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DISADVANTAGES AND ADVANTAGES OF PUMP OPERATION WHEN TRANSPORTING MANURE

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Introduction. For a stable fermentation process from the point of view of technological biology, the ideal case is a continuous flow of substrate through a biogas plant. In practice, such conditions are unlikely to be realized, so, as a rule, the substrate is fed into the reactor in several batches during the day [1, 2]. All units required to transport the substrate must not operate continuously. This plays a key role in the calculation of the plant.

In most cases, a mixture of renewable materials, solid and liquid coenzyme is used to increase the gas yield and, consequently, the efficiency of biogas plants. This increases the amount of dry matter and impurities in the receiving tanks, so pumps and mixers should be carefully selected. Because for daily filling of methane tanks it would be enough a small pump that delivers slowly; rapid filling is more detrimental to the biogas formation process and can create high pressure zones in the methane tank if the fermented substrate or biogas cannot be displaced quickly enough. On the other hand, small, low-flow pumps clog faster. Even if it is planned to stir and fill the tanks with manure for export to the fields with the help of a universal central pump, it is necessary to have high productivity.

Main part. Analysis of the literature [1–3] has shown that for the transport of substrates that can be pumped, within the biogas plant are used mainly pumps driven by an electric motor. They are controlled by time relays or process computers, so the whole process can be fully or partially automated. In many cases, the entire substrate transport system within the biogas plant is implemented using one or two pumps located in the pumping station. In this case, the laying of the necessary pipelines is performed in such a way that all relevant technological processes (supply to the reactor, complete emptying of tanks, actions in case of accident, etc.) can be controlled by easily accessible or automatic gates.

The choice of appropriate power and characteristics of the pumps largely depends on the substrates used and their degree of preparation and / or

dry matter content (DM). To protect the pumps directly in front of them can be installed cutting and grinding mechanisms, as well as separators of impurities; pumps can also be used, in which the transport elements are equipped with suitable grinders.

When feeding the substrate to the reactor should take into account its temperature. With a large temperature difference between the substrate and inside the reactor (when feeding the substrate to the reactor after sanitation or in winter) there is a strong influence on the biology of the process, which can lead to a decrease in gas flow. Heat exchangers and heated receiving tanks are sometimes used as technical solutions in such cases.

It must be ensured that the pumps are freely available to perform the necessary work [4]. Despite the precautions taken and the substrate well prepared, the pumps can become clogged. Clogging should be removed quickly. It should also be borne in mind that the moving parts of the pumps wear out, they are subjected to heavy loads and need to be replaced from time to time. The operation of the biogas plant should not be interrupted. Therefore, the pumps should be equipped with valves, thanks to which they are isolated from the pipelines for maintenance and repair work.

Pumps are required to bridge the gap between individual biogas tanks and, if necessary, to operate hydraulic units.

Centrifugal pumps are widely available in manure equipment. They are easy to manufacture and relatively stable in operation, can be used with substrates with a DM content of less than 8 % [5]. Typical for centrifugal pumps is the strong dependence of the pump supply on the discharge pressure (or on the discharge head). The maximum achievable pressure is within 4–20 bar. The amount of injected material varies between 2 and 6 m^3/min, with an energy consumption of 3–15 kW.

But the distinguishing feature [6] of these pumps is that before commissioning the pump and suction line must be filled with liquid, or the pump must be directly immersed in the liquid, as the impeller of the pump, rotating in the air (not flooded), creates so a slight discharge that it is insufficient to lift the fluid from the lower level to the pump. The peculiarity of the structure of the centrifugal pump is that the distance between the edges of the impeller blades and the pump housing is 1–1,5 cm, which makes it impossible to create a significant vacuum, but allows the pump to start even in very dense matter.

Cutting pumps – special form of centrifugal pumps - have hardened cutting edges on the impeller and an anti-cutting plate on the body [6]. Thus, it is possible to grind substances with long fibers (straw, feed residues) con-

tained in manure. These pumps are immersed in a liquid substrate, so there are no problems with suction.

Submersible pumps of the PTS Cri-Man S.R.L. (Italy) have a large diameter inlet with a multi-channel open impeller, equipped with a powerful double cutting and grinding mechanisms. The design of the pumps is specially designed for pumping very concentrated, aggressive and heavy liquids that require pre-grinding of the solid components of the substrate. Pump failure occurs in the event of prolonged operation without fluid entering the inlet.

