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stack machine. After all these steps, we get a complete shell.

Summarizing, we can say that when we create interpreters for certain computers, we must consider not only specific algorithms of creating of the interpreter, and the architecture of the machine as a whole. In conclusion, we note that the existing interpreters fully correspond with all existing requirements of developers.

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PLANT BIOMASS AND ITS MIXTURE WITH ORGANIC WASTES AS SUBSTRATE FOR BIOGAS PRODUCTION

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Abstract

Possibility of utilization of urban leaf fall for biogas production was evaluated. Application of mixture of oak, plane and poplar leaves for biogas production in mesophilic and thermophilic conditions was studied. Qualitative and quantitative composition of microorganisms of dry leaf fall and of biomass after the biogasification process was determined. Study on effect of addition of different proportions of plants biomass (water lettuce - *Pistia stratiotes*) and organic wastes (chicken manure) on biogas production were conducted.

Keywords: biogas, leaf fall, chicken manure, water lettuce, anaerobic microorganisms, methanogenesis, microbiological analysis.

Introduction

Traditional power engineering is based on fossil fuel, the deposits of which are not endless. Attractiveness of biogas application is stipulated by the fact that it may be easily produced from livestock manure and plant wastes [1, p.78-85]. At the same time, utilization of urban plants wastes, including leaf fall and so on, is ecologically important task in large cities. It is known that natural processes of plant biomass degradation in soil are quite slow and may take, depending on environmental conditions, more than two years [2, p. 35-36]. Leaves of trees belongs to category of natural leaf fall observed in forests, as well as in urban parks and orchards, of temperate zone. In the natural conditions leaves and needles of trees fallen on soil surface are gradually digested by the complex of soil borne living creatures (insects, worms, microorganisms, protozoa and so on) and form humus, promoting enhancement of soil structure and fertility and protecting sprouts and roots of young trees from winterkill. The quantity of the leaf fall is estimated as much as 54-78% in coniferous forest and 83% in deciduous forest out of 2.51-7.76 tons per hectare of annual biomass fall [3, p. 133; 4, p. 771; 5, p. 234]. At the same time, the total biomass of forest plants in the world is estimated as 1.5 billion of tons of dry matter, which is equal to 80% of weigh of aggregate biomass on Earth [6, p. 233]. The quantity of leaf fall of arboreal and shrubby plants is considerable in managed plantations as well. In urban conditions, where, as opposed to natural forest, many natural leaf fall digesters are absent and where exist certain standards of territory maintenance, there is strong necessity to follow a number of rules, like mandatory removal of leaf fall from sidewalks and road surface, mandatory disposal of and so on. Whereas this disposal of may be replaced by biomass transformation in the process of methanogenesis. Biomass of urban leaf fall is one of renewable sources and organization of its fuller and efficient utilization becomes more important.

One of attractive plant wastes is biomass of higher water plants, such as water lettuce (*Pistia stratiotes*) and water hyacinth (*Eichhornia crassipes*), which are used on a number of sewage cleansing facilities and is accumulated in large quantities [7, p. 37; 8, p. 353]. Accumulation of urban leaf fall in waste fields results in considerable expenses, while its incineration leads to air pollution and thus prohibited. Conversion of the plant biomass into biogas may be one of the solutions of the utilization problem [9, p. 131].

The aim of work was to study possibility of application of urban leaf fall in mixture with plant biomass and chicken manure for biogas production.

Materials and methods

Urban leaf fall in a mixture of leaves of oak (*Quercus robur*), plane (*Platanus orientalis*) and poplar (*Populus alba*) was used as substrate for biogas production. Biomass of water lettuce (*Pistia stratiotes*) and chicken manure were used as well in the study.

Methanogenic association of microorganisms isolated from the active silt of sewage cleansing facilities (Khorezm city) was used for the fermentation of the substrate. pH of the medium was 7.0. Experiments were conducted in anaerobic chambers (figure 1) in mesophilic (t=30-40°C) and thermophilic (t=50-55°C) modes.

Figure 1. Laboratory methane tank (anaerobic chamber)

Nutrient media described in a guidebook [10, p. 113-114] were used for microorganisms' isolation from the initial substrate and from biomass after the methanogenesis process. Microbiological analysis was conducted using method of serial dilution with further cultivation on solid and liquid nutrient media.

Results and discussion

Microbiological analysis of dried biomass of urban leaf fall revealed presence of different forms of microorganisms in it. Dominating forms were microorganisms growing on beef extract; ammonifying spore forming microorganisms were isolated in large quantities. Heterotrophic denitrifying and cellulose degrading microorganisms, both aerobic and facultatively anaerobic, were revealed in ecologically considerable amounts (table 1).

