Bio and natural gas use to micronize grain by applying infrared heating system with heat capacity of 300 kW

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Background

The issues of providing cattle with ecologically clean forage and of environmentally safe recycling of cattle biowaste are considered most important in modern cattle breeding, and for swine breeding, where biowaste is highly toxic and requires processing, in particular.

Technological solution

The authors have developed a locked model of piggery waste processing with biogas production, which is used partly in grain micronization and partly in heat and power generation. It is also possible to use part of biogas as fuel for natural gas vehicles. One of the key elements of this model is the grain micronizer, which produces forage for swine.

Grain micronization is a process of heating up the grain layer to a certain temperature during its preparation and further lamination. The goal of this processing is the increase of food-value and sanitary characteristics of the processed grain. This technology could be used on mixed feed plants, grain processing plants, agricultural facilities and food processors.

Within the scope of this work, a unit was created with a capacity of 2 tons of processed grain per hour. This capacity is considered optimum for future use in swine farms in Russia. The infrared heating system was developed for this unit. Its total heating capacity is 300 kW.

The technical specifications of the infrared heating system are shown in Table 1.

Table 1 – Technical specs of the IR heating system of the micronizer

Parameter	Unit	Value
1	2	3
Fuel type	–	Natural gas
LHV	MJ/cm	16,8 – 56,1
Nominal heating capacity	kW	300
Minimum heating capacity	kW	268
Gas flow rate in nominal mode	Cm/h	32
Input gas pressure, min.	kPa	7,0
Mixer input gas pressure, min.	kPa	3,5
Nominal air flow rate, max.	Cm/h	400
Input air pressure in mixer at nominal heating capacity, max.	kPa	3,5
Air/Fuel ratio	–	1,05 – 1,15

Parameter	Unit	Value
1	2	3
Heating up time of emitting surface of the burner, min.	minutes	4
Temperature change range of emitting surface of the burner	°C	800 – 960
Radiating efficiency at nominal heating capacity, min.	%	35
NOx emission in dry flue gas at air/fuel ratio of 1.0 at nominal heating capacity, max.	mg/cm %	40 0,002
CO emission in dry flue gas at air/fuel ratio of 1.0 at nominal heating capacity, max.	% mg/cm	0,02 250
Overall dimensions max. width height length	mm	 1573 2200 5400
Mass, max.	kg	720

The main element of the IR heating system are 40 IR burners (GIK-8), developed with the authors' participation. The GIK-8 burner is specially designed to burn gas with high LHV. On the farms, where biogas is produced, these burners are tuned to its use. A combined use of natural gas and biogas is also possible.

The burner provides homogenous dispersion of the air-fuel mix as well as equal heating of the grain. It also provides the absence of local overheating for some zones. There is also a number of options of heat utilization for the needs of the piggery.

The high accuracy of tuning of these burners allows achieving of good emission values.

Operating principle of the burner part of the micronizer

The micronizer consists of two main parts: a grain container and a heating unit. The grain heating unit system is shown on Figure 1.

Natural gas is delivered to tap (pos. 1) after the gas reduction station. The gas is then filtered (pos. 8), registered (pos. 9) and sent to the pressure regulators (pos. 13 and 14). An additional bypass is also provided for the launch of the burners. The air from the ventilator flows through the slide valve (pos. 7) to the mixer (pos. 15). The air-fuel mix flows to the burners (pos. 19) through the compensating bellow sealed insert and the collector (pos. 19)

The ignition of the IR system starts as follows:

- The air ventilates the system for 3 minutes.
- Natural gas is then delivered by opening the main and bypassing lines.
- The air-fuel mix fills the system for 5 seconds.
- The ignition electrodes launch the first rows.
- After the burning starts on the first burners, the flame starts its spread from one burner to another.
- After the burning has started on the last burners, the bypass is turned off.

Conclusions

These technologies allow creation of a locked effective waste processing cycle for piggery with biogas production, which in full, or partly, in combination with natural gas, fulfills the demand for the autonomous forage production cycle for the swine farms.