

OPERATING EXPERIENCE

Multifunctional gas treatment units ENERGAS: experience of reliable operation



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The first block-type gas treatment station produced by ENERGAS Group was put into operation eight years ago at the 5th power generating unit of Yuzhno-Sakhalinsk CHPP-1. This project initiated the introduction of multifunctional gas treatment units. Since then, considerable experience has been accumulated in the supply of such process equipment, its versatile capabilities have been revealed, and its efficiency and reliability have been proven.

ENERGAS Companies Group annually implements dozens of projects and receives new confirmations that gas treatment (Upstream, Midstream) is a verified and consistent engineering calculation of a comprehensive process procedure that allows achieving and sustainably maintaining the specified gas parameters in terms of purity, humidity, temperature, pressure, and flow rate and other characteristics.

According to their type, ENERGAS gas treatment units come under groups of complete and multi-packaged.

Compact complete units consist of 1-2 modules, within which the equipment is integrated on a single frame. These are:

- Associated gas treatment units;
- Block-type gas treatment units (for natural gas);
- Fuel and starting gas treatment systems;
- Gas receiving stations;
- Block-type gas-control stations;
- Automated gas distribution stations.

Multi-packaged units are used in complex and large-scale projects. They are characterized by high capacity (flow rate of treated gas) and consist of several



Photo 1. Gas treatment unit for the combined-cycle power units of the strategically important Pregolskaya TPP

individual block-boxes with equipment for various purposes, which, when mounted, are docked in a single building (photo 2). At the same time, a number of elements may have external version.

These units operate at generating facilities with large-capacity gas turbines, as well as at oil and gas production sites, where it is necessary to contemporaneously provide high-quality gas (with different parameters) for several main and auxiliary facilities at once.

In total, complete and multi-packaged units in automatic mode continuously provide purification, drying, heating, reducing, determination of composition and measurement of various gas parameters, odorizing, technological or commercial metering, quality control of gas before it is supplied to gas-using equipment:

- Gas turbines;
- Gas-reciprocating units;
- Boiler houses;
- Direct oil heating furnaces;
- Gas-pumping units etc.

ENERGAS multifunctional units are characterized by the maximum degree of factory readiness upon delivery (98%), high maintenance ability and long service life – at least 25 years. The technical use ratio is 0.92+, the confirmed rating of reliability in operation is 0.95+.

Basic Configuration Of Multifunctional Units

The minimum (basic) functionality of ENERGAS process units is gas filtration and metering. Such equipment includes five indispensable elements.

Filtration system

The standard system consists of two filtration lines with a throughput of 100% flow or three lines with a throughput of 50% of the flow each. In special projects, a cascade scheme is used, including a pre-filtering module (photo 3) and a gas fine purification module.

Gas filters are selected depending on the composition of gas supplied to the facility, as well as the content of mechanical impurities and liquid fractions. Predominantly, highly efficient two-stage coalescing filters with replaceable elements are used in ENERGAS equipment. Varying of cart-



Photo 3. External pre-filtration module and condensate drainage module

ridge types and their combining optimize purification when the composition and characteristics of the incoming gas change.

In the case of high gas humidity there are used filters with a vortex lattice at the first stage of filtration and subsequent final purification by filter elements. The passage of the gas flow through the vortex lattice of the first stage of the filter creates vortices, causes flow disruption and a successive reduction and increase of gas pressure with subsequent condensation of liquid impurities of gas. High efficiency of gas purification is achieved by using own gas condensate as an absorbent.

In multifunctional units, the degree of purification reaches 100% for solid particles of at least 3 microns and droplet liquid of at least 5 microns. For particles ranging in size from 0.5 to 3 microns, the efficiency is 98...99 %.

Condensate drainage module

The gathering of gas condensate and mechanical impurities occurs automatically. As a rule, the drainage tank is located underground. If climatic conditions permit, ground execution is used (photo 3), and the tank is equipped with electric heating. In multi-packaged units, given their large size, the drainage reservoir can be placed directly in the process part – inside the enclosure.

The level of condensate in the storage tank is set and maintained at a given value by the automated control system.



