УДК 631.863

OPTIONS FOR BIOLOGICAL CONTROL ANAEROBIC DECOMPOSITION PROCESS

O. Skliar, Ph.D. Eng.,
V. Mits, student
Dmytro Motornyi Tavria state agrotechnological university, Zaporizhzhia, Ukraine

The control of a biological process and its regulation are complex. The purpose of the anaerobic decomposition process in agriculture usually consists in obtaining a constant volume of methane. The most commonly used is a (semi-)continuous mechanically stirred reactor. Continuous production of methane is achieved here if there is a steady state operation. In this case, the changes in the process parameters are equal to zero and the maximum reaction rate possible for the process is achieved [1].

Therefore, parameters such as volumetric load, residence time, achievable degree of decomposition and gas production rate are determined in advance at the stage of plant design and selection of the substrate for processing. The plant operator must ensure that these parameters are kept as constant as possible. However, a steady state regime is not achievable in practice, since problems inevitably arise (for example, changes in the properties of substrates, malfunctions and failure of pumps, supply of disinfectants to the reactor, etc.) [1,2].

These failures lead to deviations from the desired state, which must be detected so that the cause can be identified and corrected.

The volume of biogas production is an important indicator as a metabolic product and a target parameter. The biogas flow rate is the amount of gas produced per unit of time, which, given the volume of feed to the reactor and the composition of the substrate, serves as the basis for calculating the specific production of biogas (per substrate and volume). It is impossible to do without measuring the biogas flow rate when balancing metabolic processes and assessing the productivity of the methanogenic population [2].

When installing devices for measuring the amount of passing gas, the location of the sensors is important. If it is necessary to monitor the processes in individual reactors, then their biogas flow rate should be recorded separately. In the case of foil roofs, the volume of the storage tank must be taken into account to calculate the gas flow rate, it can be measured based on data on the filling level (for example, a displacement sensor with a rope system), internal pressure and temperature in the gas chamber. Sensors in the gas chamber must comply with explosion protection requirements and must be resistant to corrosion and high humidity.

The composition of biogas can serve to evaluate various factors. Below are explanations of the individual components and their significance to the process.

The share of methane in biogas serves to assess the state of methanogenic biocenosis. In connection with the gas flow rate, it is possible to calculate the methane flow rate – if it drops significantly, despite the constant loading, one should proceed from the inhibitory effect on methanogenic archaea. In order to evaluate the productivity in terms of methane, places [3] for measurements should be provided in all reactors. Methane concentration is measured in biogas technology using infrared sensors or thermal conductivity sensors.

Since almost no heat is generated during anaerobic fermentation (except for some renewable biogas plants), the substrate must be heated to fermentation temperature. It is important that the temperature is maintained at the same level. First of all, the thermophilic process sensitive to temperature fluctuations.

The temperature sensors must be mounted at different heights, so that separation and insufficient mixing can be detected. In addition, care must be taken to ensure that the sensors are not located in dead zones or too close to temperature control devices. Resistance sensors or thermocouples are suitable for temperature measurement.

To balance the decomposition process, it is impossible to do without an accurate measurement of the supplied volume of the substrate. Since solid substances are fed into the reactors in addition to liquid substrates, various measuring systems are used.

Solids are best weighed, which is done using wheel loader scales or weighing units on reactor feed systems. At the same time, the latter are more accurate and can be integrated into automatic process control systems.

For liquid substrates in pipelines, flow meters can be used, and in the case of receiving tanks, the corresponding volume can also be obtained using level meters. Fill levels (also for reactors) can be determined using pressure sensors (hydrostatic pressure in the reactor) or ultrasonic or radar distance measurement to surfaces. When choosing and locating sensors, care must be taken to ensure that special operating conditions such as deposits on the bottom of the reactor (e.g. sand), foam formation, sulfur deposition in the gas chamber, etc. did not affect the measurement accuracy. In addition, explosion protection must be provided.

For flow meters, devices that operate without moving parts in the measured medium have proven themselves. Mainly inductive and capacitive sensors are used [3], sometimes ultrasonic and thermally conductive sensors are used. Depending on the technology, a sufficient inlet area upstream of the sensors should be provided to create laminar flows in the pipe. Along with the amount of the supplied substrate for mass balance, it is necessary to know its concentration and composition.

For concentration, summary parameters are used, such as the content of dry matter (DM) and organic dry matter (oDM) [3]. For liquid substrates, chemical oxygen demand (COD) can also be used, and sometimes total organic carbon (TOC) is also used. Only the first two indicators mentioned above are of practical importance.

The first step to determine the degradable proportions in the substrate is to determine the content of water or dry matter. To do this, the sample is dried in the laboratory at a temperature of 105°C to constant weight. There are also now new microwave and near infrared sensors that measure these parameters without shutting down the process.

The initial data for assessing degradability is obtained by determining the proportion of organic components in dry matter. organic dry substance is the total parameter that is obtained by calcining a dried sample at a temperature of 550 ° C. Loss of mass, also called loss on ignition, is called organic solids. This indicator is a summary parameter that does not give any information on degradability or expected biogas production from the tested substance. In the literature [4] there are indicative indicators, with the help of which, if the substrate and the content of SS are known, it is possible to estimate the expected volume of gas production.

The formation of floating crusts can be a problem in installations with fibrous substrate. Floating crusts [4] are formed when the fibrous material floats and, due to felting, forms a strong structure on the surface. If the crust is not stirred appropriate agitators, it can build up to a thickness of several meters. In this case, it must be removed manually.

But a certain stability of the surface structure is quite desirable in plants where desulfurization is carried out by means of air supply to the gas chamber. In this case, the surface serves as a habitat for desulfurizing bacteria. Floating crusts are a problem for optimizing the operation of the installation, in most cases they are detected visually through the sight glass window. Currently, there is no measuring technique that can detect the formation of floating crusts.

Bibliography.

1. Войтов В.А. Аналіз технологій утилізації відходів птахівництва за кордоном. *Праці ТДАТУ*. Мелітополь, 2019. Вип. 19. Т. 4. С. 100–109. DOI: 10.31388/2078-0877-19-4-100-109.

2. Komar A. Definition of priority tasks for agricultural development. *Abstracts of XIV International Scientific and Practical Conference. «Multidisciplinary research».* Bilbao, Spain 2020. Pp. 431–433.

3. Skliar R. Justification of conditions for research on a laboratory biogas plan. *Motrol: Motoryzacja I Energetyka Rolnictwa*. 2013. Vol. 16. № 2. P. 183–188.

4. Skliar O.G., Skliar R.V Substrate management in biogas plants. *Молодь і технічний прогрес в АПК: Мат. Міжнародної науково-практичної конференції*. Том 2. Інноваційні розробки в аграрній сфері. Харків: ХНТУСГ. 2021. С. 260–262.