Solar Hybrid Combined Cycle Gas and Steam Power Plant

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Abstract- In the modern world, electricity is mainly produced in steam and gas turbine power plants. Such plants use a large amount of feed water and organic fuels. As a result of burning fossil fuels, a large amount of CO_2 and NO_x gases are released into the environment as the end product, which creates conditions for the greenhouse effect. The application of solar energy, one of the alternative energy sources, can solve the problem. Studies show that the impact of solar energy on the environment is many times lower than that of traditional energy sources. By using solar energy, we can both reduce the fuel consumption used to produce electricity and make our world more ecologically livable.

Keywords-gas turbine,steam turbine,solar panels(sun energy),hybrid combined cycle gas-steam power plant,medium cycle

I. INTRODUCTION

Electrical power outages are a serious issue on a global scale. Furthermore, the generation of power is decreasing along with the daily depletion of fossil resources such as coal, oil, and natural gas. As a result of their declining availability, fossil fuel prices are currently increasing, which exacerbates the problem. It would be wise to use renewable energy sources more often in addition to or instead of fossil fuels, especially because they are so abundant and include sun, wind, biomass, and hydro. Natural resources are the source of naturally renewed energy, or renewable energy. The most promising renewable energy source is solar thermal power [1]. For the production of power, several countries still rely on nuclear and non-renewable fossil resources. As fossil fuels run out and people become more conscious of the harm that burning fossil fuels causes to the environment, there is a growing interest in renewable energy sources. In addition to the rising cost of power generation, environmental degradation is becoming a serious problem. This study suggests integrating solar energy with our current power plant to boost efficiency while lowering fuel costs.

II. PROBLEM STATEMENT

Problems with the environment Global warming, rising energy consumption, and resource scarcity necessitate innovative power plant technologies that, while increasing the total share of renewable energy sources, also provide steady electricity supply. Among other emerging technologies are hybrid power plants that run on a variety of interchangeable and combinable energy sources. Among the typical power plants are gas turbine power plants, steam power plants, and combined gas steam power plants, which combine the concepts of steam and gas turbine power plants. They are employed in the traditional process of producing electrical energy from fossil fuels. A steam turbine converts the thermal energy of the water vapor into electrical energy in a steam power plant that uses fossil fuels to evaporate water. The steam turbine then powers an a generator. Natural gas is one example of a liquid or gaseous hydrocarbon-based fuel that powers a gas turbine in a gas turbine power plant. In addition to producing electricity, the gas turbine itself powers a generator. The debilitate gasses of the gas turbine have tall temperature and can hence be utilized for moreover warming a squander warm heat recovery steam generator within the gas-steam half breed control plant. In a combinedcycle gas-steam control plant, a gas turbine, other than specificallyproducing electrical energy from fossil fills, is additionally utilized as a warm source for the ensuing squander warm kettle which capacities as a steam generator for the steam turbine. The steam is hence extended through a routine steam turbine handle. The gases from the gas turbine are fed to the recovery heat boiler, where they pass through various heat exchangers to produce steam. In the steam turbine, the steam expands in the working blades, and in the final state, the potential energy of the steam is converted into kinetic energy in the working blades, which in turn is converted into mechanical energy in the shaft, producing electrical energy in the generator. After the steam turbine, it is transferred to the condenser and condensed in the condenser by seawater. In order to produce steam more efficiently, it is also necessary for the water to be at saturation temperature in order to separate the oxygen, carbon and sulfur gases contained in the feed water. It is possible to use solar energy to bring the feed water to saturation temperature and transfer it to the waste heat boiler. The

application of solar energy, accordingly, consists of a solar panel, a reflector and a guide. The sun's radioactive waves are collected on the panel and transmitted through the guide.[1]
Solar tower power plants are typically steam power plants with Solar steam generation. A steam generator which is heated in a conventional steam power plant through fossil fuels like oil, natural gas or coal is replaced by a solar steam generation unit, a receiver or absorber on a tower. When the Sun shines, automatically positioning mirrors, so-called heliostats, align so that the Sunlight is reflected onto the central receiver. Therein the radiation energy is transmitted to a heat transfer medium like air, liquid salt or the process medium waterfsteam in the form of heat. The heated heat transfer medium is then used, for example, for generating steam in a steam turbine power plant and for Subsequent electric energy generation through a generator coupled with a turbine. The following figure shows a typical solar receiver (tower) and heliostats.

