P a r t 7

ENERGY SAVING

7.2. Application of expander-generating apparatuses in process of using the technological pressure drop at natural gas conveying

7.2.3. Inclusion of EGA in heat flow diagrams of power plants

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Let's consider several general flow diagrams of EGA application at power plants. We'll consider the cases when gas is heated only before the expander and EGA is included in the heat flow diagram of TPP.

7.2.3.1. Condensing power plants (CPPs)

The heating environment in EGA is steam of one of the heating bleed-offs of the turbine (fig. 7.8).

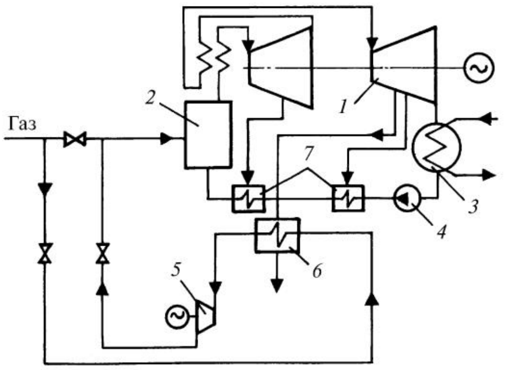

Fig. 7.8. Principle flow diagram of EGA inclusion in heat flow diagram of CPPs:
1 — turbine; *2* — boiler; *3* — condenser; *4* — pump; *5* — expander with generator; 6 — gas heater; *7* — regenerating heaters

Different options of EGA application are possible at power plants with turbines of condensing type, which depend on CPP operation mode, and also on power system operation mode, being a part of it. Let's consider two the most important options.

In the first option after inclusion of EGA in heat flow diagram, electric capacity of CPP doesn't change. For this, a capacity of steam turbines after EGA inclusion should be decreased by value of additional capacity, generated by EGA, due to changing the steam consumption for turbines and by correspondent changing the fuel consumption in boilers.

This option of EGA application is characteristic for power plants, operating in power systems with excess capacity.

In the second option EGA is included in the heat flow diagram of CPP at constant (nominal) steam consumption for turbines. Such mode of EGA application is characteristic for power plants and power systems, operating with deficit of power capacity. By this, a decrease in electric power, generated by turbo-installation, will occur because of steam consumption reduction into turbine sections, located lower than a bleed-off. But additional electrical power will be generated at EGA. Changing of the total power plant generation ΔN_{CPP} will be positive, if additional power, generated by EGA, exceeds the loss of steam-turbine plant generation.

Calculations, made for power units К-300-240, show that at inclusion of EGA in heat flow diagram of power unit, the specific consumption of reference fuel for power generation can be decreased approximately by 2…3 g/(kW·h.)

7.2.3.2. Combined Heat Power Plants (CHPPs)

Let's consider several basic flow diagrams of EGA application at power plants. We will consider the cases when gas is heated only before the expander and EGA is included into heat flow diagram of TPP.

A heating environment in the heat-exchanger of gas heating is the heating water from CHPP (fig. 7.9).

After the heat-exchanger of gas heating the heating water is fed to the pipeline of return heating water. To maintain a constant heat load of CHPPs, and also a heat schedule in this case it's necessary either to supply an additional amount of steam to the "head" of the turbine, or change the diaphragm location.

According to the estimations made, increase in CHPP efficiency on power generation at inclusion of EGA in its heat flow diagram, strongly depends on a type of schedule (thermal or electric), according to which CHPP operates, and can make 0,5…0,8 %.

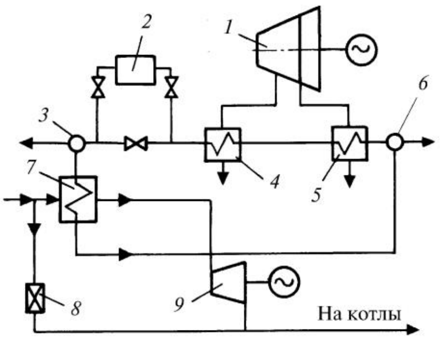

Fig. 7.9. Principle flow diagram of EGA inclusion in heat flow diagram of CHPP: *1* — turbine; *2* — peak water-heating boiler (PWB); *3* — collector of the heating water; *4* — horizontal district heater HDH-2; *5* — HDH-1; *6* — collector of return heating water; *7* — heat-exchanger of the gas heater; *8* — GDS; *9* — EGA; на котлы – to boilers

7.2.3.3. Steam-gas installations (SGIs)

Let's consider several basic flow diagrams of EGA application at power plants. We will consider the cases when gas is heated only before the expander and EGA is included into heat flow diagram of TPP.

Today in order to increase the economic efficiency of power and heat generation, different options of steam-gas technology application are considered. By this, application of SGIs as initial elements of TPPs, and also using of steam-gas technology for modernization of the existing power units by raising gas-turbine installations (GTI) is supposed. Efficiency of several options of SGI flow diagrams can be increased by inclusion of EGA into its structure. Such flow diagrams can be ones, in which not only the heat of GTI flue gasses is supplied to the furnace, but also a fuel is additionally combusted. The possible flow diagram is shown in fig.7.10.

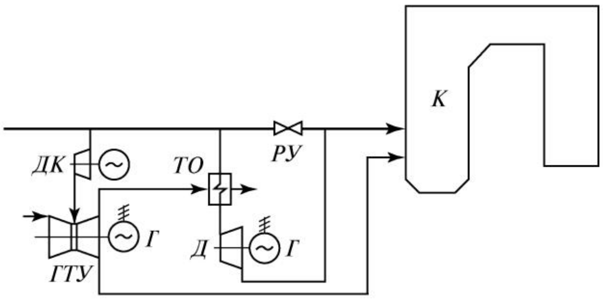

Fig. 7.10. Heat flow diagram of SGI with EGA:
BC — booster compressor; GTI — gas-turbine installation; HE — heat-exchanger; E — expander; G — power generator; *RA* — reducing apparatus; B — boiler

These flow diagrams can be also applied in process of modernization of the existing power units. In this case (see fig. 7.10) a part of fuel gas is fed to GTI, and a part of it comes through the reducing apparatus (RA) into the boiler. A parallel installation of RA and EGA allows an additional quantity of power generation and increase in the installation efficiency, as a whole. It is obvious that parts of the utilized heat in the total amount of heat fed, can be different in different flow diagrams and, accordingly, gas consumption, coming through EGA, and expander capacities will be different.