The immovable mixers for the dosing of the substrate on the biogas plants

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Abstract: *In this paper the solutions, types and groups of immovable mixers for the dedicated biogas power plants, as well as the connections (calculation) of the pipes for the transport of the substrata from the mixer to the digester are presented.*
The continuous feeding on biogas devices represents the challenge with which every producer of the electricity, more precisely, of the biogas device, is faced.
Apart from numerous research, the feeding with the immovable mixers for the dosing of the mass, turned out to be an adequate and the most economical solution.
The using of the immovable mixers with the direct inserting of the mass into the digester represents the most effective way of feeding the biogas devices which have the need for the solid matter and it does not have the liquid preparation. The new way of feeding is ideal for the biogas devices which have diagonal mixers in the digesters and which can follow the dosing of the immovable mixers.
Keywords*: IMMOVABLE MIXER, SUBSTRATUM, BIOGAS DEVICE, DIGESTER*

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1. Introduction

The biogas plant is a renewable energy source and it has its place in the modern energetics of the 21st century. It enables a stable supply of electricity and heat, without affecting the environment with emissions, and it has a long-term support of the European Union [1-3]. In addition to the primary task of energy production, biogas plants also have a role in protecting the environment, not only by reducing the greenhouse effect, but also by eliminating agricultural production waste and biodegradable municipal waste. The controlled process of anaerobic fermentation is the basic technology on which the biogas plant is based [4-6]. Anaerobic fermentation is a biochemical process in which complex organic compounds are decomposed by the action of different types of bacteria in anaerobic conditions (without the presence of oxygen) and the organic matter is converted to energy-rich biogas by heating and mixing. The properties and composition of biogas depend on the type of substrate, the method of production, the type of plant, the temperature at which the process took place, the duration of hydraulic retention, the volume of the digester and other factors [6-9]. The energy value of biogas is chemically bound in methane. The average calorific value of biogas is about 6.5 MJ / m3.

Raw materials for biogas production can be: animal manure, green mass (plants), corn silage, expired food products (if hygienically safe), rotten seeds, beet pulp, molasses, fruit pulp, residues from vegetable and fruit processing, seeds, peel, fallen fruit, leftovers, residues from the beer industry, residues from milk and cheese production, residues from oil production, etc.[1, 10, 11]

Biogas Composition: methane CH4 ca. 50 - 75%, carbon dioxide CO2 ca. 25 - 50%, nitrogen N2 ca. 0 - 3%, hydrogen H2 ca. 0 - 1%, oxygen O2 ca. 0 - 1%, hydrogen sulfide H2S ca. 0 - 2%. The composition of the biogas is generally affected by the substrates used, the fermentation process and various technical performances. The goal of the plant is the production and delivery of electricity in the public network, as well as the use of thermal energy as an accompanying product for internal purposes [5, 7, 10].

Biogas installation is a clean and logical way to generate and sustain energy from agricultural resources.

The biogas producer strives to produce more energy with a minimum amount of mass input [10,12].

2. Material and method

2.1 Substrate preparation

The method and scope of substrate preparation, on the one hand, affect the general usability of the substrate in terms of the content of undesirable substances, so that they have a direct impact on the availability of technical equipment of the plant. In addition, an adequate preparation process can positively affect the course of the fermentation process, and thus the utilization of the energy potential of the substrates used. With the fragmentation of the substrate, the substrate surfaces are prepared for biodegradation and thus for methane production.

In principle, one can start from the fact that with the increased degree of fragmentation, the rate of biodegradation increases, but not necessarily the gas yield. Among other things methane production is influenced by fermentation time and the degree of fragmentation. Therefore, great attention must be paid to the use of adequate technical devices.

The solid substrate shredder can be installed externally before feeding into the pit, piping or fermenter. For this, shredders, mills, crushers as well as shafts and augers with tearing devices and blades are available.

Fragmentation can be done, among other things, by means of separate mixers with an integrated shredding device in the pit which is connected upstream from the fermenter in the process line [13].

There are stationary mixers with vertical coils and capacities from 10 to 80 m³, which will be explained in great detail in this paper.

2.2 Technical description of vertical mixers

So far, it has been shown that the company "Trioliet" has a solution for the most economical and above all adequate technology for feeding digesters. Trioliet vertical mixers type SOLOMIX (Fig. 1, Table 1) are excellent for feeding biogas plants [13].

The machine is equipped with one drain door as standard, it contains two augers for mixing with a planetary drive mechanism driven by one or two electric motors, four height-adjustable brackets with the option of installing scales for different installation options and two manually operated counter knives (Figure 2).

There are:

1. Mixers with 15 mm winding / 18 mm auger wings (1200 - 2000)

2. Mixers with 22 mm thread / 25 mm auger wings (from 2400)

Trioliet vertical mixers are excellently suitable for feeding biogas plants. All Trioliet stationary mixers have a highly stable auger supported by the integrated frame. Consequently, all forces extended on the mixing auger are directly taken up by the frame. This design relieves the mixing chamber bottom and the gearbox. The compact and closed planetary drive ensures a constant and controlled rotating movement of the cutting mixing auger. The auger runs in a maintenance-free conical roller bearing at the top and a sinter slide bearing at the bottom. The optimum auger shape ensures quick and homogenous mixing at a low power requirement. Just above the bottom, at the lower end of the mixing chamber wall where the pressure on the wall is highest, a special Trioliet wearing ensures stability and a long service life.

Fig. 1. *Fixed dosing basket with mixers [13]*

Fig.2. *Interior design of the dosing basket [13]*

There are mixers that provide:

(A) Feeding in standing digesters.

(B) Feeding into semi-underground soil digesters.

(C) Feeding into underground digesters.

