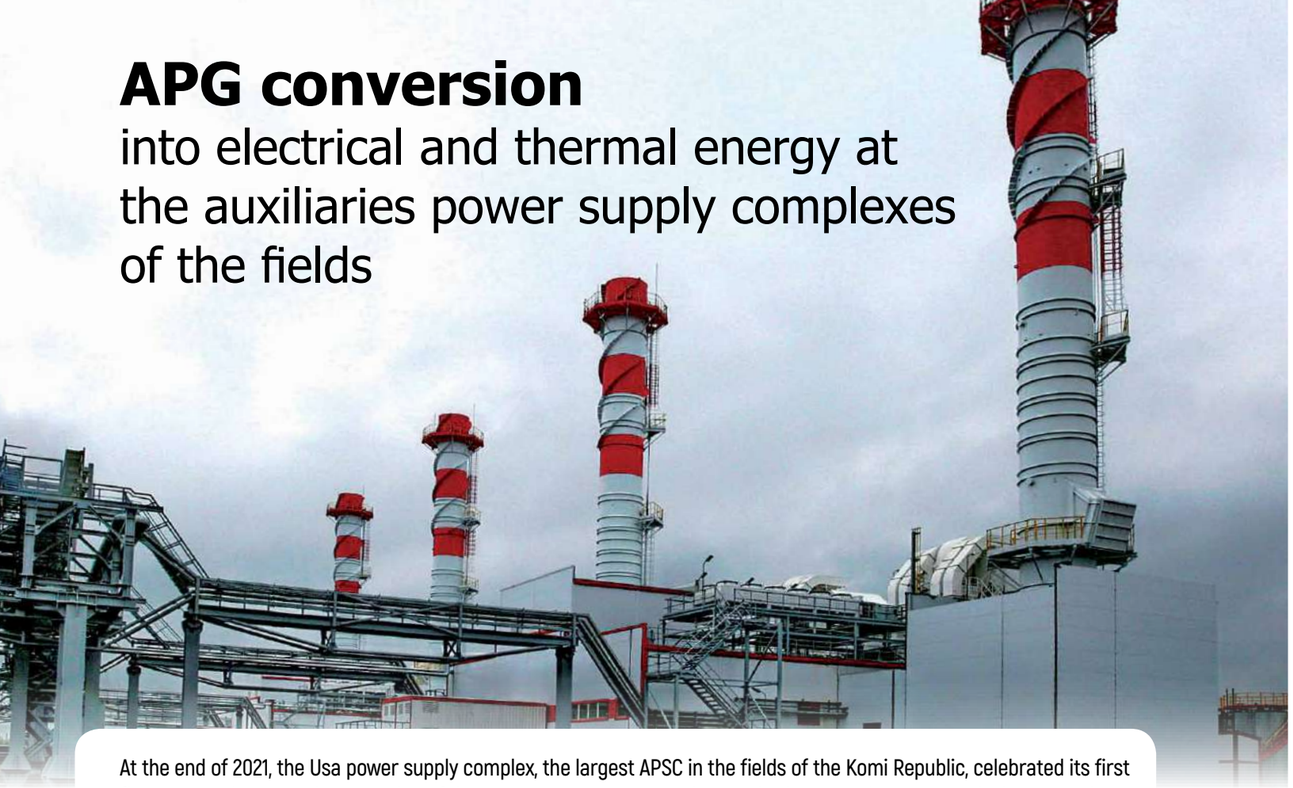
APG conversion

into electrical and thermal energy at the auxiliaries power supply complexes of the fields



At the end of 2021, the Usa power supply complex, the largest APSC in the fields of the Komi Republic, celebrated its first five-year anniversary. The operation of the autonomous power supply complex is an another one convincing example of the efficient applying of a cogeneration cycle to energy convert associated petroleum gas.

On November 25, 2016, LUKOIL-Komi commissioned a GTU-CHPP at the Usinsk oil field (Photo 1). Construction was carried out by the LUKOIL-Energoengineering LLC. Application of the main equipment of domestic production and the use of innovative technologies at all construction stages have allowed complete the project in 14 month. The main and reserve fuel for APSC is associated gas. The capability of the power facility are designed to consume 170 million cubic meters of APG per year.

