ADVANCED TECHNOLOGIES AND POWER INSTALLATIONS FOR THERMAL AND ELECTRIC ENERGY GENERATION

6.3. Heat and power supply units of low capacity

6.3.3. Gas turbine building-up of water heating boilers and installation at low capacity thermal power plants

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The conducted studies showed that a heating load of a heat supply boiler-house, operating in a hot water supply mode makes only 14…37% of the installed capacity, depending on climate conditions of the boiler-house location. Therefore, for building up of heating boiler-houses GT of medium and low capacity are required in order to provide operation of the GTU with complete utilization of exhaust gas heat. Unfortunately, low-capacity GTUs have, as a rule, lower initial parameters (gas temperature at a turbine inlet and compression rate), as a result an efficiency of such unit in an independent mode does not exceed 30%. Recently stationary high-effective GTUs of low and medium capacity were developed based on aero-engines. Such GTUs have sufficiently high initial parameters and efficiency in an autonomous mode achieves 35% and higher. However, aeroderivative GTUs are, as a rule, more expensive compared to stationary GTUs (in average the price for each kW of the installed capacity is by 100 USD higher).

Currently gas turbine market is quickly developing. Taking into consideration only Russia, almost all works of former military-industrial complex, earlier produced aero-engines, offer GTUs, mainly, of medium and low capacity. Besides, such machines are manufactured by Ural turbine motor works and Nevsky works. At the world market all companies, producing aero-engines and turbine equipment (for example "Alstom", "Hitachi", "General Electric", "Siemens", "Mitsubishi", "Rolls Royce", etc) offer units of different capacities. Most of installations, manufactured currently by different companies, have similar characteristics. Therefore, some national and foreign GTUs were taken for comparison of their characteristics. It should be noted that GTUs, offered by foreign countries, are, as a rule, well mastered and such units have an operational experience. Most of GTUs, designed for initial gas temperature of more than 1100°C, offered by our works, are pilot models, which have not yet passed industrial test. Technical characteristics of GTUs of low and medium capacity are provided in Tab. 6.11.

In order to ensure optimal conditions for joint operation of GTUs and water heating boiler, it is necessary to provide an approximate equity of GT exhaust gases, discharged to the water heating boiler, and flow rate of exhaust gases at autonomous operation of the water heating boiler. This provides optimal conditions for convective heat exchange in the boiler and does not cause a significant increase in resistance at the GTU exhaust.

Due to the fact that exhaust gas flow rate at autonomous operation of the water heating boiler is determined, mainly, by its heat production, then a choice of GTU type and boiler heat production are associated parameters. Tab. 6.12 describes a possible combination of GTU building up to water heating boilers.

Table 6.11. **Technical characteristics of some types of gas turbines of low and medium capacity**

Characteristics	Gas turbine type					
	GTU-2,5P	NK-37	GTU-4P	GTG-16	Tempest	Tornado
Capacity, MW	2,5	25	4	17	7,7	6,75
Gas temperature, °C:						
at the turbine inlet	961	1080	1060	1070	1130	1020
at the turbine exhaust	383	426	448	420	549	472
Compression rate	6,0	23,1	7,3	20	13,7	11,92
Air flow rate, kg/s	24,5	105,8	30,1	71	29,8	29
GTU efficiency, %	21,3	35,0	24,0	35,5	29,11	31,3
Rotation frequency, rev./min	5500	3000	5500	3000	14 010	11 050
Overall sizes, m	—	—	—	—	10,1x3,58x2,4	10,4x3,2x2,4
Utilized heat capacity of the exhaust gas flow, MW	7,5	36,1	11,4	26,5	14,5	11,74
Power generation at heat consumption, %	33,3	69,2	35	64	53	57

Table 6.12. **Combinations of gas turbines and water heating boilers**

Heat production of water heating boiler, Gcal/h	Exhaust gas flow rate, kg/s	GT type for a building-up
10	6,3	—
20	11,8	—
30	18,4	GTU-2,5P
50	30,3	GTU-4P, Tempest , Tornado
100	59,2	GTG-16, NK-38CT
180	104,7	GT-25, NK-37