Fig.3. *Types of mixers [13]*

The substrate dosing basket on the biogas plant is made of steel and protected with epoxy coatings. Total working volume V = 8m^3, maximum silage tonnage Q = 6.8t. The basket is equipped with a spiral for removing silage and a spiral for overturning and dispersing it. Basket dimensions (Length x Width x Height): 7.5 x 2.5 x 2m.

In Table 2, the dimensions of the Triolet for the existing gas plant are given

Table 1*: SOLOMIX 2 basket types and dimensions*

Type Solomax 2	1200	1600	2000	2400	3000	3200	4000
Capacity (m^3)	12	16	20	24	30	32	40
Length (m)	4,21	4,6	5,2	5,72	5,72	6,56	6,56
Length with motors (m)	5,24	5,59	6,28	-	-	-	-
Width (m)	2,15	2,29	2,44	2,44	2,44	2,80	2,80
Width with motors (m)	-	-	-	3,67	3,67	3,84	3,84
Height (m)	2,55-2,85	2,85-3,15	2,85-3,15	2,77-3,07	3,35-3,65	2,75-3,05	3,35-3,65
Weight (kg)	3.400	4.300	5.400	6.400	7.600	9.400	10.000
Maximum load (kg)	6.000	8.000	10.000	12.000	15.000	16.000-20.000	20.000
Number of coil blades	4	5	5	6	6	9	9
Coil diameter	Ø1500	Ø1700	Ø1960	Ø2200	Ø2200	Ø2660	Ø2660
Electrical installation required	Soft-start device	Soft-start device	Soft-start device	Soft-start device	Soft-start device	Soft-start device	Soft-start device
Required power of electric motor	15	22	30	2x15	2x18.5	2x22 2x30	2x30

Table 2: *Triolet dimensions for an existing gas plant*

Triolet	Value	Unit
Length	6558	mm
Width	2792	mm
Height	3643	mm
Total volume	40	m^3

Triolet is used for receiving and mixing fresh matter - substrate. It contains two devices for mixing freshly introduced substrate and each of them has 9 knives.

Two electric motors are used to drive the mixer, each with a power of 30 kW. The basket also includes a helical conveyor. The first on the pull-out is the horizontal Ø300mm, and the length is 3000mm, whose drive is an electric motor with a power of 5.5kW, the number of revolutions of the drive is 56. The second vertical is the total length of 7900 mm, Ø300mm. The third is oblique and it is inserted into the fermenter at an angle of 45 ° in relation to the horizontal, its length is 2500mm and Ø300mm, it is powered by an electric motor with a power of 5.5kW and it is in a special version [13].

3. Results of research and discussion

The location of the mixer is within the biogas plant. A universal system for receiving silage from the Triolet basket with the addition of liquid from the previous thickener and transport with a screw pump is given. Input data is obtained by the user depending on the needs of the plant. In addition to the capacity and other input parameters, the required pipeline diameter must be calculated with the length of the section for supplying the Premix System (devices for crushing and mixing various solids with liquid) [12].

The mass from the mixer basket is inserted with a spiral into the PreMix system. The SOLOMIX 2 basket is equipped with a measuring scale, a force meter and in this way the daily feeding doses are determined. The speed and operating time of the substrate dosing system is harmonized with the operation of the existing plant and the drawing capacity of the centrifugal pump in the pumping station.

3.1 Determination of pipeline parameters for substrate transport from baskets to digesters (2)

The tube DN200, Ø200 SDR17 made of polyethylene PEHD is acquired. The thickness of the wall of the tube is 11.9 mm.
The necessary volume- flow of the mass is

$Q_v = 35 m^3/h = 0.0097\ m^3/s$

For the acquired tube, the velocity of the circulation is:

$$v = \frac{Qv*4}{d^2*\pi} = \frac{0.01*4}{0.176^2*\pi} = 0.41 \text{ m/s}$$

The fall of the pressure at the section whose length is 30 m is:

$$\Delta p = \rho*\lambda*\frac{L}{d}*\frac{V^2}{2} = 990.9*0.013*\frac{0{,}41^2}{2} = 185 \text{ Pa} = 0.0018\text{bar}$$

In the table 3 are given the results of the calculation of the pipeline-substratum.

Table 3: *The results of the calculation of the pipeline- substratum*

Working conditions		
Working medium		Ferment - Substratum
A state of matter		Liquid
Volume- flow	m^3/h	35.0
The flow of mass	kg/h	34650
Density	kg/m^3	990.919
Dynamic viscosity	10^{-6} kg/ms	1.5
Kinematic viscosity	10^{-6} m^2/s	0.002
The elements of the pipeline		
The mark of the pipeline		PE HD - Substratum
The form of the pipe		Round pipe
Number		1
The dimensions of the pipeline	SI	The diameter of the pipe D in mm: 200.0
		The length of the pipe L in mm: 30.0
The results of the calculation		
Velocity	m/s	0.41
Reynold's number		9.346E+07
The type of the circulation		turbulent
Roughness	mm	0.03
Abrasion coefficient		0.013
Ceta value		7.778
The fall of the pressure	bar	0.0018

4. Conclusion

The paper describes the significance and application of the Triolet Type Solomax 2 mixer, as part of a biogas plant. The selection of a

mixer of appropriate capacity for feeding PreMix systems and existing digesters was performed, as well as the calculation of pipeline parameters for substrate flow.

The conclusion of this paper is that using stationary mixers with direct injection of mass into the digester is the most efficient way of feeding biogas plants that need solids. The new feeding method is ideal for biogas plants that have inclined mixers in digesters and that can monitor the dosing of the immovable mixers.

The advantages of these systems are seen in the fact that they do not require the continuous servicing of the basket itself, they are mounted easily and fast, they have the long-term duration.

5. References

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