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Studies on Gas Turbine Combined Heat and Power - A Review

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Abstract

Cogeneration (a system that provides both power and heat) is a method used to produce electricity while simultaneously using the exhausted heat energy of the flue gases. It is the most productive and effective use of the exhaust heat recovered. CHP utilizes the wasted heat of flue gases. Natural gas is used as the primary energy source; however, biomass is the sole source of energy in the renewable variant. Steam generation, electricity generation, and space heating are all handled by large CHP plants. A CHP plant comprises a primary mover, electricity generator, heat recovery system, and a control system. Long-running hours, high efficiency, lower emissions, cheap cost, higher reliability, and increased output are just a few of the benefits.

Keywords: *Combined Heat Power, Gas Turbine, Cogeneration.*

1. INTRODUCTION

As non-renewable energy supplies become exhausted, energy conservation has become a top issue for most countries, and all organizations are working to find ways to conserve energy. The most efficient energy management solutions are CHP systems. Through cogeneration, we can obtain improved overall efficiency in closed process systems. Alternative fuel sources include biomass and methane, but natural gas is the most prevalent primary fuel source to obtain a higher power-to-weight ratio. Fuel powers a gas turbine in a cogeneration system, which continually generates electricity and steam. In a gas turbine cogeneration system, fuel is the major energy source and other energy types are generated to optimize energy consumption. Combined Heat and Power System Cycles boost overall efficiency while also making use of the flue gas exhaust heat. The only drawback is that it relies on huge generator packages, which are inefficient at part load. Gas turbines and CHP systems generate a significant portion of the main energy needs. Thus, energy efficiency and harmful emissions must be addressed. Given global warming uncertainty, CO_2 emissions must be monitored and reduced. Energy efficiency and environmental protection might improve over time.

2. REVIEW

CHP production improves energy efficiency and reduces pollution compared to single-generation electricity. An optimization model based on thermodynamic principles in the working fluid and component operating conditions may design cost-efficient CHP system operation [1]. Enescu and Diaconu[2] gave a presentation on the operation of a cogeneration plant where he discussed the use of raw materials utilized in energy generation, as well as the environmental, social, and economic implications. Najjaret al. [3] explained that an effective gas turbine engine has a low capital cost, compact in size, has higher flexibility and reliability, with lower emissions and quick starting and loading properties. However, at part load, they become inefficient. Shabbir and Mirzaeian[4] proposed that cogeneration is an effective energy-saving and energy-producing strategy using fuel. He determined the value of the energy usage factor and yearly life cycle cost. Kumar et al. [5] has performed a parametric study to evaluate the working of cogeneration plants using parameters like superheated gas pressure, compression ratio, pinch point temperature, and inlet gas temperature.

Verbruggen [6] evaluated from his study that the energy produced at the time of cogeneration for a particular interval is used to evaluate CHP activity. During a given time period, the quantity of cogenerated electricity ($E_{CHP)}$is used as a performance metric for combined heat and power (CHP) activities. The metric proposed is the appropriate one to employ since it takes into account both the quality characteristics (the power-to-heat ratio,) and the quantity characteristics (the recovered heat, Q_{CHP}). Finding the right numerical values of power-to-heat ratios can be difficult in practical implementations of the method, so be prepared for some challenges. Kavvadias et al. [7] explained the necessary conditions required for the working of the CHP plant in their study. We need to construct a cogeneration plant-based model along with a dispatch model to obtain it. Gambini et al. [8] argued about the incentive model used for cogeneration plants to achieve high efficiency. It was divided into energy and heat-producing and non-energy and non-heat-producing. Pantaleoet al. [9] proposed that industries with natural gas plants perform heat utilization and power generation. It is vast both in terms of the range of possible powers and the number of producers. Puppa and Chandrashekar [10] researched to improve and speed up the analysis of cogeneration systems by resorting to computer software packages. This paper describes a computer programme that was developed to simulate and optimize any sort of cogeneration plant layout. The software is named SAPPOS. Limaye et al. [11] aimed to examine several operational cogeneration systems to establish their application, economics, and attitudes towards industrial and utility executives. Their research was divided into two jobs. The first task was doing a literature review and identifying potential cogeneration sites. Cogeneration capability, geographical variety, generation type, and industrial diversification were all factors in the first task. In job two, the remaining sites were contacted to gauge their interest and an industrial questionnaire on technical, economic, and institutional cogeneration challenges was produced.

Varmaand Srinivas [12] proposed that in comparison to other industries, a cement mill has significant potential to use a cogeneration-based process system. A case study was conducted for two different energy units at three different exhaust temperatures in the cement mill. They attempted to quantify the power generation capability in the power plant layout.Coelho et al. [13] explained that cogeneration facilities play a key role in reducing primary energy consumption. It lowers the production costs and improves the total efficiency. A cogeneration system can help in enhancing fuel economy and achieving greater environmental compliance by reducing emissions. Onovwiona and Ugursal [14] found that micro-cogeneration systems have an increasing potential in the home sector as they can generate both heat energy and electricity simultaneously. In these systems, there is a gain in energy efficiency and a reduction in costs and greenhouse gas emissions. Cakir et al.[15] have explained methods to save energy and then use it efficiently in a cogeneration system (CHP). Cogeneration plants provide higher energy savings and lower CO2 emissions when compared to fossil-fired heat generation plants.

3. CONCLUSION

As a result, from the literature review discussed above the different conditions that will be covered in this study are as follows.

- CHP systems in gas turbines improve overall efficiency while utilizing the collected exhaust heat of the flue gases.
- They use natural gas and biomass as their energy source.
- CHP is good for the environment as it produces fewer emissions,
- It is costly but can be used for part-load also.
- It has high reliability and can be used for longer terms with little maintenance.
- Overall size of the CHP plants is huge.

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Declaration of Competing Interest

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