Journal of The Gujarat Research Society

ISSN: 0374-8588
Volume 21 Issue 9, September 2019

An Overview of the Analysis of the Exergy of the Thermal Power Plant

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ABSTRACT: In the economic development of the country, the power generation industry plays a key role. Increasing demand for electricity has made power plants of theoretical interest, but most power plants are only based on the first thermodynamics law and are designed according to energy efficiency requirements. The demand for energy sources around the world is shrinking day by day. The first law of thermodynamics cannot describe the real useful loss of energy, since it does not differentiate between the quality of energy and the quantity. The current thesis deals with the energy study of coal-fired thermal power plants and provides a detailed review of the different studies performed over the years on coal-fired thermal power plants. This analysis will list the main causes of loss and energy destruction in the power plant. It will have ways and means to increase the system's performance and reduce the environmental impact.

KEYWORDS: Efficiency, Exergy destruction, Exergy analysis, Rankine cycle, Thermal power plant.

INTRODUCTION

Energy consumption is one of the most important indicators, illustrating the stages of countries' development and the quality of life of the population. Growth in the population, urbanization, industrialization and technical development directly lead to increased oil consumption. This growing trend brings crucial environmental problems such as greenhouse effects and emissions into the forefront. Approximately 80% of the world's electricity is currently generated from fossil fuels (coal, oil, fuel oil, natural gas) fired from thermal power plants[1]. In recent decades, energy research based on the Second Thermodynamics Law has been found to be a useful tool in the design, assessment, optimization and production of thermal power plants. The thermal power plant exergy analysis is based on the first and second thermodynamic laws together, while only the first law is based on the energy analysis. Exergy analysis, which provides a more analytical view of the process and a valuable tool for engineering evaluation, uses the modern approach to process analysis for these purposes[3]. The prime mover is powered by steam in a thermal power plant. Water is heated, converted into steam, and there is a steam engine which spins an electric generator. After it passes through the turbine, the steam is condensed in a condenser and recycled to where it has been heated; this is referred to as the Rankine cycle[2].

Exergy:

Exergy is a measure of the full capacity of a system to perform useful work as it proceeds to a given final state in equilibrium with its environment[5]. Energy, in general, is not retained as energy but is lost in the system. Energy loss is the indicator of irreversibility, which is the cause of loss of efficiency. The location, magnitude and magnitude are thus described by an exergy analysis measuring the exergy destruction magnitude. The core of thermodynamic inefficiencies in a thermal device.

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$$\acute{\eta} = {}^{\text{Exergy output}}/_{\text{Exergy input}}$$