Photo 2. Separate block-boxes during erection create a common process space of a multi-packaged unit (panoramic view)



Photo 4. Commercial gas-metering unit with ultrasonic flow meters



Photo 5. ACS compartment of complete gas treatment unit

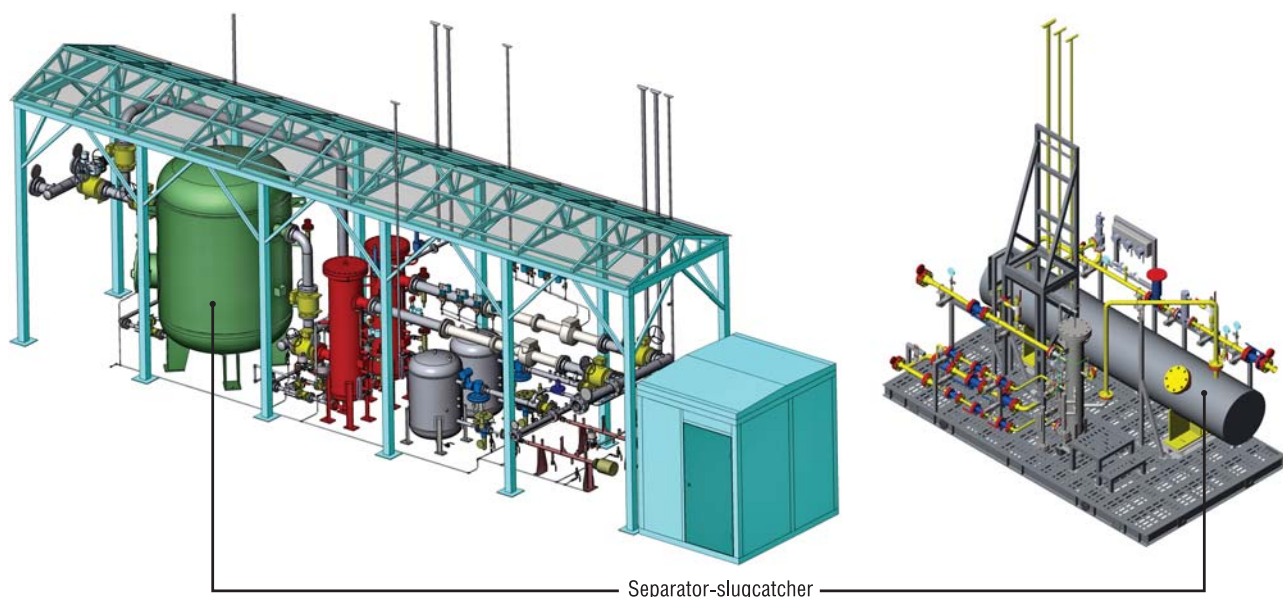


Figure 1. Design of separator-slugcatcher in process units for APG treatment

The drainage module is equipped with a liquid level control device and equipment for removing purification products into a mobile cistern.

Gas-metering unit

After purification, gas enters the metering unit, which has one or more normal flow measuring lines, a low flow line, and a bypass line (in the case of one measuring line or on customer's request). The relative error of the metering unit is no more than 1%.

Commercial or process metering of gas is carried out by measuring the volume and volume flow of gas under operating conditions and automatically bringing the obtained data to standard conditions, depending on the pressure, temperature and gas compressibility factor.

Primarily there are used turbine and ultrasonic primary flow transmitters (flow meters). Rotary, vortex, diaphragm, Coriolis or thermoanemometric flow meters also used. The data from the converters come to the corrector-calculators.

The commercial gas-metering unit (photo 4) allows to carry out mutual financial calculations between the supplier, the gas distribution company and the consumer, to make up balances of gas reception and supply, to control consumption and fuel use efficiency.

Automated control system

Multifunctional gas treatment units are fully automated and do not require additional manual adjustment for debugging the correct interaction of various equipment systems.

Control system (ACS) is based on microprocessor technology, using modern software and switching equipment. It is placed inside the block-module of complete unit (or inside the block-building of multi-packaged unit) – in a compartment separated from the process part by gas-tight fire-resistant partition (photo 5).

The main components of the ACS have redundancy, that guarantees the continuity of control. If the voltage is lost, the in-house uninterruptible power supplies support the autonomous operation of the software and hardware complex from 1 to 3 hours.

The local control system is integrated with the upper level of the APCS. It provides remote control of unit, automatic protection and alarm; controls the process parameters and indoor gas hazard; handles the parameters of the workflow and emergency events; displays information to the operator panel.

Life support and safety systems

Along with life support systems (lighting, heating, ventilation), the ENERGAS units necessarily have safety systems: fire and gas detection, alarms, fire fighting.