Plunger pump (pump with extruder). Plunger pumps are used primarily for substrates with a high dry matter content. These pumps are self-priming and more stable to pressure compared to centrifugal pumps, which means that the amount of substance that is pumped depends less on the height at which the supply is carried out. Pumps of this type can also be pumped in the opposite direction after a change in direction of rotation [7]. The first are equipped with a stainless-steel rotor running in a stator made of elastic material. Eccentric screw pumps can self-suck to a depth of 8.5 m and produce pressures up to 24 bar, but cannot pump as much as centrifugal pumps. They are also sensitive to «dry» work, solid foreign bodies or the ingress of long fibers.

In Seepex BN series pumps, actuator is flanged directly to the pump. This does not require a separate support for the pump, it becomes more compact and reduces its cost. The detachable connection of the shaft between the drive and the rotating unit facilitates the replacement of worn parts and the seal of the shaft. Uniform pumping without ripples does not require the use of additional ripple dampers or compensators in the pipelines. This makes the pumps easy to maintain. Also, these pumps can be completed with the device of protection of a stator against «dry» course (thermoelectric) that allows to prevent its destruction [6, 7].

Rotary pumps have become increasingly popular in recent years. They have two parallel-axial shafts moving in gear in different directions. The volume rotors fixed on shafts move in the closed case with small axial and radial backlashes. The rotors provide the necessary pressure for pumping the liquid, and they are designed so that in any position the suction and discharge sides are separated from each other. When the rotors roll on each other, cavities are formed, which are filled with the material being pumped. The material is captured in a circular motion and moved into the pressure pipe. The maximum pressure is within 2–10 bar [8], and the pump supply is within 0,5–4 m^3/min., power 7,5–55 kW. Compared to eccentric screw

pumps with the same power consumption, these pumps allow the pumping of more solid foreign bodies and substances containing fibers (up to 12 % dry matter). For this reason, they are increasingly used in plants that work with high amounts of fibrous material, energy crops or sparse and crushed solid manure as a substrate.

Conclusion. Daily one-two-time filling of the fermenter with modern pumps, as a rule, does not meet the needs. With this feed at once in the methane tank receives a large amount of cold substrate, they are constantly clogged with fibers. The way out is to turn on the productive pump only at short intervals when filling the methane tank or to use a plunger pump with a speed switch (drive with power take-off shaft, multi-speed electric motor or gearbox).

REFERENCES

1. Komar, A. Definition of priority tasks for agricultural development / A. Komar// Multidisciplinary research. – Bilbao, 2020. – P. 431–433.
2. Podashevskaya, H. Directions of automation of technological processes in the agricultural complex of Ukraine / H. Podashevskaya. – Минск: БГАТУ, 2020. – С. 519–522.
3. Boltianska, N. Directions of increasing the efficiency of energy use in livestock / N. Boltianska // Current issues of science and education. – Rome, 2021. – P. 171–176.
4. Skliar, A. Justification of conditions for research on a laboratory biogas plan / A. Skliar // Motrol: Motoryzacja i Energetyka Rolnictwa. – 2014. – Vol. 16, Nr. 2. – P.183–188.
5. Boltianska, N. Measures to improve energy efficiency of agricultural production / N. Boltianska // Social function of science, teaching and learning. – Bordeaux, 2020. – P. 478–480.
6. Skliar, R. V. Substrate management in biogas plants / R.V. Skliar // Молодь і технічний прогрес в АПК. – Харків: ХНТУСГ, 2021. – С. 260–262.
7. Skliar, R. Basic elements of a process line for anaerobicaerobic treatment of pig complexes manufactures / R. Skliar // Технічний прогрес у тваринництві та кормовиробництві. – Глеваха, 2020. – P. 89–91.
8. Sklar, A. G. Energy efficiency analysis of methane tank /A. G. Sklar // Proceedings of the Tavriya State Agrotechnological University. – 2015. – Vol. 15, Nr. 2. – P. 316–322.

Аннотация. Приводится сравнительных анализ современных и наиболее часто использующихся насосов для транспортирования навоза при работе биогазовых установок. Описаны особенности их работы в зависимости от качества исходного сырья, а также преимущества и недостатки.

Ключевые слова: насос, биогаз, навоз, сухое вещество.