Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 17, Issue 3, 2017
PRINT ISSN 2284-7995, E-ISSN 2285-3952

THE ROLE OF ACTIVATED CARBON IN THE PRODUCTION OF BIOGAS

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Abstract

The research has shown that activated carbon can increase the production of biogas and methane from anaerobic digestion, thereby reducing the startup time. Activated carbon has raised the possibility of microbial resistance to the organic load. A more developed structure of mesoporous the activated carbon was favorable for the colonization of specific bacteria, which leads to increased syntrophic associations between bacteria and methane producers. Thus, the anaerobic reactor complemented with activated carbon would be economically efficient for the production of biogas.

Key words: *biogas, activated carbon, substrate, anaerobic bioreactor, membrane concentration, mixture quality*

INTRODUCTION

Efficient use of agricultural wastes - large and important problem of our time. [4] It is related, on the one hand, with the ability to use the vast energy potential of biomass for the production of liquid and gaseous fuel (biogas), on the other - with the need to prevent water pollution, soil contamination by pathogenic bacteria, and helminthes contained in manure runoff of livestock farms. Both of these aspects have been the object of research and experimentation.

Most common method of obtaining energy from biomass - anaerobic (without oxygen) fermentation of agricultural waste [3,6,14]. Obtained as the result products of this process - biogas and fermented semi-liquid mass of the representing a greater value as the gaseous fuel and organic fertilizer. It is equally important aspect of the use of biogas plants - prevention of pollution of air and water pollution, soils and crops through utilization of manure and deodorants large livestock farms and complexes, the production of highly effective organic fertilizers disinfected.

In today's world there is strong interest in the problems of methane fermentation of manure and other organic waste. To construct biogas plants designed for the processing of manure and agricultural waste [8,13]. In addition to the plant itself, which includes the fermentation chamber, gas holder and storage for the fermented mass (slurry), built a pumping station to pump the slurry to the fields and power plant that runs on biogas. Thus biogas preparation (cleaning it from CO_2, H_2S and subsequent compression dehydration with for storage and distribution to customers) using membrane techniques as compared with conventional, such as absorption and adsorption may provide significant economic benefits [8,10,13].

Biogas is produced by anaerobic decomposition of waste, contains methane (≈60% (vol.)) and carbon dioxide (≈40% (vol.)). The gas contains hydrogen sulfide, ammonia, water vapor; its calorific value is low - 19,5-19,8 MJ/m^3. After cleaning and drying gas should contain at least 98% (vol.) CH4 (calorific value of at least 33.0 MJ/m^3) H2S concentration should not exceed (5.3) 4 10% (3.5 million -1). There are several possible options for the process for each of which determine the required membrane surface, the cost of compression, the degree of extraction of methane from the feed mixture under different conditions (pressure, number of stages and the degree of separation in recycling schemes recycle) [5,9,16].

This paper presents the results of studies on the addition of the activated carbon with different pore sizes in the anaerobic reactor. Reactor productivity and methane were determined.

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MATERIALS AND METHODS

The paper used the classical and modern physical and chemical methods of research; you always get the full characteristics of the objects of research.

Cultivation of anaerobic methanogenic conditions. Methanogenic bacteria - strict anaerobes, the growth of their possible during the initial a redox potential of the environment below - 300 mV. The temperature optimum for the growth of the mesophilic - in the region 30-40°, with the optimum pH in the region 6.5-7.5.

Waste analysis: content of carbon and nitrogen. Organic and inorganic part of the waste was analyzed separately by various methods. Since the process of anaerobic digestion are involved in mainly organic waste, then, in terms of biotechnology, more efficient to operate the process only with their participation.

Branch inorganic waste component carried by calcinations in a muffle furnace at a temperature of - 350 ^{0}C. The inorganic part is determined only by the contents of N, Ca, K, Na, P, Mg, Fe, etc, the most important elements for feeding the microorganisms according to [1, 12]. Elemental composition of the organic part to the carbon and nitrogen content was determined using a mass spectrometer as described in [7,17]. Fraction content (water-soluble compounds, which are soluble in alcohol, protein, hemicelluloses, cellulose, lignin, ash) was determined as described in [15].

RESULTS AND DISCUSSIONS

Parameters of the porous structure of the modified activated carbon obtained by thermal activation are shown in Figure 1. Raising the temperature from 573 K to 773 K leads to poor development of the porous structure, wherein the total pore volume is from 3.8 to $5.0 \cdot 10^{-4}$ m^3/kg. Increased activation temperature from 873 K to 973 K is accompanied by increased pore volume to a maximum value ($8.5 \div 11.0 \cdot 10^{-4}$) m^3/kg. A further increase in temperature from 1,073K to 1,273K do adversely affects the quality of the activated carbon, as hydrocarbons contained resin and decompose to form inactive carbon deposited on the surface of the coal and also leads to sintering pore.