It is known that biomass degradation takes place under action of three types of bacteria. Subsequent bacteria in the food chain consume waste products of preceding bacteria, thus, there observed change of biocenoses or development of microorganisms' successions. It is necessary to note that in biogas production process participate not only microorganisms-methanogens but other microorganisms as well that precede methanogenesis. Under action of these microorganisms insoluble organic matter present in biomass start to disintegrate on simple organic compounds. This stage is called hydrolysis and it results in accumulation of amino acids, sugars and fatty acids.

Hydrolytic oxidation of the part of simple organic compounds under action of heteroacetogenic bacteria takes place, which results in formation of acetate, carbon dioxide and free hydrogen. The rest of organic compounds together with acetate produced at the second stage form simple organic acids.

Table 1

Microbiological analysis of samples

Sample	Amount of microorganisms, CPU/g						
	Beef-peptone agar	Ammonifying	Denitrifying	Sulphate-reducing	Cellulose-degrading	Anaerobic cellulose-degrading bacteria	Methanogenic bacteria
Initial biomass with active silt and nutrient medium	4.5×10^6	2.5×10^3	2.5×10^3	2.5×10^4	2.5×10^4	2.5×10^3	6.0×10^1
After the 3rd stage of methanogenesis	1.9×10^3	2.55×10^3	2.5×10^2	6.0×10^3	-	6.0×10^4	6.0×10^4

Analysis of microorganisms' development on further stages of acidogenesis and acetogenesis reveals that at increased anaerobiosis the decrease of amount of saprophytes, the decrease of amount of aerobic cellulose degrading microorganisms takes place with subsequent increase of anaerobic cellulose degrading bacteria, mainly representing genus *Clostridium*. The final microbiological analysis of obtained mass was conducted after completion of the methanogenesis process. It was established that number of all studied microorganisms decreased by 2-3 orders (table 1). The last stage of methanogenesis is represented by ecologically significant numbers of methanogenic microorganisms – bacilli, sarcinas, cocci. Methanogenic microorganisms are mainly represented by *Methanosarcina, Methanococcus, Methanobacterium, Methanomicrobium* species.

Biomethanogenesis is complex microbiological process, in which organic matter is degraded to carbon dioxide and methane in anaerobic conditions. Almost all compounds of natural origin and considerable amount of xenobiotics of organic origin are liable to microbial anaerobic degradation.

Earlier we established possibility of application of urban leaf fall (intact) for biogas production. The maximum pressure was observed on 20th day while methane production was observed starting from the 3rd day with subsequent increase of gas yield up to 51%. Addition of active silt and organic wastes considerably intensified the methanogenesis process. Biogas yield was observed starting from the first day, whereas maximum methane content was observed starting from 10th days reaching 55.3% [11, p. 107-108].

It is known that depending on temperature of the process methanogenic bacteria are divided on mesophilic (optimal temperature 30-40°C) and thermophilic (50-60°C) one. In general, thermophilic process of methanogenesis is more intensive and the substrate becomes almost totally helminth- and pathogen-free in these conditions of anaerobic transformation of waste. Thermophilic methanogens possess higher velocity of development and are capable to conduct intensive process of methanogenesis, and that is why are considered as most promising objects for application in biotechnology. Thermophilic methane-producing bacteria *Methanobacterium* and *Methanosarcina* are the main components of thermophilic anaerobic community conducting destruction of organic matter to methane.

It was established that in the thermophilic process indices of pressure considerably change, volume of produced biogas increases and duration of the process changes as well (figure 2, 3).

Comparative analysis of the dynamics of methanogenesis process in thermophilic and mesophilic conditions established high degree of intensity of biogas formation in thermophilic conditions (figure 4).

Fresh chicken manure classified as the second-class toxic industrial waste because it usually contains a number of pathogenic bacteria and large quantities of nitrogen (2.69%). Its utilization may create certain problems. At the same time, it may be used in the process of biogasification. That is why, the next stage of study was application of chicken manure with mixture of different plant biomass in the process of methanogenesis.

