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METHODS OF FEEDING TO THE BIOGAS PLANT REACTOR

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Modern production technologies, if possible, should be interconnected in such a way that the final cycle of one of them becomes the beginning of another cycle, due to which almost complete wastelessness and intensification of production is achieved. It is this integrated approach, when waste and by-products of one production act as raw materials or semi-finished products for another, that will help solve the problem of sustainable development of society.

It is known that animals do not fully assimilate the energy of plant foods and more than half of it goes into manure, which, after one or another type of processing, is a valuable organic fertilizer. Keeping animals on farms leads to an increase in the concentration of manure and manure runoff on farms. And this makes it possible to organize their processing not only into fertilizers, but also into biogas, without polluting the environment. At the same time, biogas essentially becomes a renewable energy source [1].

An integrated approach to production activities, when “waste”, including organic, thermal, water, gas-air, is processed in the production chain, minimally affects the quality of the environment and the productivity of zonal ecosystems.

In the digester, it is necessary to organize periodic mixing of the substrate, which ensures efficient and stable operation of the plant. The purpose of mixing is to release the generated biogas, mix in fresh substrate and bacteria (inoculation), prevent the formation of a crust and sediment, prevent the formation of areas of different temperatures inside the digester, ensure an even distribution of the bacteria population, and prevent the formation of voids and accumulations that reduce the effective area of the digester. When choosing a mixing method, it should be taken into account that the fermentation process is a vital process of symbiosis of various bacterial strains, and if this community is destroyed, the fermentation process will be unproductive until a new bacterial community is formed. Therefore, too frequent or prolonged stirring is harmful. Slow mixing of the substrate every 4-6 hours is recommended.

There are many systems and products that are commercially available for supplying organic feedstock to the reactor of a biogas plant. They allow you to dose the feed by weight at predetermined intervals.

The supply of raw materials occurs in three ways [1,2]:

- preliminary storage tank;

- indirect supply to the reactor;
- direct supply to the reactor.

At the same time, the delivery methods differ significantly from each other:

- power;
- "specific" productivity of the conveyor;
- use of electricity;
- cost.

The choice of the optimal technique for feeding will depend not only on the substrate and its quantity, cost, installation location, etc., but also on the intentions and working hours of the plant manager. Therefore, we will consider in detail each of the methods and dwell on their advantages and disadvantages [2].

Indirect supply of substrates that can be stacked. Solids can be fed into the reactor directly or through receiving tanks. In indirect feeding, the substrates that can be stacked are fed into a receiving vessel or into a substrate conduit leading to the reactor. With direct feed to the reactor, solids are fed directly into the reactor, bypassing mixing with the liquid in a receiving vessel or pipeline.

Thus coenzymes can be fed into the reactor independently from liquid manure and at regular intervals [2,3]. It is also possible to increase the dry matter content (CB) in the reactor and thus increase the yield of biogas.

Substrate supply through the receiving tank If the biogas plant does not have the possibility of separate feeding of co-substrates directly into the reactor, the stacked substrates are also mixed, crushed, homogenized, and, if necessary, mixed with the liquid to obtain pumped mixtures, in the receiving tank. For this, the receiving containers are equipped with agitators, if necessary in combination with devices for grinding the substrate (tearing and cutting). If substrates containing foreign matter are used, the receiving container also serves to separate stones and submerged layers; they can, for example, be concentrated and removed using retractable bottoms and screw conveyors [2,3]. If the receiving container needs to be closed to avoid the release of odors, the overlapping should be done in such a way that the receiving container can be easily opened and heavy objects that have settled on the bottom can be removed from it.

Loading is carried out, for example, by wheel loaders or other mobile equipment, as well as by automated solids feeding systems. The mixture of solid materials and liquid is supplied to the reactor by appropriate pumps [4].

Indirect feeding into the liquid stream Instead of feeding into a receiving tank, solid substrates, eg biowaste, silage and manure, can be fed into the liquid stream using suitable metering devices, eg screw pumps with rubber stator [2]. Feeding can be done by pushing into the substrate feed line or by directing the flow directly through the substrate feeder, at which point the substrate can also be coarsely ground. Depending on the DM content and the volume of substrate fed into the reactor, the feed equipment can be

adapted in terms of productivity. Liquid manure from a receiving tank or substrate from a reactor or fermented residue storage can be used as a liquid stream. Such systems are used in biogas plants of medium and large size, since the modular design guarantees a certain flexibility and resistance to failures [2,3].

Direct feed by means of a pressure piston. When feeding by a piston, the substrate is fed using a hydraulic cylinder through a hole in the reactor wall directly into the reactor [3]. Feeding is carried out at a level near the bottom, due to this the substrate is saturated with liquid manure and the risk of formation of floating layers is reduced. The system is equipped with counter-rotating mixing shafts that feed the substrate into the bottom cylinder and at the same time grind long fiber materials. The supply system is in most cases connected to and/or mounted below the receiving container.

Direct feeding with augers. In screw feeding, the substrate is fed into the reactor by the screw below the liquid level in the reactor. Thus, the exit of gas from the reactor through the screw is prevented. In the simplest case, the dosing device is located on the reactor, so that only a vertical screw is needed for feeding. Otherwise, the height of the reactor must be overcome with the help of ascending screws. The augers can be used with any receiving containers, which, for example, have grinding devices [3].

Grinding of biomass into gruel. Coenzymes (e.g. beets) are prepared on the machines used for beet processing, so that they can be pumped. The content of the remaining dry matter is up to 18%. The liquefied substrates are stored in appropriate tanks and, bypassing the receiving tanks, are pumped directly into the reactor by pumps.

Thanks to this technology, when using liquid manure in as the main substrate, an increase in the dry matter content in the reactor cannot be achieved [4]. Hydraulic backfill shafts. Hydraulic backfill shafts are a very reliable and technically simple solution for supplying substrates, they can be easily filled with wheel loaders. They allow even large quantities of substrate to be fed very quickly.

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