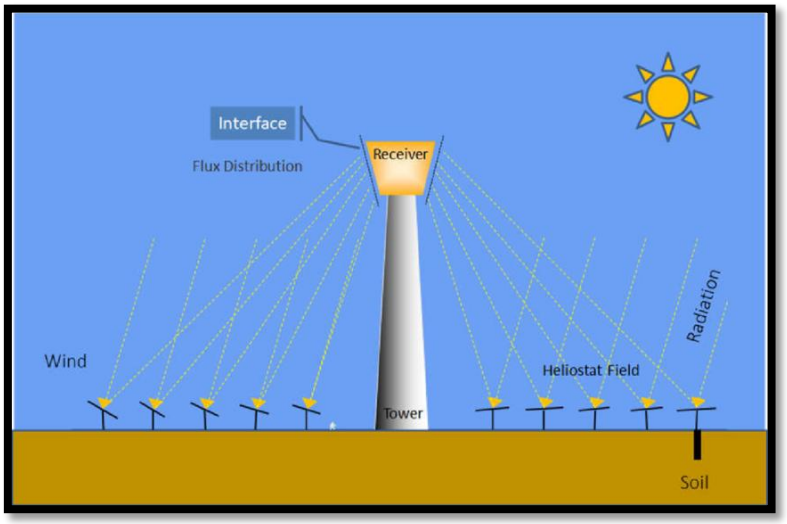
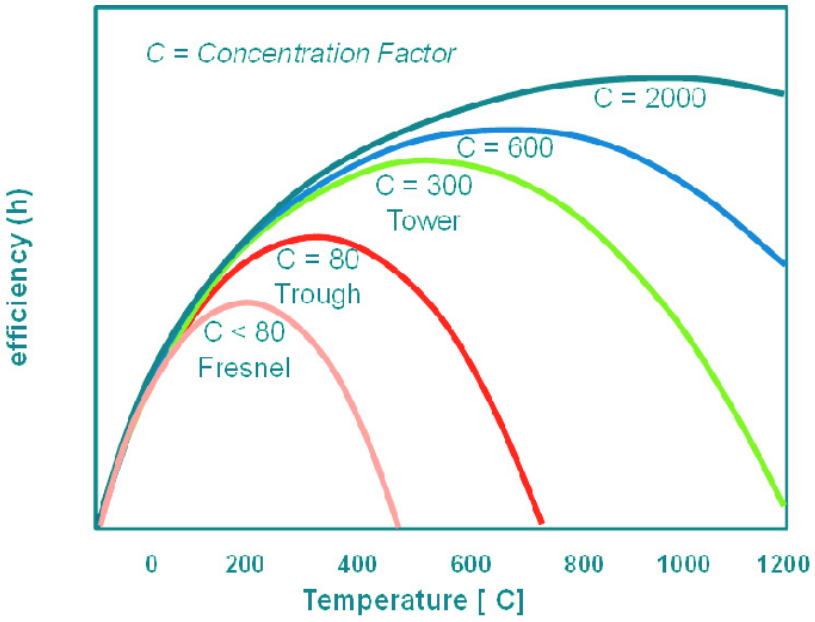


Fig1 . The following figure shows a typical solar receiver (tower) and heliostats.

III. Main Part

Although the proposed model exist in practice, some models that are compatible with it have found application in production. A model exists in Ain-Beni Mathar Solar-Thermal Power Plant,Morocco[12] .And in other countries there are such thermal power plants. As it is known, the absorption capacity of solar panels depends on the material they are made of. For this purpose, the material from which solar panels are made directly affects their efficiency. The efficiency of modern solar panels is between 15-30%[2]. For this reason, various alloy mixtures are used to increase their efficiency, including silicon-based additives[13]. Since the thermal energy, which is the main unit of thermal solar panels, is high, parabolic shaped structures are more promising. Therefore, the concentration coefficient of parabolic shaped panels is assumed to be C=300 for **1200** °C.[11]



Temperature-dependent efficiency of solar power plants The link between temperature and efficiency for several CSP systems is depicted in Figure 2 .

The tower receiver is the most efficient of the main CSP technology in use today[11]. The tower receiver's overall efficiency rises as a result of the greater heat flow and higher operating temperature. Additionally, the water vapor cycle is made to operate at high pressure in order to boost the saturation temperature and, consequently, the rankine cycle's total working temperature. The start-up, shutdown, and transient operation of the solar power plant provide special design and operational issues due to the rise in the overall operating temperature and pressure.

