A Mathematical Model of the Level Processing of Organic Wastes on Methanogenesis Mixing Process

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Abstract

The article presents the results of the authors’ many experiments on organic waste processing in agriculture. The analysis of the existing biogas plants of advanced countries and comparison of the products obtained during the anaerobic treatment of organic agricultural wastes is presented.

Key words: organic waste, biomass, periodic mixing, methanogenesis, dwarf mixer.

Mathematical model of processing of organic wastes.

The major drawbacks of modern renewable energy sources are the combination of daily emissions of organic matter into biological reactors in anaerobic processes. In order to overcome this shortfall, we use biogas reactor to increase biogas rates 2 ... 2.7 times and improve the quality of organic fertilizers several times. However, there is a need for a mathematical model to identify the biogas plant, which is a part of the biogas plant, and its optimal parameters for the proposed organic wastes. Theoretically, the difference between biomass mixing method [2,3,4,5,6,7] has been put in place, requiring the ability to calculate the mixing process of the biomass of anaerobic biomass without interfering with organic waste. The above mentioned renewable energy types of the energy-based device in a new construction of organic waste are graded in separate containers and differ from the calculation of mixtures of known conventional equipment [3, 4, 5, 6, 7]. Therefore, there is a need to create a special mathematical model that takes into account the mixing process, without mixing the organic waste together.

It is well known, that the technical productivity of the devices of forced mixing of energy devices on the basis of renewable energy types on the basis of periodic mixing organic waste can be determined by the physico-mechanical properties of the newton-type fluid category,

\[ U_g = 94.2 \pi (D^2 - d^2) n L_s k_w k_{tw}, \text{ m}^3/\text{coar} \]  

(2.1)

where \( D \) is the diameter of the mixed stomach, m; \( d \) - spindle drum diameter, m; \( n \) - number of cycles of mixing valve, rpm / min; \( L_s \) - mixing arc step, m; \( k \) - bioreactor saturation coefficient (\( k \approx 96 ... 98 \) [8,9]); \( k_{tw} \) - the friction coefficient of the biomass is 0.09 - 0.19 [8]).

However, when bioreactors are mixed in the same quality as microbiological requirements (at a speed of 5 ... 7 km / h), it is clear that the total energy produced from the process is so high [8, 10, 11, 12].

During high quality mixing of the biomass to bioreactor for high quality mixing in methanogenesis, the average speed of the mixing wings should not exceed its maximum speed, otherwise it will generate discomfort in anaerobic bacteria [13] and the centering force acting on the molded material particles may exceed the frictional slurry, will cause the adhesive to stick. The state and the forces acting on one stage of the bioreactor are shown in Figure 1.

![Picture 1. Compact calculator scheme](image-url)
In order to ensure that material particles are not pulled out of the drawing, the inertia force must ensure that the following condition is satisfied:

\[ F_{\text{ин}} = (G + Q) f, \text{н} \]  
(2)

where the force of inertia of the material wound; Weight of G-blender material in groats, kg; \( Q \) - the force acting on the mixture by the mixing gun: \( Q = f' \cdot G, \text{н} \); friction coefficient on the surface of the mixing coat of the mixture of \( f' \)-mixture (0.14 ... 0.59) [7].

The inertial force of the bioreactor elemental material is defined as follows

\[ F_{\text{ин}} = G/g \omega^2 R, \text{н} \]  
(3)

2.1 PCB can be written as follows:

\[ f' \cdot G + f^2 \cdot G = G \cdot \omega^2 \cdot R/g \]  
(4)

the maximum angular velocity can be defined:

\[ \omega_{\text{max}} < \sqrt{g \cdot f' \cdot (1 + f')} / R, \text{sec}^{-1} \]  
(5)

where \( R \) is the radius of the biodegradation step of the bioreactor in the stepwise treatment, m. It is well-known that the rate of mixing of the biomass in the bioreactor to the amount of energy obtained from the anaerobic process is studied by several practitioners [14,8,5,12] and, in general, suggests that the speed of the biomass in the bioreactor does not exceed the value given above (7 km / h).

The rate of biomass in a biologic M. Corolev recommends the following formula:

\[ v_{\text{wp}} = 2/3 \omega_{\text{max}} \cdot R_{\text{wp}}, \text{м/дак.} \]  
(6)

here is the fast. Average radius of mixing mud, m. The average rotation radius of the mixed aggregate. and the diameter of the mixing column can be expressed as follows:

\[ R_{\text{wp}} \approx d = 0.33 \cdot D, \text{м} \]  
(7)

The amount of energy and the quality of fertilizer will be determined by the biomeactors at design time, depending on the geometric dimensions of the stages and the ability to process the organic extract [15,16]. Considering this, the interior diameter of the container is determined by the following formula:

\[ D = \frac{4 \cdot V}{\pi \cdot h}, \text{м} \]  
(8)

where \( V \) is the volume of organic waste, m³; \( h \) - the height of the mixing biomass at a level, m. From the above, the total surface of the active surface of the blender beads is determined by the following formula:

\[ S_{\text{in}, \text{m}} = \sum S_i \cos \alpha \cdot \sin \beta, \text{м²} \]  
(9)

where \( S_i \) is the natural (surface) surface of each mixing blade, m²; \( \alpha \) - Angle of adjustment angle relative to the horizontal angle curve, grad; \( \beta \) - angle of inclination to vertical curve, grad.