Photo 1. Usa power supply complex – GTU-CHPP with an electric capacity of 100 MW

The project has been implemented with the aim of developing production activities at Denisovskiy license area. Usa power supply complex solves several problems:

- Electricity base-load provision in conditions of transmission constraints;
- Thermal power generation for own needs;
- Provision steam for process needs of injection into reservoirs;
- Shortening energy resources consumption costs;
- Decrease depending of the enterprise on the tariff policy in the electricity market;
- Reduction of stress on the environment and improvement of ecological situation at the fields.

Therefore, the possibilities of the APSC, along with an increase in the volume of APG useful use, ensure the growth of hydrocarbon production and the energy autonomy of the Usinsk, Bayandyn and Eastern-Lambeyshor fields.

Installed electric capacity of GTU-CHPP is 100 MW, thermal capacity is 120 Gcal/h.

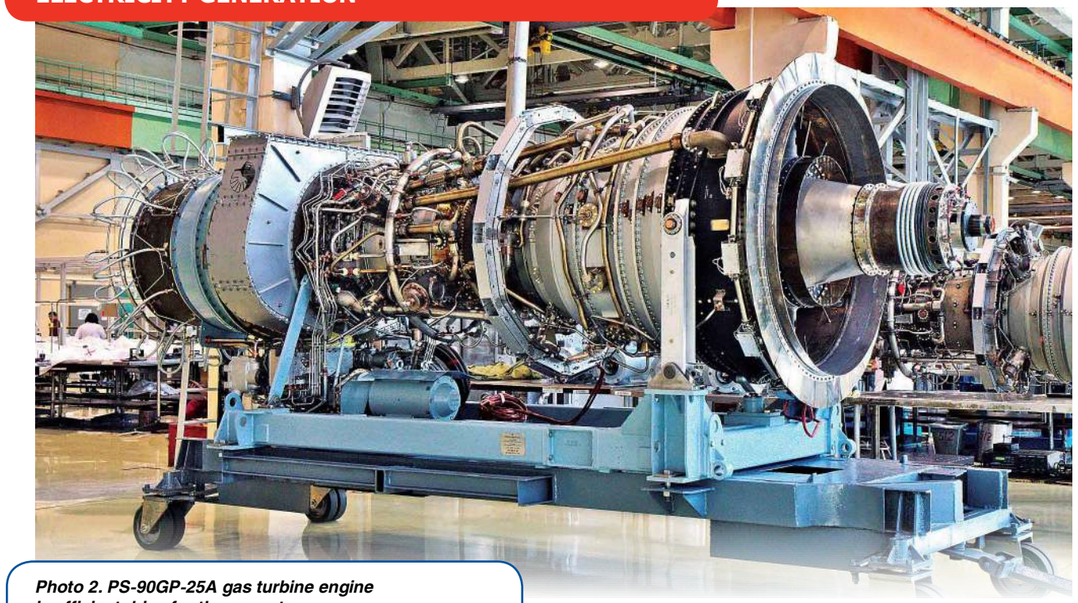


Photo 2. PS-90GP-25A gas turbine engine is efficient drive for the gensets

Power supply complex comprises four cogeneration power unit each of which is based on a GTE-25PA gas turbine unit with reduction gear and turbogenerator with a capacity of 25 MW. The number of simultaneously operating GTU depends on the current needs of the fields facilities for electricity.

As part of the GTU, the PS-90GP-25A three-shaft gas turbine engine (Photo 2) is used as a drive for the synchronous turbogenerator. Its design allows for visual-optical and special types of control of the gas-air path parts, making it possible to operate the drive according to its technical condition.

At the same time, it is possible to replace all components, individual parts and assembly units of the engine.

