# ENERGY EFFICIENCY OF COMBINED CYCLE POWER PLANT

**Rafikov Jasurbek Rustamovich**

Undergraduate student Namangan Engineering Construction Institute

**Abstract:** This article discusses the principle of operation of a combined cycle plant, its advantages and disadvantages compared to steam and gas turbine plants. The design of a more advanced three-circuit combined cycle plant. An analysis of the literature was also carried out, achievements in this field are briefly described. The prospects for the use of combined cycle plants at thermal and nuclear power plants. Also considered are the prospects for the use of combined-cycle plants using renewable energy sources (biofuels).

**Keywords:** turbine, gas turbine plant, steam turbine unit, combined cycle power plant, heat recovery steam generator, boiler feed pump, biofuels, electricity.

**Introduction.** In industry, electricity is obtained by converting thermal energy into mechanical energy and then already in electricity. Converting heat into electricity with high efficiency without intermediate transformation of it into mechanical work would be a big step forward, would disappear the need for a thermal power plant, and as a result, the use of heat engines, the efficiency of which has very small value and also require careful care.

At the present time, technology cannot create installations that convert heat into electrical energy directly. At the moment, all such installations have either very low power, or short operating time, or low efficiency, or depend on temporary factors (weather conditions, time of day, etc.). One way or another, they cannot provide reliable country's electricity supply. Therefore, it is impossible to do without heat engines at thermal power plants [1].

In our country, electricity is mainly generated at thermal power plants (TPPs), while

Organic fuel is used: coal or natural gas. At the present time, natural gas, which is flared at thermal power plants, is approximately 70% of the total share produced in the country. However, the efficiency of steam turbines installations that burn gas does not even reach 40% [2]. According to the Energy Strategy [3], in the electric power industry in the period up to 2020 it is planned to put into operation a significant number of modern combined-cycle plants (CCGTs). CCGTs are promising direction in the energy sector due to the relatively high efficiency compared to steam turbine settings. The efficiency of combined cycle plants at the moment already reach 60%.

**The device and principle of operation of the simplest CCGT.**

CCGT in its design two blocks, separate from each other: gas turbine and steam power. In the gas turbine installation, the turbine is driven into rotation by the gas formed during the combustion of fuel, then it performs mechanical work. A generator is located on the shaft with the turbine, which, due to the rotational movement rotor generates electrical energy. After passing through the turbine, the gas has a pressure, the value of which is close to the outer, which does not allow him to do the work. However, its temperature is still quite high and is about 500-600 C. Then the combustion products are sent to the steam power plant, waste heat boiler, where they heat the water and the resulting steam, the still rather high temperature of the gas makes it possible to obtain steam, the pressure of which reaches 100 atmospheres, which makes it possible to successfully use the resulting steam in a steam turbine. But the steam turbine, in turn, drives the second generator (Fig. 1) [4].

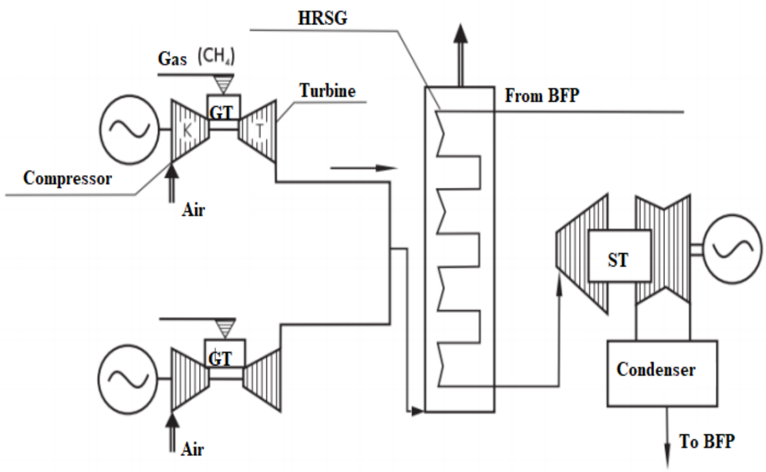


Fig.1 - Combined Cycle Power Plant

**Advantages:**

-Very high efficiency up to 60% compared to 33-45% steam power plants and gas turbines installations 28-42%.

- Low cost per unit of power.

-Construction time is only 12-24 months

-Less water consumption per unit of generated power compared to a steam turbine plant.