The thermal diagram of the solar hybrid gas-steam turbine combined cycle power plant is shown below. This scheme is the main system of modern hybrid power plants. As it is known, the pressure and temperature of the environment directly affect the efficiency. Therefore, efficient management of these parameters is the basic condition.[10]

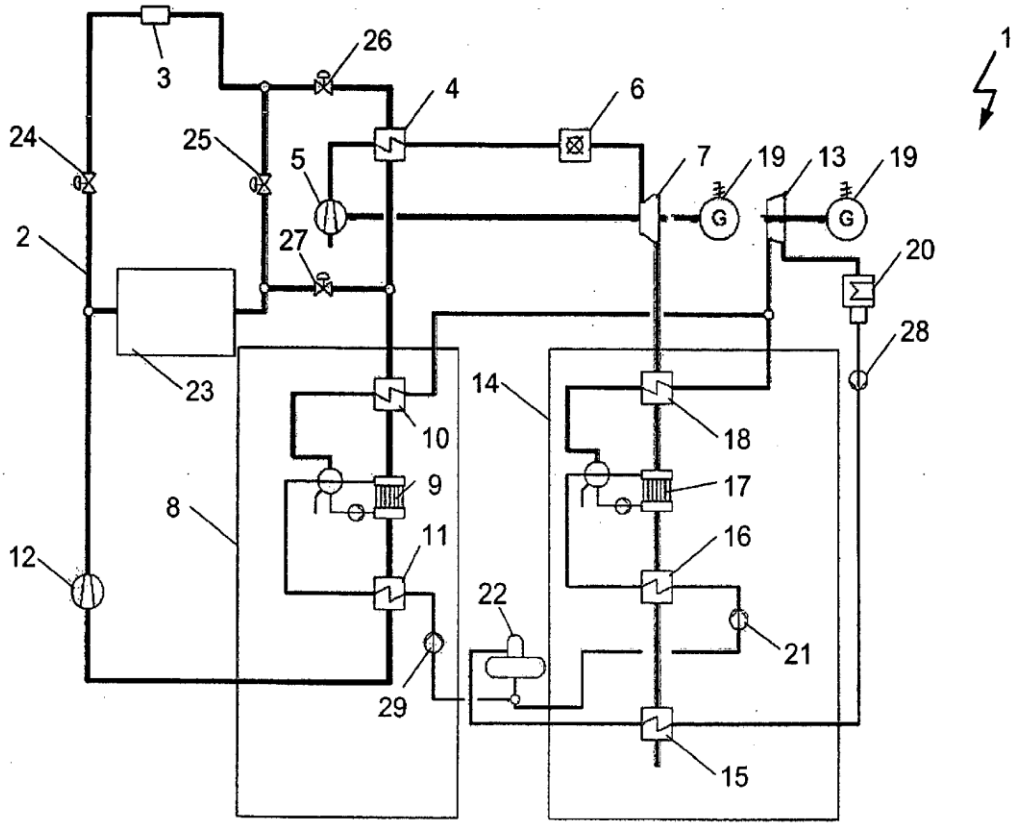


Fig3. Thermal diagram of solar hybrid gas-steam turbine combined cycle power plant

The principle of operation of the hybrid system with a steam-gas unit is as follows[3] :
(5) The air taken from the atmosphere by means of an air compressor (4) is heated by solar energy in a heat exchanger and enters the combustion chamber (6). At the same time, gaseous fuel is introduced into the combustion chamber as follows: of a gas compressor. In the combustion chamber (6), the air-gas mixture is ignited and the flue gases (7) are passed to the gas turbine. In the gas turbine (7), an expansion process occurs at high pressure and temperature and the turbine blades begin to rotate. The shaft of the gas turbine and the shaft (19) of the electric generator are identical. In this case, as a result of rotation, electrical energy is generated in the synchronous electric generator. The flue gases are transferred to the waste heat boiler (14) and the feed water is converted into steam by passing through the condensate heater (15), economiser (16), evaporator (17) and steam heaters (18). The steam enters the steam turbine (13) with high parameters and in the same process, electrical energy is obtained in the electrical generator (19). In the steam turbine (13), the parameters of the steam decrease as a result of expansion and the steam is transferred to the condenser (20). In the condenser (20), the vapour is converted into condensate by the cooling water and recirculated as precious water to produce steam. The condensate is transferred to the mains boiler via the electric feed pump (28). Günəş energy is

collected in a reservoir (tower) (3) and collected in a high-temperature heat exchanger (23) and transferred to a utilised boiler. When we say hrsg(heat recovery steam generator), we mean a boiler that does not burn any chemical combustible fuel, but only utilises the heat energy it receives from the second seal. The hrsg, which operates with the heat energy received from the sun, is also the same number of heat exchangers as the ultimate hrsg. The solar-powered utilisation boiler(8) converts the feed water from the deaerator(22) into steam by passing it through the economiser(11), evaporator (9) and steam superheater(10) and it is given to the steam turbine through the steam superheater pipe of the utilisation boiler. The difference from the solar-powered utilisation boiler is that in this type of boiler, the superheated gases are not discharged into the atmosphere (12) but are transferred to the atmosphere by means of a blower ventilator.

IV. CONCLUSION

In conclusion, we can say that solar-powered hybrid thermal power plants are both environmentally and economically viable. The commissioning of such plants will lead to additional fuel consumption reduction, increased efficiency and simultaneous operation of green energy and conventional power plants.

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