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BIOGAS POWER PLANT FOR ENERGYSAVING TECHNOLOGIES

The comparison of different cycle parameters of various biogas units (i.e. a combustion turbine unit, a combined cycle gas turbine unit with gas discharges into the boiler and a combined cycle gas turbine with a high-temperature vapor generator and a reheating stage) was made, and the comparison of their exergy characteristics was carried out. The results of exergy analysis had demonstrated that the cycle of biogas CCGT (combined cycle gas turbine) with a reheating stage and using a high-pressure steam generator is the most effective, that can be explained by the fact that the thermal energy proportions of combustion products, accounting for the steam cycle and the gas cycle are approximately equal, comparing to conventional combined cycle gas turbine units.

Keywords: *exergy characteristics, biogas unit, combined cycle gas turbine, high-temperature steam generator, reheat of steam.*

Advantages of biogas power plants (BPP) which are an alternative to traditional power plant, they have not received wide distribution yet [1].

First of all, this can be explained by the fact that in the case of using the natural gas, the costs of maintaining facilities are minimal, while the use of biogas involves difficulties with poorly predictable expenses for collection, transportation, storage and preparation of raw materials [2]. In such way substitution of traditional fuels by biogas is economically viable in areas that are located near objects of agricultural production where there are developed infrastructure of collecting and preparing biomass for BPP [3].

Secondly, the expedience of using an alternative fuel is determined by thermal efficiency of power installation.

One of the ways of increasing the thermal efficiency of biogas technologies is the use of combined-cycle power plants (CCPP) [4].

For analyzing the effectiveness of various thermal schemes of biogas CCPP can be used the exergy method [5] that is a universal method for evaluating the rational use of

energy. An exergy analysis identifies the causes of thermo-dynamic inefficiencies and enhances understanding of energy conversion processes in BPP.

The results of numerical simulation of an exergy parameters of various schemes of BPP show that: gas turbine efficiency equal 21%; CCPP with the gas discharge to the steam generator – 37%; CCPP with the high-temperature steam generator and intermediate super heater –47% (Fig. 1).

Exergy analysis shows that that biogas CCPP with the high-temperature steam generator and intermediate super heater is the most effective because proportions of thermal energy of combustion products, accounting for the steam cycle and for the gas cycle are approximately equal, comparing to conventional combined cycle gas turbine units. In the traditional combined cycle plant it's possible to increase efficiency due to high potential gases at the outlet of the gas turbine flowing to the steam generator with further it's feeding to the steam turbine. However, proportions of the thermal energy of combustion products for steam cycle are about 3 times less than for gas cycle [6].

Thermal scheme of biogas CCPP with the high-temperature steam generator and intermediate super heater enables to correct this deficiency due to high-temperature steam generator, which realizes the same amount of thermal energy of combustion products, as steam generator at the outlet of the gas turbine. Therefore, the proportion of the thermal energy of the combustion products consumed by steam cycle is doubled [7]. As a result of redistribution of thermal energy of the combustion products between the gas cycle and the steam cycle in favor of the steam cycle, as more efficient, the efficiency of combined cycle power plant increases in comparison with conventional scheme by 6% [8].

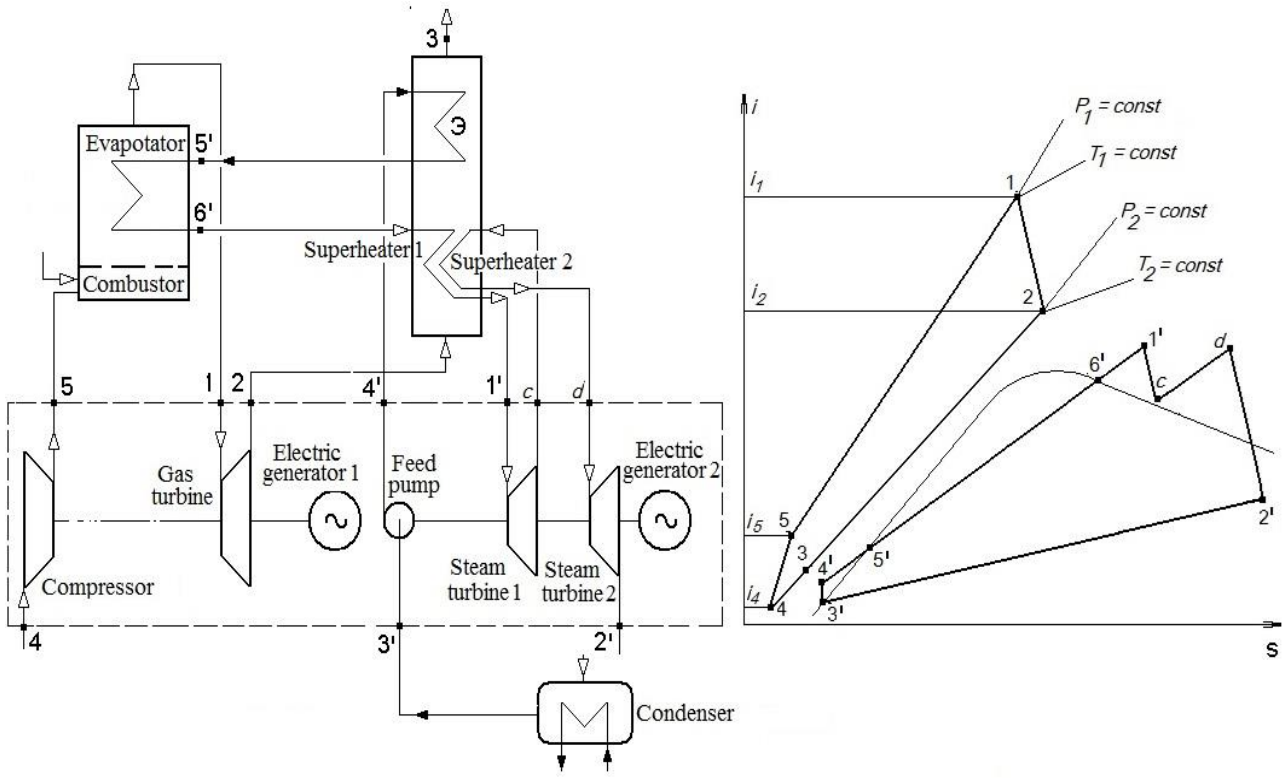

Fig.1. Scheme and the cycle of biogas CCPP with the high-temperature steam generator and the intermediate super heater

Results of numerical simulation shows that at optimal parameters of working fluid efficiency of biogas installation with the high-temperature steam generator and intermediate super heater increases by 10 % comparing to conventional combined cycle gas turbine units [6].

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