-There is no need to bring fuel by rail or sea (When this installations on gas or liquid fuel).

-Small weight and size dimensions, which allows them to be placed directly at the consumer. Thereby reducing the cost of power lines and the delivery of electrical energy.

-More environmentally friendly.

**Disadvantages:**

-It is necessary to filter the air that is used in the fuel combustion chambers.

-Restrictions on the types of fuel used.

-Seasonal power restrictions. Most effective during winter.

At the present time, many articles are published on this topic. Developed and CCGTs are being improved, efficiency, rated power, etc. are being increased. Recently, in the most highly efficient CCGTs, three-circuit CCGTs are used using steam with a fairly complicated scheme.

A three-loop CCGT is a steam-gas utilization plant in which three cycles are combined: a gas turbine cycle and two steam turbine cycles: upper - a steam turbine cycle based on water and steam, and a lower turbine cycle based on low-boiling substance [2]. High efficiency indicators of existing CCGTs can be achieved mainly with help to increase the initial gas temperatures before the steam enters the gas turbines up to 1300-1500°C, s the prospect of creating gas turbines operating at initial gas temperatures of 1600°C. With such high temperatures, the GTP efficiency is only 39–41%, and the high CCGT efficiency (58–61%) is determined by the depth utilization of the heat of gases leaving the gas turbine in a steam turbine cycle with an initial steam temperature of level 540–560°C. One of the important components determining the CCGT efficiency is the heat recovery steam boiler. Boilers heat exchangers are of two types with horizontal and vertical arrangement of heating surfaces. According to in [5] the best is a waste heat boiler of vertical type. Because it reduces losses capacity of the gas turbine, consequently to increase the efficiency of the entire CCGT cycle, the metal consumption of the boiler is also reduced due to higher values of heat transfer coefficients. The work [6] presents a fundamentally new thermal scheme of combined cycle plants using regenerative heating of feed water in the utilization steam turbine cycle, which allows to increase the efficiency combined-cycle plants by 5%. In [7], it is proposed to use steam cooling of gas turbine blades, which allows to increase the CCGT efficiency by 1.7-2.1%.

It is possible that in the future CCGTs will also be used at nuclear power plants. Data perspectives installations at nuclear power plants are the subject of works [8, 9].

Much attention is directed to renewable energy sources. One of the most promising renewable energy sources is plant biomass (wood and waste from its processing, peat, agricultural waste of vegetable origin). The development and implementation of biofuel CCGT is mainly aimed at creating installations of much lower power, which in turn will provide decentralized consumers highly efficient autonomous power plants. Works devoted to CCGT on biofuel [10, 11].

Currently, there are a huge number of different types used by gas turbines, as well as schemes used steam turbine part of CCGT. Units can be classified according to the number of gas turbine units (GTP) (one, two, three), according to the number of circuits of waste heat boilers (HRSG) (single-circuit, double-circuit, three-circuit), the absence or presence of intermediate overheating of steam in the STU, etc. And also by the type of fuel used by this installation (Gas, liquid fuel, biomass, etc.).

Conclusion.The introduction of combined cycle plants in Uzbekistan energy sector is a very promising direction. CCGT have very high economic and investment efficiency. Also the use of CCGT on biofuel will solve the problem associated with the growth of the economic world crisis associated with the lack of fuel and energy resources.

**References:**

1. Gas Turbine Combined Cycle Power Plants by S. Gülen CRC Press; 1st edition (December 10, 2019) Dr. S. Can Gülen **(**PhD 1992, Rensselaer Polytechnic Institute, Troy, NY).

2. Gas Turbine Engineering, Handbook 4th edition by Meherwan P. Boyce

3. Power Plant Equipment Operation and Maintenance Guide by Philip Kiameh.

*4. Steam Plant Operation latest pdf by Everett B. Woodruff.*

*5. Boiler Operator's Guide 5th Edition 2021.*

6. Combined Cycle Power Plant CCPP – Boilersinfo.

7. Advanced thermodynamics for engineers by Ali Turan and D. E. Winterborne.

8. Power Plant Engineering by Black & Veatch.

9. Blade Design and Analysis for Steam Turbines Book by George Lucas and Murari Singh.

10. Nuclear Power Explained Dirk Eidemüller (Author) 1st ed. 2021.

11.Design and Construction of Nuclear Power Plants by Rüdiger Meiswinkel , Julian Meyer, Jürgen Schnell. (Author) 1st ed. 2021.