UDC 621.31

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SUPPORT FOR THE FUNCTIONING OF THE GAS TURBINE COGENERATION SYSTEM ON BIOGAS FUELE

Abstract. The structural scheme of maintenance of the network water temperature in the conditions of operation of the gas turbine cogeneration system on biogas fuel with the use of a heat pump for which a fermented wort is a low-energy source of energy is proposed. Making decisions on the change of the number of plates of the heat utilizer when measuring the temperature of the gases at the inlet to the heat utilizer and the temperature of the return water allows, for example, to operate a cogeneration system with a capacity of 65.5 MW to reduce the cost price of the produced energy to 20-30%.

Keywords. Operation support, cogeneration system, decision making.

Introduction. In the conditions of the operation of cogeneration systems using biogas a special approach requires the support of the ratio of electricity production and heat production with round-the-clock functioning of biogas installations and not constant energy consumption [1–3]. The energy-saving technology of functioning of a biogas plant with the use of a heat pump, a low-energy source of energy for which there is a fermented wort, has been developed [2].

The purpose of the work. Develop a structural scheme for maintaining the temperature of the network water as part of the dynamic system: gas turbine cogeneration unit – heat utilizer for making decisions on the change of the heat transfer surface of the heat recovery unit in conditions of support of the functioning of the biogas installation using the heat pump.

The main part of the work. The prediction of change in the temperature of the network water during the measurement of the temperature of the gases at the inlet to the heat utilizer and the temperature of the return water is proposed. The starting data of the gas turbine cogeneration system type UGT 25000C with a total capacity of 65.5 MW were selected. Heat utilizer – plate heat exchanger type PO, 35-F-1.6 / 1.0-1 with gaskets type PON-500/T. The mathematical model of dynamics of the system is developed: gas turbine cogeneration unit – heat utilizer [3]. The transfer function of the channel: "the temperature of the network water – the temperature of the gases", obtained as a result of the solution of the system of nonlinear differential equations, allows us to estimate the change in the temperature of the network water both in time and along the length of the heat utilizer when the temperature of the gases is changed. The following levels of operation of the gas turbine cogeneration system have been established in accordance with the change in the temperature of the gases at the inlet to the heat utilizer and at the outlet of the heat utilizer: the first level: 490 °C ... 93 °C; second level: 480 °C ... 93 °C; the third level: 470 °C ... 93 °C. The established levels of operation correspond to changes in the number of plates: 36, 38, 40 and the change in the flow of gases: 79.8 kg/s, 81.9 kg/s, 84.1 kg/s, respectively. On the basis of the mathematical description of the support of the operation of the heat utilizer [3] it is possible to obtain a functional summary information (1–4) (Fig. 1). For example, the summary information (1), (2) is obtained. which characterizes the discharge or charge of a biogas plant, respectively, and is accompanied by a decrease or increase in the power of the compressor of the heat pump:

$$(CT_{\text{c}}(\tau)(\Delta t(\tau)/\Delta t_{\text{c.e.f.}}(\tau) < \Delta t_{\text{c.e.lev.}}(\tau)/\Delta t_{\text{c.e.f.}}(\tau) > 0)), \quad (1)$$

$$(CT_{\text{c}}(\tau)(\Delta t(\tau)/\Delta t_{\text{c.e.f.}}(\tau) > \Delta t_{\text{c.e.lev.}}(\tau)/\Delta t_{\text{c.e.f.}}(\tau) > 0)), \quad (2)$$

where t is the temperature of the network water, K; CT is the event control; τ is the time, s. Indices: c – control work ability; c. e. f., c. e. lev. – the constant estimated value of the temperature of the network water of the first level of functioning, the level of functioning, respectively.