Additional Features

Units in the basic configuration are rarely used in practice. As a rule, to efficient solve project problems, additional assemblies and systems are embedded in the process flow diagram.

Systems of separation and dehydration

The treatment of associated petroleum gas assumes the inclusion of a separator-slugcatcher (figure 1) into the equipment structure for receiving the peak liquid blowout and smoothing the pulsation of the gas mixture.

Also, gas dehydration unit based on adsorbers can be installed. This is necessary in the event that the capabilities of the basic filtration system are not sufficient to achieve the design set gas parameters by humidity.

Gas heating module

To achieve design gas temperature, the unit is equipped with a heating module.

In the presence of a third-party heat carrier (hot network water), this process module comprises shell-and-tube exchangers of various types, operating in a direct «water/gas» scheme or according to a scheme with an intermediate circuit – «water/antifreeze + antifreeze/gas».

In the absence of an external heat source, two solutions are used:

- 1) explosion-proof electric gas heaters (photo 6) with a device for smooth regulation and heating blocking are used;
- 2) multifunctional units are equipped with their own block-modular boiler rooms.

Block-modular boiler room

The block-modular boiler room provides preparation of the heat carrier for the gas-heating module. Compact BMBR is placed in a special compartment inside the unit (photo 7). The number of water-heating boilers and their thermal capacity are set depending on the volume of gas being treated and the need for redundancy.

BMBR is equipped with its own devices for reducing and measuring gas flow rate, safety system, as well as a tank for draining heat carrier. The workflow of boiler room is



Photo 6. Fuel and starting gas treatment system for BCS Alan (Uzbekistan). Electric gas heaters are used here



Photo 7. Compartment of block-type boiler room is integrated into common process module

automated; the local BMBR's control system is integrated with the ACS of the unit.

Gas reducing system

If the gas pressure in the supply pipeline is higher than the level required for the correct operation of the conjugated gas-using units, the gas treatment equipment is equipped with a reducing subassembly, which have one or two lines with redundancy.

The ENERGAS multi-packaged unit includes multi-line reducing system. This is necessary for the parallel supply of gas (with different pressure parameters) to several facilities at one production site. The number of reducing lines depends on the number of facilities-consumers.

Odorizing unit

The odorizing unit with a tank for odorant storage (a substance that gives a warning odor to gas) is an indispensable element of the process facilities used in the automated process of gas offtake and its treatment for transportation to the end consumer.



Photo 8. Multi-packaged fuel gas treatment facility for the facilities of CGCTP at East Urengoy – the main (on left) and standby modules

Gas quality control module

According to the special project requirements of the customer, the equipment for measuring and analyzing various gas parameters is built into the process flow diagram of the unit.

For example, a continuous gas chromatograph (calorimeter) with a sampling device. Its functionality is determination of the component composition of gas, measurement of calorific value, calculation of the density and relative density, calculation of the Wobbe index.

The measurement of the gas dew point temperature for water and hydrocarbons is provided by a moisture analyzer with a sampling device.

In addition to manometers, thermometers, pressure and temperature sensors, analyzers of impurity content can be installed on the outlet manifold – to monitor the compliance of the treated gas with the design parameters.

Examples Of Existing Multifunctional Units

The projects of the ENER GAS Group in the oil and gas complex and the electric power industry give an idea of the process features and capabilities of gas treatment equipment. Let us consider the application of the ENER GAS units by examples of the practical treatment of natural and associated petroleum gas for gas-using equipment of various types and purposes.

Multi-packaged fuel gas treatment facility for the facilities of CGCTP at East-Urengoy licensed area

Complex gas and condensate treatment plant of JSC Rospan International (Rosneft) is equipped with the ENER GAS multi-packaged fuel gas treatment facility (FGTF).

FGTF is intended to filtering, metering, heating, reducing gas and parallel feeding it to the main and auxiliary sites of CGCTP. Among them: gas turbine power plant, boiler house, technical propane-butane purification unit from methanol, intake flow lines, low-temperature separa-



Photo 9. Automated gas distribution station manufactured by ENER GAS Group

tion unit, burner for combustion of industrial wastes, methanol regeneration unit, flare unit, booster compressor station of low-pressure gases, and condensate stabilization unit. For each consumer, the supplied gas has individual parameters in terms of pressure, temperature and flow rate.