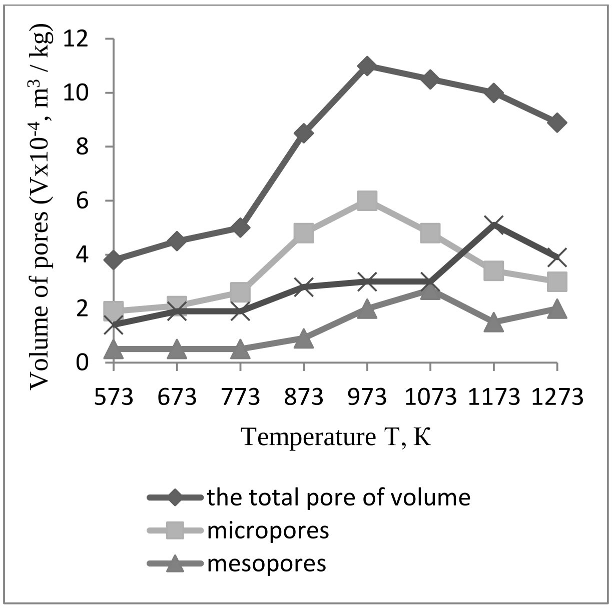

Fig.1. Effect of heat activation temperature in a stream of CO_2 at a pore volume of bones of the shell

The experimental results show the effectiveness of the thermal treatment of the shell of apricot stones, which have a large volume of micropores and moderately advanced transition porosity provides an intense diffusion of the adsorbate into the adsorbent grains.

The process of chemical activation adsorbent of natural origin - one of the important processes of high quality activated carbons used in various sectors of the economy. It is known that in the case of adsorption of substances from solutions to large molecules, which practically inaccessible micropores is the main importance of transition pore surface. In this regard, the study features a chemically-activated shell apricot kernel is the aim of this part of the work and the conditions for the further studies of their use in the production of biogas.

The parameters of porous structure the shell of apricot stones activated zinc chloride ($ZnCl_2$) with impregnation ratio 0.2; 0.3; 0.4; 0.5; 0.6, followed by activation in a quartz furnace in an atmosphere of carbon dioxide (CO_2) at temperatures from 573 K to 873 K are shown in Figure 2. The figure shows the same as in

Vol. 17, Issue 3, 2017
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the previous example, with the increase in the coefficient of impregnation of 0.2 to 0.4 is the development of coal porosity, and at the expense of increasing the total pore volume of $6.8 \cdot 10^{-4}$ m^3/kg to $12.0 \cdot 10^{-4}$ m^3/kg.

If the value of the coefficient of impregnation of 0.5 to 0.6 decreases the volume of micropores of $4.0 \cdot 10^{-4}$ m^3/kg to $3.0 \cdot 10^{-4}$ m^3/kg and the volume of mesopores $5.5 \cdot 10^{-4}$ m^3/kg to 5.0 10^{-4} m^3/kg and the development of macro porosity begins from $1.5 \cdot 10^{-4}$ m^3/kg to $2.0 \cdot 10^{-4}$ m^3/kg. When the impregnation ratio of 0.4 increase in temperature from 573 K to 773 K leads to a significant development of the porous structure (the total pore volume of from $7.0 \cdot 10^{-4}$ m^3/kg to $12.0 \cdot 10^{-4}$ m^3/kg). Further increase in temperature to 873 K adversely affect the pore structure, which reduces the volume of the micropores of $4.2 \cdot 10^{-4}$ m^3/kg to $4.0 \cdot 10^{-4}$ m^3/kg and a mesopore volume of $6.5 \cdot 10^{-4}$ m^3/kg to $5.7 \cdot 10^{-4}$ m^3/kg.