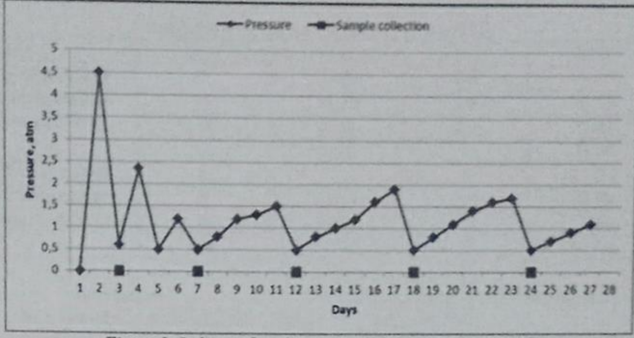

Figure 2. Indices of methanogenesis process at t 30-35°C

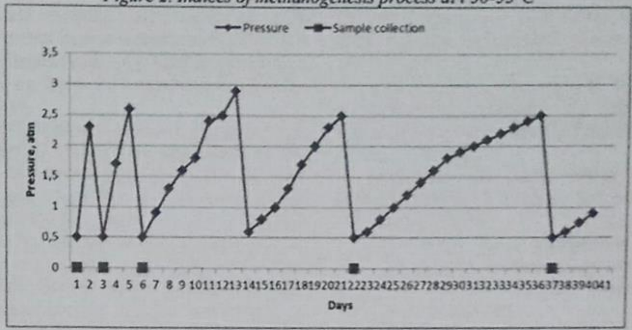

Figure 3. Indices of methanogenesis process at t 55°C

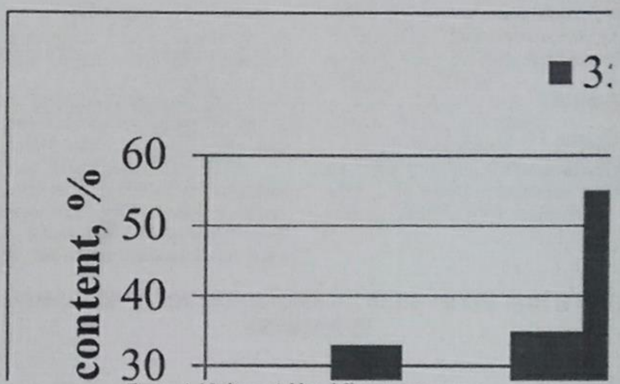

Figure 4. Methane yield at different temperature

As result of conducted study, it was established that at fermentation of urban leaf fall with chicken manure and grinded biomass of higher water plants the biogas yield increases in thermophilic conditions (table 2). Already in the first day, the pressure in working anaerobic chamber raises up to 1.5-2.3 atm, but methane content is considerably low. On 10th day methane content reaches 53%, after which activity inconsiderably decreases. But, the process of methane production lasts till the end of experiment. Increase of CO_2 portion in composition of biogas mixture in thermophilic conditions was observed, which is linked with the fact that at high temperatures carbon dioxide dissolved in substrate transits to the gas phase (biogas).

Table 2

Chromatography analysis of samples (%)

Sample	Day	CH_4	N_2	CO_2	other
Urban leaf fall with mixed substrate of chicken manure and water lettuce, 55°C	2	31.92	3.0	49.17	<10
	6	39.29	2.8	47.12	<10
	10	53.0	2.0	34.47	<10
	16	56.1	-	33.68	<10
Urban leaf fall with mixed substrate of chicken manure and water lettuce, 35°C	2	-	-	47.35	<10
	6	36.63	5.6	37.79	<10
	10	53.11	4.8	33.89	<10
	16	54.28	1.2	28.14	<10

Conclusion

Biogas may be successfully produced from plant wastes, in particular from mixture of urban leaf fall and waste biomass of higher water plants. Our study on biogas production in thermophilic and mesophilic conditions established some opportunities for application of temperature factor for regulation of the methanogenesis process.

Application of different mixtures of organic matter and plant biomass revealed that application of both urban leaf fall and higher water plants biomass with addition of organic waste (like chicken manure) may be quite efficient at certain conditions. It may promote to facilitation of the process of utilization of chicken manure and urban leaf fall into biogas production. Utilization of such waste promotes to solution of power, ecologic and social issues on both community level and state level.

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THE INFLUENCE OF MODIFIED NANOCATALYSTS ON THE STRENGTH OF CONCRETE

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ВПЛИВ МОДИФІКОВАНОГО НАНОКАТАЛІЗАТОРА НА МІЦНІСТЬ БЕТОНУ

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Abstract

Carried out physical-mechanical studies of nanostructured concrete, which showed that modification of micellar catalyst, which is used as nanoparticles, namely micelles of surface-active substances, due to the introduction of conventional surface-active substances, increases the rate of the formation strength, as the cement stone

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