The FGTF includes 8 units for various purposes, combined into two modules (*photo 8*) – the main (FGTM-1) and standby (FGTM-2). The maximum capacity of FGTM-1 for gas is 90,400 Nm³ / h. The rated gas flow of FGTM-2 is 32,612 Nm³ / h.

Automated gas distribution station AGDS Aleksandrovka

AGDS Aleksandrovka (*photo 9*) carries out gas offtake from the main gas pipeline, purification, commercial metering, quality control, pressure reduction, heating and gas odorizing before its transportation to a remote thermal power plant.

AGDS equipment: 2 filtration lines with coalescing filters; condensate drainage unit (with a tank of 3 m³); 2 measuring lines with ultrasonic flow meters; gas heating unit consisting of 2 shell-and-tube heat exchangers; 2 lines of reduction; calorimeter; moisture analyzer; odorizing unit (with a tank of 2.1 m³ for odorant storage); automated control system; life support and safety systems; standby generator.

Preparation of the intermediate heat carrier for the gas heating unit is provided by the block-modular boiler room, the enclosure of which is docked to the AGDS module. The basis of the boiler room is two water-heating boilers with a total (useful) thermal capacity of 1 MW.

Associated gas treatment unit for gas-turbine power supply complex at Usinsk field

At Usinsk oil field (LUKOIL-Komi) there is operates power supply complex with an installed electric capacity of 100 MW and thermal capacity of 152.1 Gcal / h. The generating equipment includes five GTPP-25PA power units produced by JSC UEC-Aviadvigatel.

The main and reserve fuel for the power supply complex is associated petroleum gas. Its treatment and feed to the turbines of GTU-CHPP are carried out by the



Photo 10. Associated gas treatment unit for the GTU-CHPP at Usinsk field of LUKOIL-Komi

ENER GAS multifunctional gas treatment system, which comprises three compressor units and an associated gas treatment unit (AGTU).

The AGTU (*photo 10*) performs flow measurement and gas filtration, it is equipped with a two-line unit of commercial metering, a separator-slugcatcher and a filtration system. The degree of gas purification is 100% for the liquid fraction and 99.8% for solid particles larger than 10 μm.

Also there is being treated fuel for a boiler house for field's own needs. For this, the AGTU is equipped with a gas heating module and a reducing system.

Block-type gas purification unit for GTU-TPP in Yelabuga

In the city of Yelabuga (Republic of Tatarstan), the GTU-TPP with electrical capacity of about 20 MW and thermal capacity of 28 Gcal / h operates. The main equipment consists of 4 Solar gas turbines of the Taurus 60 GS type with waste-heat boilers. Turbines fuel is natural gas.

At the power plant there is operates ENER GAS gas treatment system, which includes a booster compressor station and a block-type gas purification unit. BGPU is a typical example of a compact unit in the basic configuration. All process equipment is integrated on a single frame. The complete unit has a small capacity (8,240 m³ / h), due to the low power of conjugated gas turbines.

BGPU (*photo 11*) provides gas purification from solid particles and droplet moisture to the turbine manufacturer's design requirements, gathering of trapped liquid into a drainage tank with subsequent transfer to a mobile vessel or special transport, gas flow measurement, determination and recording of gas composition and its changes, determination of calorific value, gas dew point measurement.

Fuel and starting gas treatment system for gas-pumping units at Alan field

A booster compressor station for natural gas transportation consisting of two GPA-16 Volga gas-pumping units (KMPO) operates at the Alan field in Uzbekistan (NHK Uzbekneftegas). BCS is equipped with the ENER GAS fuel and starting gas treatment system (*photo 6*).



Photo 11. Block-type gas purification unit for GTU-TPP in Yelabuga is a compact unit in the basic configuration

The FSGTS is a multifunctional unit for purification, heating and reducing gas. On an open frame, the following process equipment is placed: coalescing filters-separators (gas filtration degree – 99.98%), automatic condensate drainage subassembly, electric gas heaters with a device for smooth regulation and heating blocking, two-line assemblies for pressure reduction of starting and fuel gas.

The project was implemented in the shortest possible time; designing, production, factory testing and delivery were completed in 2 months.

Multi-packaged gas treatment unit for the combined-cycle power units of Pregolskaya TPP

The largest facility of the new Kaliningrad generation, the Pregolskaya thermal power plant with capacity of 455.2 MW, consists of four combined-cycle power units, each of which includes 6E.03 gas turbine (produced by the Russian Gas Turbines LLC), generator (SPA Elsib), steam turbine (Power Machines PJSC), waste-heat boiler (Machine-Building Factory of Podolsk JSC).