It is known that the productivity of the anaerobic process depends on the process of mixing on energy sources based on renewable energy, due to the strict requirements of methanogenesis. However, practitioners [17,18] tend to mix biomass continuously in the bioreactor. However, the mixing parameters in stepwise processing by Sh.Imomov 6 ... 8 times 10 ... 25 min. The rapid mixing has led to high results [8]. If the mixing of the biomass in the biomass continues uninterrupted, we will define the productivity of the mixing process as follows:

\[ U_a = 94,2 \cdot \pi \cdot (D^2 - d^2) \cdot n \cdot L_q \cdot k_{\text{sat}} \cdot k_{\text{w}}, \text{м³/соат} \]  
(10)

where \( D \) is the diameter of the mixing pin, in m; \( d \) is the diameter of the aisle valley, m; \( n \) - number of cycles of mixing valve, rpm / min; \( L_q \) - mixing arc step, m; \( k_{\text{sat}} \) - bioreactor saturation coefficient (\( k_{\text{sat}} \) - 96 ... 98) [8,9]; \( k_{\text{w}} \) - the coefficient of conversion of the biomass on the screw surface of the mixed slag. The bioreactor is made of screw driving blades to increase the mixing intensity and quality and reduce the energy consumed by it. The calculation of such surfaces is relatively complex. Taking this into account, we use Figure 2 to determine the coefficient of the submersion of the biomass on the screw surface.

**Figure 2. An integrated scheme for calculating dry dripers**

From this:

\[ k_{\text{w}} = \frac{z_s \cdot b \cdot \sin \alpha}{\pi \cdot D} = \frac{z_s \cdot b \cdot \sin \alpha}{\pi \cdot D} \]  
(11)

where \( z_s \) is the number of arcs between one step of the mix
er; \( b \) - width of the trunk, m; \( a \) - the angle between the surface of the mixing beams and the rotation axis, grad; \( b \) is the angle between the spatial edges of the arid arc and its circle, grad. The length of the mixer depends on the diameter of \( D \) in \( D \):

\[
L = (2.7 \ldots 3.0) \cdot D, \text{ m}
\]  

(12)

Instantaneous momentum for the mixing beams in the device can be found using the steps 2 and 3.

\[
M = 0.5 \left ( R_{\text{mix}}^2 - R_{\text{mv}}^2 \right ) k_{\text{mv}} b \cdot \cos a, \text{ m} \cdot \text{m}
\]  

(13)

where \( D \) is the diameter of the mixing pin, in m; \( d \)-diameter of the box holder, m; \( n - R_{\text{mix}} \) and \( R_{\text{mv}} \) - proper external and internal radius of the mixing pad, m; \( k_{\text{mv}} \) - the resistance coefficient of the mixture with the dry, \( R_{\text{a}} \cdot [1.0 \ldots 1.6] \cdot 10^{-5} \text{R}_{\text{a}} \).

Knowing the moments of power coming down on the doves, the amount of energy used to mix a bioreactor on a stirrup is determined by the following formula:

\[
N = N_{\text{eva}}/\eta
\]  

(14)

where the \( N_{\text{eva}} \) - rotating power rotating power, kW; \( \eta \) - F.I.K.

The force that can be used to rotate the rotary valve (Nkva) \( q \) can be determined by the following formula:

\[
N_{\text{kva}} = \pi \cdot \frac{I \cdot n \cdot z \cdot k_{\text{n}}}{3 \cdot 10^3}, \text{ kBT}
\]  

(15)

Conclusion

In order to check the adequacy of the mathematical model mentioned above, it is necessary to take into account theoretical calculations and all the factors influencing the energy performance of renewable energy types on the energy performance of the laboratory equipment. For this purpose, the approximation to the conditions in which the selected device is to be compared with the theoretical estimation of the optimal parameters of the mixing and stroke parameters and provides the basis for subsequent studies to develop the theory. At the same time, the main indicator of increasing the quality and quality of its products by transforming biogas generators into energy-efficient biogas generators, which maintains the methane-gas requirements in each of the stages of organic waste at renewable energy sources.

References

1. Imomov Sh., Kayumov T., Usmanov K., Khakimov B., Sultonov M. Organic waste recycling and its processing equipment (Sposob pererabotki organicheskix otxodov i ustanovka dla ego osushchestveniya), A01S3 / 00, S05G3 / 00, IAP 20160389.UZ. Official Gazette, №3.


8. V. Sultanov, Sh. Imomov, A. Rustamov Usage biogas plants with regarding climate conditions of Uzbekistan. IJARSET.ISSN:2350-0328. p.3619-3622.


11. Trachunova I.A. Povyshenie Effektivnosti anaerobnyy pererabotki organicheskix otxodov v metantenke s gidravli-
cheskim peremeshivaniem na osnove chislennogo eksperimenta. Diss ... kand. tex nauk., Kazan, 2014. 115s.