In these conditions, it is necessary to decide on the charge or discharge of the cogeneration system in relation to the change of the heat transfer surface of the heat utilizer on the basis of the change in the number of plates (Fig. 1). The same is the summary information regarding the assessment of change in the temperature of the network water:

$$(CT_{\text{c}}(\tau)(\Delta t(\tau)/\Delta t_{\text{c.e.f.}}(\tau) \leq 0 \quad (3)$$

predicts a non-permissible change in the temperature of the network water if the temperature of the gases is within 180 °C – 93 °C. Such conditions require a decision to support the shipment of fermented wort and the loading of fresh material using an information evaluation:

$$(CT_c(\tau)(\Delta t(\tau) / \Delta t_{c.e.f.}(\tau) \geq 1 \quad (4)$$

concerning entering into the admission of the first level of functioning of the cogeneration system on the basis of connecting 36 heat-utilization plates and supporting the operation of the biogas plant.

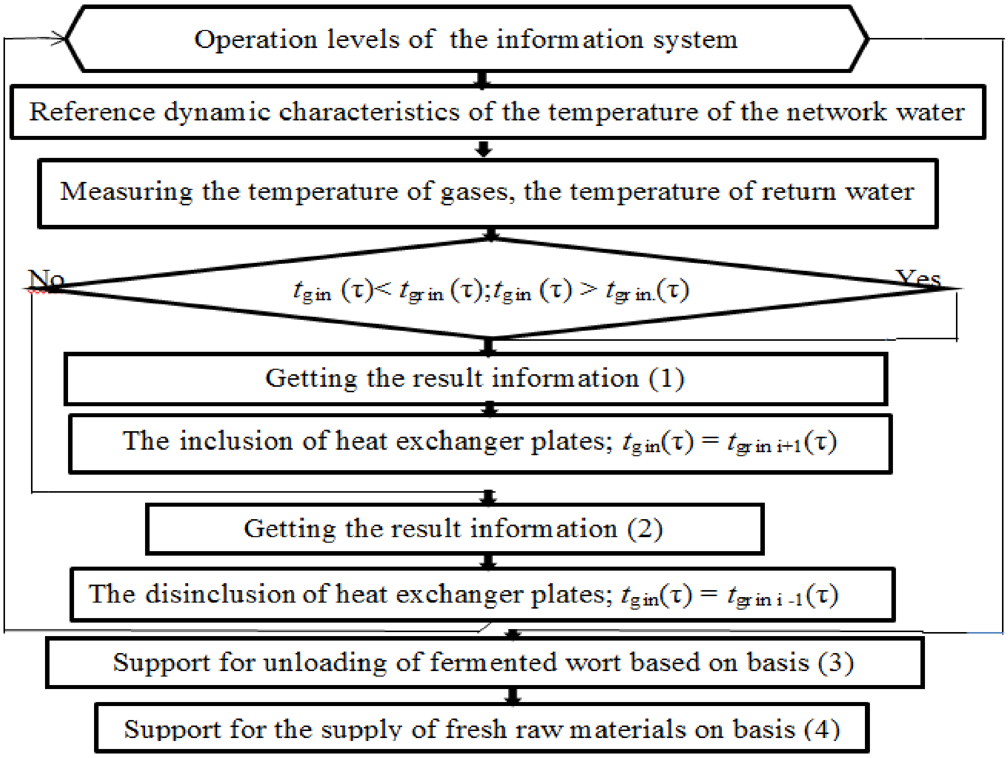

Fig. 1. The block diagram of decision-making on supporting the functioning of the cogeneration gas turbine system on biogas fuels

In Fig. 1: $t_{g\ in}$, $t_{gr\ in.}$ – functional and reference temperature of gases at the inlet to the heat utilizer, K; $t_{rw\ in}$, $t_{rwr\ in.}$ – functional and reference temperature of return water at the inlet to the heat utilizer, K; τ – time, s; i – number of levels of functioning

Conclusions. The developed structural scheme allows obtaining an integrated assessment of the change in the temperature of the network water [3], which is based on the proposed technology of biogas production using a heat pump, for which the fossilized wort is a low-energy source of energy. It is this technology due to the additional development of biogas can increase the commerciality of the biogas plant and reduce the cost of production of electric energy and heat within 20–30% [2].

References

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