Fuel supply for TPP's power generating units is provided by comprehensive gas treatment system of ENER GAS: gas treatment unit (GTU), booster compressor station, and control module.

Multi-packaged GTU (*photo 1*) with a capacity of 106,000 Nm³ / h was manufactured by ENER GAS under a special project. This is a process unit consisting of several block-boxes with equipment for various purposes, which are joined in a single building. The exceptions are the pre-filtration module and the condensate drainage subassembly, which have outdoor design on an open frame.

In addition to the external elements, the GTU is equipped with a fine gas purification system, a commercial gas-metering unit (with ultrasonic flow meters), a gas heating subassembly, a reducing system, and a gas quality control module.

Associated gas treatment facility for the gas-reciprocating power supply complex at Barsukovskoye field

At Barsukovskoye field (RN-Purneftegas LLC, Rosneft), located in the Yamal-Nenets Autonomous Area, the

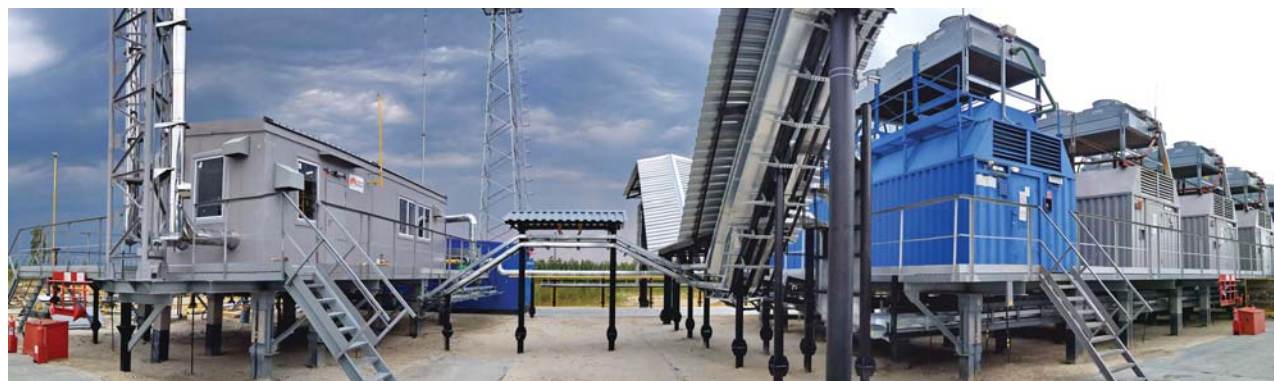


Photo 12. ENER GAS FGTF (on left) as part of gas-reciprocating power plant at Barsukovskoye field of Rosneft

autonomous power supply complex consisting of 10 Cummins gas-reciprocating units with a capacity of 1.5 MW each operates. The power plant built by LLC Alliance Generation supplies electricity to infrastructure and process sites of the field.

The fuel is associated petroleum gas. Design APG parameters (in terms of purity, temperature, pressure and flow) are provided by ENER GAS fuel gas treatment facility (photo 12) with rated capacity of 5,000 m³ / h.

This multifunctional complex comprises: gas filtration system with two-stage coalescent filters (purification rate is 100% for the liquid fraction and 99.9% for solid particles larger than 2 microns); condensate drainage module with underground tank; commercial gas-metering sub-assembly with ultrasonic flow meters; gas heating module based on a shell-and-tube heat exchanger; two-line reducing system; block-modular boiler room with a thermal capacity of 0.19 MW.

In all presented projects, the entire range of pre-launching activities (erection supervision, adjusting, own and integrated tests, operational staff training) was fulfilled by the specialists of Service ENER GAS, a member of the ENER GAS Group. Service engineers also carry out maintenance of gas treatment equipment here.

Prospective Projects

Among the projects currently being implemented, we would like to point out the most significant.

Fuel gas treatment facility for the power supply complex of Kharasavey field

During the equip of the Kharasavey field of PJSC Gazprom in Yamal, a power supply complex is being created to supply electricity to construction sites. Eight MWM gas-reciprocating power plants with a capacity from 1.2 to 2 MW and four PAES-2500 mobile automated gas-turbine power plants with a capacity of 2.5 MW each are used here.