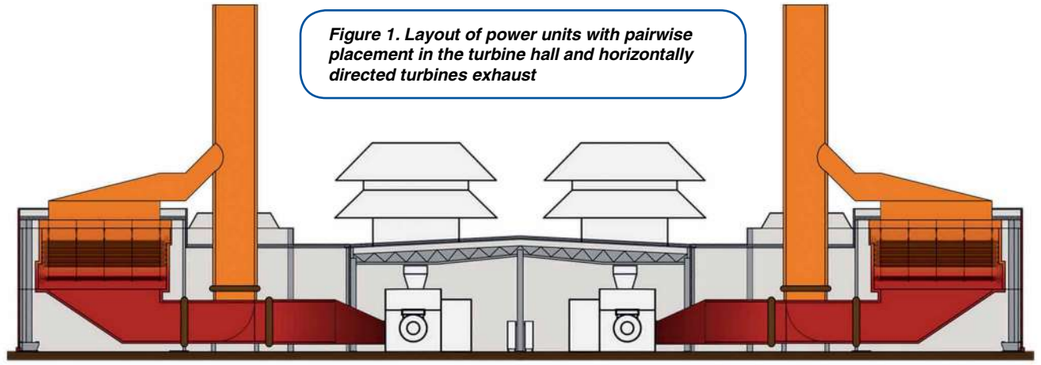
The GTE-25PA gas turbine unit was devised by UEC-Aviadvigatel JSC (Perm). Since 2013, the unit has been mass-produced by the UEC-Perm Motors enterprise. The design of GTU is based on the PS-90GP-25A turbine. It is the most efficient Russian-made power drive, created on the basis of the PS-90A2 aircraft engine.

The generating equipment is located in pairs in two pavilions (turbine halls) connected by a common passage with the control room, which corresponds to the layout solutions previously adopted and well-proven at the facilities of PJSC LUKOIL.

Each power unit is equipped with automated control and monitoring systems that provide centralized control at all stages of operation.

A distinctive feature of the project is the horizontal direction of the turbines exhaust (Figure 1). Along with the block-modular design of gensets, this made it possible to significantly shorten the construction time for APSC and reduce the cost of equipment installation.

Figure 1. Layout of power units with pairwise placement in the turbine hall and horizontally directed turbines exhaust



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HEAT GENERATION

The Permocarbon deposit of the Usinsk field is characterized by an abnormally high viscosity of oil; therefore, its production is carried out using thermal methods of stimulation.

The thermal energy generated by the power supply complex increases the oil recovery of the reservoirs. Water steam is used here as an oil-displacing working agent.

The power units have four waste-heat boilers (WHB) with a thermal capacity of 30 Gcal /h each.

These WHBs are conjugated with GTUs; water is heated, and process steam is generated using the high temperature of the turbines exhaust gases (about 600°C). The productivity of each WHB is 40 t/h.

The cogeneration cycle provides combined energy generation, high fuel effectiveness, environmental friendliness and efficiency of the facility.

The working agent resulted in waste-heat boilers is distributed through a pipeline system to special steam injection wells and pumped into the reservoirs at a pressure of ≈2 MPa and a temperature of ≈200°C.

In addition to the power units, the structure of the APSC includes an auxiliary boiler house, which also runs on associated gas. It provides heating of the GTU-CHPP and preheating the water supplied to the waste-heat boilers.

TREATMENT OF APG AS A FUEL

For the most efficient APG conversion and reliable operation of the generating equipment of the power supply complex, high-quality gas treatment is required before it is supplied to the turbines and boiler house. The required fuel parameters on purity, temperature, pressure and flow rate are guaranteed by the ENERGAS multifunctional process system, which is composed of an associated gas treatment station (AGTS) and a booster compressor station (BCS).

AGTS (Photo 3) carries out separation and filtering of common APG flow, heating and pressure reduction of gas for the boiler house of the power supply complex, as well as the measurement of the volume of fuel, separately reaching to GTUs and boiler house.

The process unit is located at an open site (inside easy-to-assemble enclosure) and equipped with necessary engineering systems. Operation mode is automatic. The throughput of AGTS is 24,059 m^3/h. After preliminary treatment, the gas intended for the power units is directed to the BCS, which compresses it and feeds to the turbines under a pressure of 4.5…5 MPa.

