Modelling of Processes of Decomposition of Organic Compounds of Municipal Solid Wastes in Cross Electromechanical Fields

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Abstract

At the present time, one of the most common methods of disposing the municipal solid wastes (MSW) is burial in sanitary landfills, where take place, long-term complex of physico-chemical and biochemical processes of decomposition.

It was developed modeling of the natural process of decomposition of the solid Municipal wastes in cross electromechanical fields.

The synthesized pellets was studied by IR spectroscopy. Residual hydrocarbons has a complex structure, represented by δ-lactones, cyclopentanone. The results of treatment of husk show there were the characteristic frequencies related to the OH group, indicating that the synthesis of dimers of branched chain alcohols (glycerides).

Analysis of model shows that hydrocarbon product formed by the method of matching the external effects of the internal response of the reacting carbon-water composition.

Introduction

Extraction of biogas from landfills of municipal waste to generate electrical energy is widely used abroad.

Regularities of formation and motion of biogas in the bulk of stored waste is currently not well understood. The main reason is the complexity and duration to obtain reliable experimental results.

The method of mathematical modeling of processes, which take place in the body of the landfill, allows to:

- To predict methane emissions at each stage of the lifecycle of the landfill;
- To develop a strategy for protection, which reduces the risk of contamination;
- To develop emergency response systems and methods for recovery of landfill gas;
- To control the speed of the natural processes occurring within the polygon.

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The development of theoretical methods for prediction of biogas during the decomposition of municipal solid waste is a prerequisite for further progress in the field of waste disposal and solid waste disposal technology.

For the development of new processing technologies, the acceleration of the natural processes of decomposition of solid waste required. For solution of this problem in the laboratory environment, were completed some works on modeling of natural processes.

The idea of Walden (1930) that there is no waste, but only the unused raw materials, is currently very relevant [1]. In current conditions, the development of energy efficient technologies is the only way out of an impending energy crisis. This line of work is taken as the basis for the development of technologies for processing solid wastes.

In the field of environmentally sound technologies, the principles of energy conservation involve the creation of such technology, which uses the natural hydro operation of solid wastes. The remaining water or rather its solutions can be used

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as a source of hydrogen and oxygen for the synthesis of light and heavy hydrocarbon fractions of the defined structure. Energy-saving methods include all of the technological regimes, which can be carried out at low temperatures and pressures.

Experimental

To achieve the objectives of this work on the stage of laboratory studies, an experiment was undertaken to study the effect of static and variable fields on the chemical composition of a mixture of water with carbon (carbonized with peanut hulls at 550°C). The experimental conditions tried to approximate the physical conditions prevailing in the above-ground tank, reservoir, capable to contain solid waste and gas, and give them out during processing. Most reservoirs are sedimentary rocks, limestones and dolomites. Argillaceous rocks – collectors for gas, but not for oil, as because of high viscosity, it cannot flow out of it, even at high pressures, but they can be surface-active for the synthesis of liquid organic compounds. Therefore, to simulate the physical conditions of the reservoir tank, alundum crucible (Al_2O_3) was used, which is a closed impervious cover, the lower part of which is impregnated with aluminum chloride (catalyst synthesis gas from liquid compounds). As the gas fraction, hydrogen produced by decomposition of water by aluminum-activated gallium was used. To obtain the static potential using a pair of Zn-FeS, which provided the contact difference of potential races in this part of the alundum crucible. Mechanical vibrations of ultrasonic frequency range (181 kHz) were also fed for 2 hours. Low carbon-water mixture was maintained near 36°C.

To this end, laboratory apparatus was created, which allows exploring oil and water-oil composition with surface-active agents (surfactants) in the fields of electro-acoustic band. In the first stage of modeling we have performed work on analyzing the behavior of water and its solutions for electro-mechanical effects, depending on the frequency of oscillations in the bulk and surface conditions. Measuring the electrical resistance showed that salt water has the ability at some frequencies in the tens of times lower electrical resistance. In physical language, this means the emergence of resonant modes of interaction with the external receiver. By knowing the frequency response to external stimuli, one can generate a processing mode in which the structures are given the form [2].

