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«Study of the biogas plant with catalytic heating»

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Catalytic devices for complete low-temperature oxidation of combustible components of biogas can be used in existing systems instead of traditional flame devices. The advantages of catalytic heaters in comparison with traditional heaters:

1) The completeness of fuel combustion, which contributes to an increase in the efficiency of the combustion process;
2) Reduction in the temperature of the combustion process, which provides the structural advantages of catalytic heaters;
3) Reduction of harmful gas emissions to the atmosphere due to a decrease in the combustion temperature;
4) Reduction of the minimum fuel concentration in the mixture to 0.5% of the volume.

The complete combustion of fuel in catalytic heaters allows obtaining exhaust gases that do not contain oxygen and products of incomplete combustion. Such smoke fumes are neutral to anaerobic bacteria involved in the process. At the same time, a decrease in the temperature of the combustion process makes it possible to reduce the heat losses from the heated surfaces of the catalytic heater. Thus, the use of catalytic heaters in biogas plants makes it possible to increase the efficiency of their operation.
The technological process parameters (the intensity of substrate mixing, the temperature of the heated gaseous heat-transfer material, the temperature of the heating layer) were selected as input control factors of the natural experiment. The range of variation in the intensity of mixing of the substrate was 0.24-0.29 (when converted to a flow of bubbled gas - 160-200 liters per min). The output values of the natural experiment were the deviation of the average temperature in the biogas plant from the optimal, the mean square deviation of temperature in the biogas plant, and the fuel consumption by the catalytic heating system.

According to the experimental data, a decrease in the intensity of mixing by 17% leads to an increase in the stability of the temperature conditions in the biogas plant by 16%, an increase in the uniformity of the temperature conditions by 3% and reduction of fuel consumption by the catalytic heating system by 2%. Similarly, a decrease in the temperature of the heated gaseous heat-transfer material by 25% leads to an increase in the stability of the temperature conditions in the biogas plant by 71%, an increase in the uniformity of the temperature conditions by 7% and a reduction in fuel consumption by a catalytic heating system by 10%. An increase in the temperature of the heating layer by 40% to the temperature of the chosen thermal regime leads to a decrease in the stability of the temperature conditions in the biogas plant by 60% and an increase in the fuel consumption by the catalytic heating system by 30%; however, the uniformity of the temperature conditions increases 60 times.
Experimental studies of the designed biogas plant with catalytic heating showed the applicability of the proposed technical solutions for the catalytic heating system. In the course of the study, an experimental prototype of a biogas plant with catalytic heating was developed, which allows processing 16 kg of liquid organic waste per day with the thermophilic digestion of biogas with an average yield of it of 0.24 $m^3$ per day.

Rational parameters of the catalytic heating system in terms of stability, uniformity of temperature conditions in the biogas plant and fuel consumed by the system are the minimum values of the mixing intensity and of the temperature of the heated gaseous heat-transfer material, and the maximum temperature of the heating layer.
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