic load expressed by COD of 328 mg/l.

RESULTS AND DISCUSSION

The results were summarized in the following table:

Table 1

Monitoring of the process carried out at different working temperatures
(the arithmetic mean of the values obtained during monitoring)

Working temperature (^{o}C)	**CCO_{Cr} anaerob effluent mg/l**	**Removal rate of CCO_{Cr} (%)**
35	224	31,7
40	212,5	35,21
55	98	70,12
60	118,6	63,83

As seen in the determinations performed, we found that the optimum temperature is for the mesophilic domain, 40°C, respectively, for the thermophilic, 55°C.

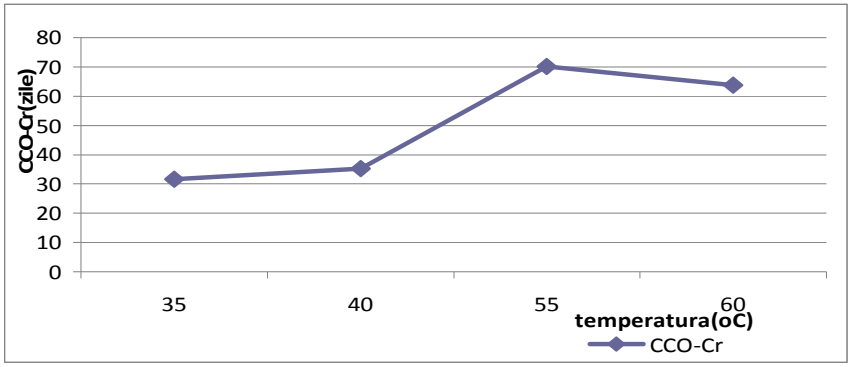

Fig.2. COD reduction rate according to the working temperature

The highest level of reducing the organic pollution expressed by COD was obtained at 55°C, 70.12% for the thermophilic respectively 35.21% at 40°C for mesophilic field.

CONCLUSIONS

The anaerobic processes have been used for the treatment of municipal and industrial waste water, of solid wastes and sludge. These systems have been used to treat sludge and their ability to reduce COD in a large proportion, generating one-tenth of sludge compared to other wastewater treatment technologies favoured the use of these technologies for water treatment.

The temperature is considered one of the important factors for the perfect functioning of anaerobic processes, on this depending both the metabolism, the capacity of methanogenic bacteria reproduction and also the fermentation duration, quantity and quality of the gas produced.

According to the experimental data, it was found that by increasing the temperature it also increases the efficiency of COD removal, with a maximum of 55°C, but after that, at 60°C, it decreases slightly, for the same hydraulic retention time.

Thermophilic systems represent an elegant solution for wastewater treatment with and average and high concentration of the organic pollutants.

High speeds of degradation at thermophilic temperatures represent an advantage compared to the common mesophilic process.

Due to the enormous need for energy, thermophilic treatment is believed to be a treating process which is inefficient from an economic point of view. But this is advantageous for waste water with high temperature for their spill into the emissaries implies cooling them. Anaerobic degradation is proposed as an alternative for the treatment of liquid residues with a high and average organic load.

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