In the course of conducting model tests it was also found that the natural frequency of water and its composition vary over a wide range of frequency and impact depends on the type of the reactions.

For example, the decomposition reaction of water reduces the range of the resonance response of the composition in the low-frequency, and the interactions at the interface of two phases lead to the appearance of resonant modes in high-frequency region. It should also be noted that these studies were performed at room temperature and normal pressure, i.e. in power saving mode that allows you to use these results for work on the modeling of processes of decomposition of solid waste.

Great job on the physico-chemical principles of synthesis of carbon-containing compositions performed at the Institute of Combustion Problems [3], which showed that almost all carbon-containing waste of modern industry can be transformed into high-quality consumer goods.

The information obtained on the terms of a resonant response to external stimuli allowed to carry out an experiment on the synthesis of hydrocarbons from water-coal mixture by treating it in an alternating field electro kilohertz frequency range. The starting materials were tap water and high dispersion of coal. In case of technical grade carbon black unstructured P324 were obtained with alcohol-benzene fraction of indeterminate composition. In another case, structured carbon was selected produced from natural raw materials by carbonization with peanut husks at 550°C, thickness of which is less 10 μm. The synthesis was carried out in an alundum crucible for 90 minutes; the decomposition of water was carried out with activated aluminum.

After treatment, some carbon particles enlarge and form resinous compounds which possess rubber-smell, which indicates that the decomposing pyrite took part in the fusion reactions – a component which sulfur was involved in a chemical reaction gumming. It should be noted that the reduced iron immediately oxidized to Fe_3O_4. Here are the IR spectra of the source of carbon and the synthesis products obtained in the simulation of the given conditions.

The synthesized pellets were studied by IR spectroscopy. IR spectra were recorded on the instrument FTJR firm *Mattison satellite (USA*) in the frequency range 400-4000 cm^{-1}, the number of scans 64, resolution – 4 cm^{-1}.

Table 1 shows the results of analysis of carbonization with peanut husks at 550°C. It gives a summary of the characteristic frequencies of oscillations with a breakdown of types and type of compounds [4, 5]. It is seen that the initial carbon fraction has a complex structure due to the presence of unburned hydrocarbons saturated with nitrogen-containing compounds. Residual hydrocarbons has a complex structure, represented by δ-lactones, cyclopentanone. Small amounts of aromatic compounds are present, which is dominated by disubstituted and trisubstituted derivatives of benzene ring.

Table 1

IR spectral composition of the initial carbon fraction obtained by carbonization with peanut husks at 550°C

Frequency, cm^{-1}	Intensity	Intensity of vibration	Nature Connection Type
3459	Strong	NH_2 stretching vibrations related	primary amines
3436	Strong	stretching vibrations of free NH (cis)	Secondary amines, amides
2925	Average	asymmetric stretching CH_3, CH_2	Saturated hydrocarbons
1744	Weak	C = O stretching	δ-lactones, cyclopentanone
1639	Average	C = O stretching, C = C	Two sets of CO in the different phases of SNR1 = CHR_2
1421	Weak	Valence and deformation δSN_2, SO_2N	fatty acids
1378	Weak	Valence in and δSN_3,-C (CH_3)	Polymer associates
1161	Weak	1,2,3 - substituted aromatic ring vibrations	diene C = C = C, aromatics connections
1103	Weak	1,2,3 - substituted aromatic ring vibrations	aromatic compounds
854	Weak	Out of plane CH deformation vibrations	Different types of benzene connections
559	Weak	deformation vibrations	Amida VI

Table 2 shows the results of treatment of husk, which shows the characteristic frequencies of synthetic resins which are radically different from the original. First there were the characteristic frequencies related to the OH group (see tabl.2), indicating that the synthesis of dimers of branched chain alcohols (glycerides). Second, new compounds (2924 cm^{-1}) appeared, characteristical for the methyl group CH_3 attached to the benzene ring. It should be noted that the remnants of unburned hydrocarbons in the carbonized husk in the course of synthesis has not changed significantly, as evidenced by the general lines inherent in the two spectrograms: 2924, 2853, 1746, 1377, 1163 cm^{-1}

