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Application of biogas installation to production of electric power in Szczecin

Urban waste contains vast quantities of organic waste that can be utilized and thus, contribute to diminishing ecological dangers. One of the ways of utilizing urban waste is its transformation into biogas first and then into electric energy.

The process of anaerobic fermentation, through which biological degradation of waste leads to the production of inflammable gas known as biogas, is a well-known phenomenon. Biogas, depending on the kind and content of waste, contains many elements, many of them inflammable, that can be used directly to power gas engines driving electric generators. During biogas utilization through energy reclaiming there occur many complications that create a great number of possible solutions. Production of electrical energy coming from biogas leads to many considerations referring not only to the possibility of synchronous or asynchronous generators application, but first of all, to problems connected with cooperation with power network, problems with the control system and the construction of the applied devices.

Municipal rubbish dump in Szczecin - Klucz, covering the area of about 5 hectares, producing biogas containing about 70 per cent of methane, supplies about 400kW of electrical power into the network. It is possible because of the application of two power generating units 26H12 and 78H12 produced by PZL Wola. Thirty gas wells, 12 meters deep each, through drainage pipes PE 100mm and collectors degas and aid the recultivation of the rubbish damp. Production of the electrical energy is possible because of the application of synchronous generator cooperating with the power network. The application of this generator results in the need of using other safety devices. It is planned to increase the production of energy through the application of the next two generators.

The analysis of work of biogas power plant without differentiating the types of electrical energy generators enables to determine the basic tasks of the metric and control systems. This is, first of all, parameter control of the gas engine which includes temperature and pressure of lubricant oil, flow and temperature of liquid cooling the cylinders, content of gas mixture and exhaust fumes, signaling point temperatures of the engine, gas supply parameters, loading state and network synchronism.

To use biogas energy optimally there should be used such control systems that would balance the economy of the biogas powerplant construction and its maximum efficiency. Gas

engine characteristics at different biogas parameters (pressure, flow, and methane figure) in rotational speed of a shaft function has one extremum. The value of this extremum, together with the growth of qualitative gas parameters, gets to higher rotation speed of a shaft. This dependence points to the advantage of asynchronous engines over synchronous in this particular situation. Combined with the lower price of the asynchronous engines, it seems obvious that the only aspect that can influence the biogas power plant work would be the construction of its control system.

To estimate the parameters and the control system structure in a biogas power plant is not an easy process. It is necessary to control not only the above mentioned gas engine parameters, but also to control some additional parameters such as: the content of combustible mixture depending on methane figure, the content of weak mixture whose index of air excess is between 1.5 - 1.7 (so called lambda window), meeting the requirements of TA-Luft, etc, and control of ignition system which enables the regulation of ignition angle of advance individually for each cylinder. The above mentioned problems can be solved by the application of the advanced, adaptable control systems such as 'fuzzy logic' and neuro - fuzzy logic.

In adaptable systems, the information knots about process parameters have different functions. In neuron networks, neurons represent only their transfer function, whereas in adaptable networks, apart from the variety because of capability of adaptation, they influence their general function. It results in the fact that the structure of the control system, the so-called 'mapping' depends on data gained during both controlled and self-induced learning.

Dynamic non-linearity of such a process as accumulated in biogas energy reclaiming results in greater attention put on the value of the electrical energy parameters while distributing the energy. Thus, the control system of the biogas power plant should be responsible not only for parameters connected with biomechanical technology, but also for frequency, voltage, phase (phase sequence, synchronization) and tg φ, imposed by the recipient of the produced energy. Technical and connecting network conditions, also determining requirements of safety automatics in, for example, non-voltage conditions, make that classical control systems in order to satisfy the requirements should be very developed. Neuro fuuzy logic systems seem to be both an economical and technological solution not only in case of boigas power plants, but also wind or water power plants, where we deal with non - linear forced signals and the necessity of control of many process factors (pitch control). Analyzing the whole process of electrical energy reclaiming from urban waste, we can admit that it is an optimal way of waste utilization - simple in its idea and a little more complex in control. To start the biogas power plants certain financial investments are necessary for the infrastructure, but soon they are paid back.