Photo 3. ENERGAS associated gas treatment station

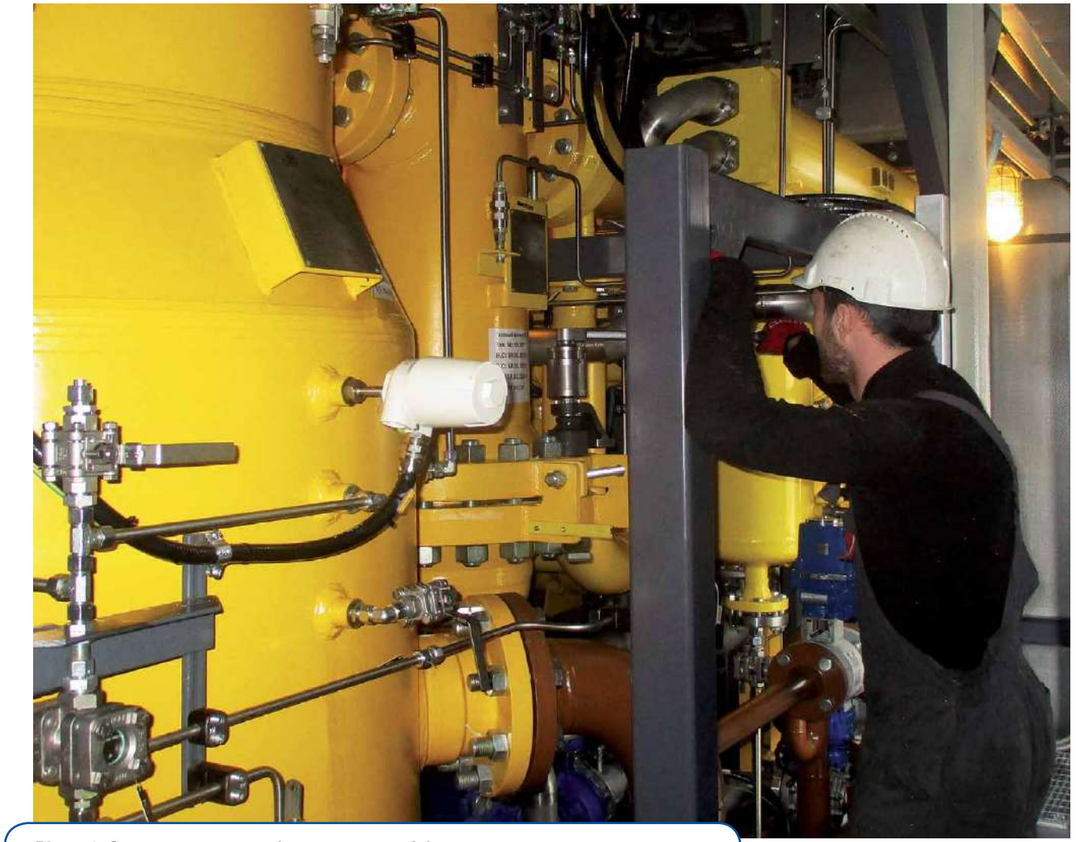

Photo 4. Gas compressor equipment as part of the gas treatment system

BCS consists of three compressor units, made based on screw oil-filled compressors. The maximum productivity of each CU amounts to 21,447 kg/h, which corresponds to the total rated fuel consumption of all 4 running turbines. The actual productivity depends on the dynamics of the load of conjugated GTUs, and is controlled in the range from 0 to 100%. For control, a special two-tier regulation system is applied.

CUs are placed in separate block-modules of arctic type (Photo 4) equipped with life support systems and safety. The units are additionally equipped with gas dew point analyzers for water and hydrocarbons with sampling devices.

The gas treatment process is complicated by the high content of liquid fractions in the source APG, therefore, the required fuel values for humidity are achieved in several stages. At first, the associated gas enters the AGTS separator-slugcatcher, where the primary separation is underway, and the peak liquid injection are neutralized. Then gas passes through coalescing filters of AGTS and filters-scrubbers of BCS.

Comprehensive treatment of associated gas as a fuel is of great practical importance for the efficient and reliable operation of the power supply complexes of the fields.

At the final stage, the method of recuperative heat exchange is used – each compressor unit is equipped with a gas drying module operating in temperature recovery mode. For this purpose, a chiller and a heater are integrated into the delivery line, which form an interim circuit and successively cool the gas, separate and remove the condensate, and heat the gas. The fuel dried in this way is fed to the turbines with a temperature of 20°C above the dew point.

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