The fuel for power supply complex is natural gas produced at the field. Its working parameters on purity, temperature, pressure and flow will be provided by the ENER GAS fuel gas treatment facility which has already been delivered to the operation site. The multifunctional complex consists of two separate modules (figure 2) operating in cascade scheme. The maximum capacity of the facility is 8,000 m³ / h, including: gas consumption for gas reciprocating units – 5,000 m³ / h, for PAES turbines – 3,000 m³ / h.

Gas-control station at oil treatment plant Usa-Heavy Oil

As part of the technical re-equipment, the oil treatment plant at Usinsk field (LUKOIL-Komi) is being equipped



Photo 13. Gas-control station will provide fuel for the direct oil heating furnaces at oil treatment plant Usa-Heavy Oil


with a gas-control station (photo 13). GCS ENER GAS is modular process unit intended for the purification, heating, and pressure reducing of gas to stable design parameters before it is fed into a direct oil heating furnaces. GCS also performs flow measurement and gas quality control.

Efficiency of GCS filtration system is 100% for the liquid fraction and 99.9% for solid particles larger than 2 μm. The reducing system reduces gas pressure from 1.6...2.5 MPa to 0.6 MPa. Explosion-proof electric heaters provide a design gas temperature of + 25°C. The block-type gas-control station is being prepared for mounting at the facility.

Gas receiving stations for the turbines of peak-standby GTPPs in the Republic of Belarus

In the Republic of Belarus, the peak-standby energy sources based on 16 Siemens SGT-800 gas turbine units are being created. At the Minsk CHPP-5 will operate gas turbine power plant with a capacity of 300 MW consisting of 6 gas turbines, at the Berezovskaya SDPP - GTPP-254MW (5 turbines), at the Lukomlskaya SDPP - GTPP-150MW (3 turbines), at the Novopolotsk CHPP - GTPP-100MW (2 turbines).

ENER GAS will supply set of gas treatment and fuel supply equipment. This four gas receiving stations (one GRS for each peak GTPP) which will be installed on supply pipelines for purification, commercial metering and heating of fuel gas entering the turbines of power generating units.

In conclusion, we can state that multifunctional units are an established factor in the process field of comprehensive gas treatment. Based on global experience and building up its practice, ENER GAS Group improves the capabilities of gas treatment equipment for projects of various complexity and scale. 

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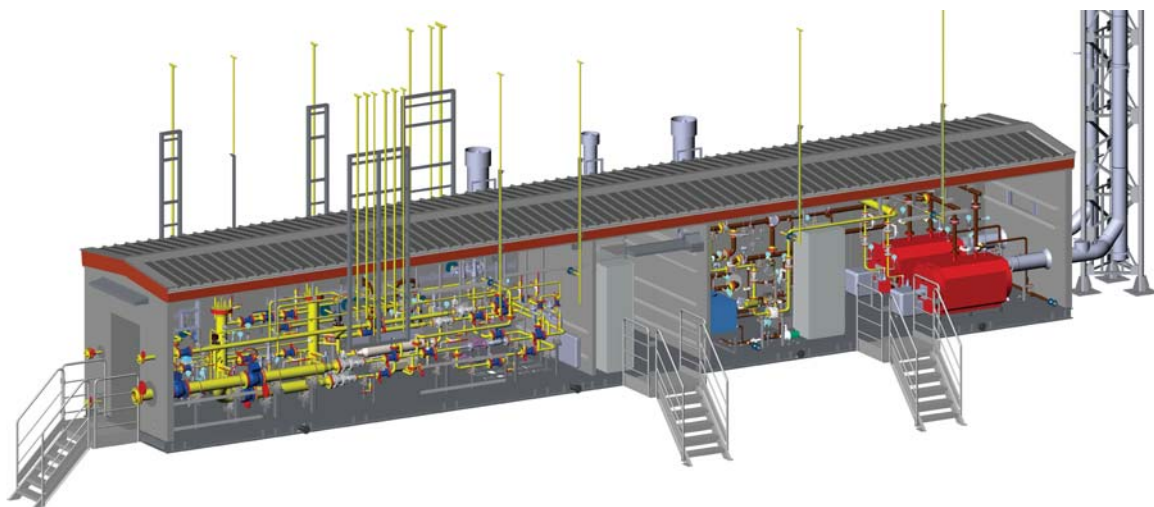


Figure 2. Module No. 2 of FGTF for the power supply complex of Kharasavey field consists of process part, boiler room and control compartment