From the above tables it is shown that the spectral composition of the initial carbonized material and synthesized product significantly differs in the number of lines of the IR spectrum, and composition of the characteristic groups. For the initial carbon fraction obtained by carbonization with peanut husks at 550°C is characterized by the presence of large amounts of amines (3459, 3436 cm^{-1}), unburned during the pre-firing, saturated hydrocarbons (2925), various forms of oxidized compounds (1744, 1639) and a small amount of polymer of associates.

After processing in cross-fields of different nature of the lines of the IR spectrum has doubled, and new connections, uncharacteristic for the IR spectrum of the starting material. Although the spectrum contains lines of unreacted starting sample, changes in chemical composition and structural relationships of a synthetic resin are clearly visible. First, there dimer alcohols (3516, 3489, 3351 cm^{-1}) with branched-chain - a sign of participation of the OH group in chemical synthesis, which is important for the decomposition reaction of water. Secondly, there were complex structure chelation, alkenes, halides (3317, 3010, 2953), indicating that at low temperatures the synthesis of complex compounds (1746, 1659, 1556, 1462, etc.) can take place, receipt of which is in operating conditions requires high temperatures (>600°C).

Table 2
The characteristic absorption frequency of the synthesized product obtained from the water and peanut husks

Frequency, cm^{-1}	Intensity	Intensity of vibration	Nature Connection Type
3516	average	OH stretching vibrations associated	dimers of branched chain alcohols
3489	strong	stretching vibrations of free NH	Secondary amines
3443	Strong	stretching vibrations of free NH_2	primary amines
3409	Strong	has not been identified	-
3351	Strong	stretching vibrations associated O - H	Alcohols with many connections
3317	Average	stretching vibrations C - H, - RC = CH	Polyer associates
3010	Average	asymmetric stretching CH_3-CH = CH_2	chelates, alkenes
2953	Average	Symmetric CH_2 stretching	SN_2H (X-halogen)
2924	Strong	asymmetric stretching CH_3, CH_2	Saturated hydrocarbons
1746	Strong	stretching vibrations C = O	δ-lactones cyclopentanone
1659	Average	stretching vibrations C = C	β - Gum form of aryl ester
1556	Weak	Flat fluctuations of aromatic carbocycled connections C = C	Diene System
1462	Weak	asymmetric deformation vibrations of-CH_3	derivatives of alkylbenzene
1377	Weak	deformation vibrations - δ-CH_3, $C(CH_3)_2$	Polymer associates
1237	Weak	asymmetric stretching vibrations of C-O-C	Esters, lactones in complex compounds
1163	Average	Fluctuations disubstituted aromatic ring	Dienes
1118	Weak	Plane deformation vibrations of C-H	Monosubstituted benzene ring
861	Weak	deformation vibration of C-H	1,2,4,5 - substituted derivatives of benzene
722	Weak	deformation vibration of C-H	1,2 - disubstituted benzene derivatives
577	Weak	vibrations of the Me-C	trans form

Conclusion

The totality of the experimental evidence suggests the following conclusions:

1. Modelling in laboratory conditions of the natural process of decomposition of solid wastes to a mixture of carbon and water with surface-active substances of natural origin is a promising direction for solving the tasks of creating energy-saving technologies for processing solid wastes in a natural occurrence.

2. The chosen line of work on the application of electro-mechanical fields for physical and chemical effects on carbon and water meets all guidelines for energy efficiency, as it ensures the implementation of the reactions in the resonant mode at normal pressure and low temperature.

3. Hydrocarbon product formed by the method of matching the external effects of the internal response of the reacting carbon-water composition was first synthesized.

4. The prospects of the work to obtain the specified properties in the synthesis of organic substances with variable vibrations of sound and ultrasonic ranges were shown.

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