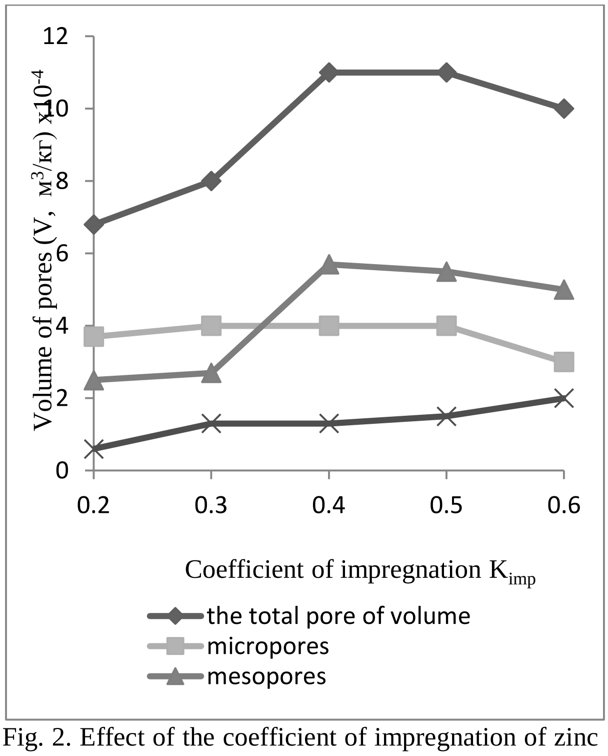

Fig. 2. Effect of the coefficient of impregnation of zinc chloride ($ZnCl_2$) followed by activation in a quartz furnace in an atmosphere of carbon dioxide (CO_2) on the pore volume of the shell bones

For samples treated of $ZnCl_2$, optimal parameters of activation modes are: infiltration coefficient – 0.4; time - 3 hours. For samples treated with $ZnCl_2$ followed by activation with CO_2 optimum parameters are: CO2 temperature - 773 K; impregnation ratio of 0.4. Modifying the surface of the sample affects the change in pore spaces, which essentially depends on the adsorption capacity of activated carbon. This requires the severity of an individual approach to each sorbent with the obligatory account of its structure, effectively defining the size and shape of the pores. The transitional pore adsorbents at high relative pressures phase transition occurs through the mechanism of capillary condensation.

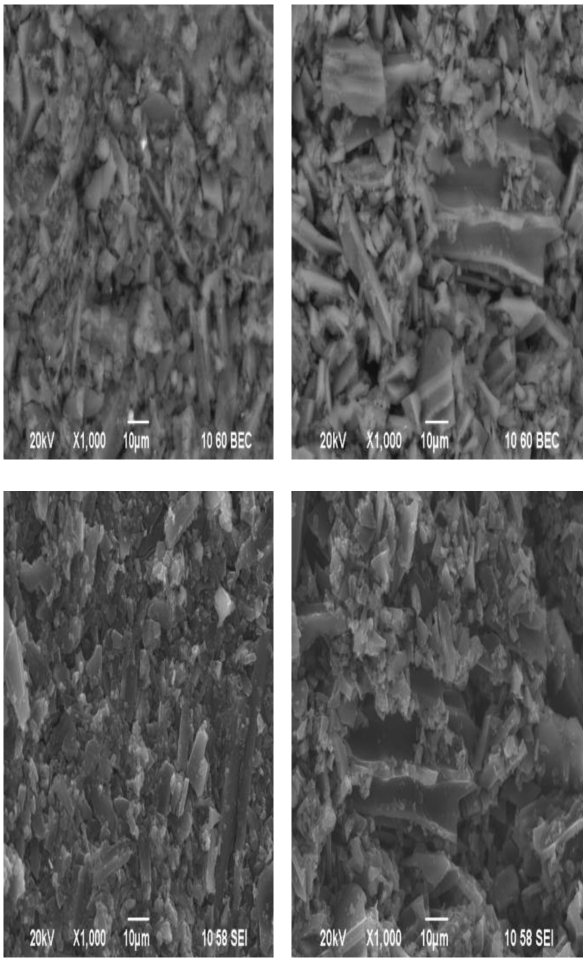

Photo 1. Microorganisms attached to the activated carbon was observed by a scanning electron microscope (JSM-6490LV).

The above results show that adding the activated carbon, a high level of methane production was observed in the anaerobic reactor with natural microorganisms. Increased productivity can be attributed to an increase in the microbial population producents of methane bacteria and syntrophic bacterial metabolism. The absorbed microorganisms that have a high level of metabolic capacity have increased pores of AC. It has been found that activated carbon showed extensive colonization within the porous structure. Activated charcoal ensures the development of mesoporous structure for the methane producers that use bacteria to colonize.

CONCLUSIONS

The obtained complex structural and adsorption data indicate that the samples chemically activated seed shells on the physical and chemical adsorption, and structural characteristics are not inferior to the applicable industrial activated coals and will be able to find a practical application as adsorbents in obtaining biogas. Thanks to advanced (transition) mesoporosity and a large specific surface area is effectively large-scale colonization of micro-organisms for which the micropores are practically inaccessible.

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