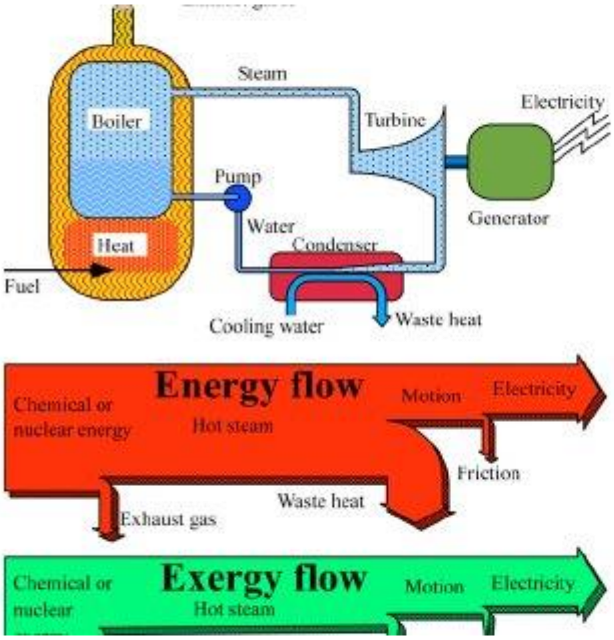

Figure 1: Exergy diagram

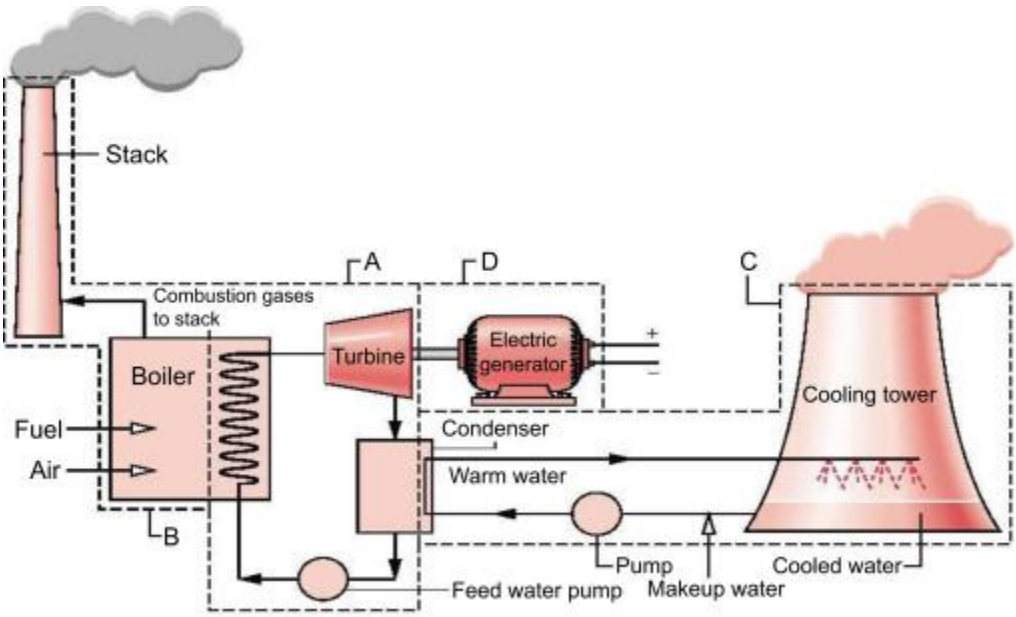

Figure 2: Power Cycle in thermal power plant

The following literature review summarizes significant research findings with respect to the study of the thermal power plant:

The capacity and energy study of the Al-Hussein power plant (396MW) in Jordan is provided by **Isam H. Aljundi (2009)**. The quality of a part wise modeling calculated the plant and a thorough break-up of energy and energy losses for the considered plant was carried out. The exergy destruction rate of the boiler was found to be dominant over every other irreversibility in the cycle. This alone accounts for 77 percent of the plant losses, although the condenser's exergy destruction rate is only 9 percent. The actual loss is mostly back in the boiler where entropy was generated. Contrary to the first law review, this shows that major changes occur in the boiler system rather than in the condenser. Exergy analysis provides the tool for a strong distinction between environmental energy losses and process internal irreversibility. Analysis of energy is a technique for assessing the efficiency of devices and processes and includes analyzing the energy at various points in a sequence of steps of energy conversion. Efficiencies can be assessed with this knowledge, and the process steps with the greatest losses (i.e., the greatest margin for improvement) can be identified[3].

Kiran Bala Sachdeva and Karun (2012) have determined the extent, location and source of thermodynamic thermal power plant inefficiencies.The first thermodynamics law presents the principle of conservation of energy, which states that energy enters a fuel thermal system, It conserves and can not kill energy, flowing streams of matter, and so on. Generally speaking, the energy balances do not have any detail on the energy quality or grades that cross the boundary of the thermal system and no internal loss data. The second law of thermodynamics, on the other hand, incorporates the useful notion of energy in the study of thermal systems. Exergy is a consistency or energy grade measure which can be lost in the thermal system. The second law states that as a result of irreversibility, part of the exergy entering a thermal system with fuel, electricity, flowing streams of matter, and so on is destroyed inside the system. The frictional effects and pressure drops in the turbine blades as well as the pressure and heat losses to the atmosphere are due to the exergy losses in the turbines. Therefore, the study of the First Law (energy analysis) cannot be used to classify possible areas for improving the efficiency of electricity generation. The Second Law Review, however, serves to recognize the true inefficiencies in power production occurring throughout the power plant. This paper summarized the findings of the study of energy and energy conducted in a steam power plant. The total plant energy losses are measured as 68 percent from the energy analysis. The exergy results show that the boiler produces the greatest exergy destruction[4].

M.A. A. A. Mozafari, Ehyaei and M.H. Alibiglou (2011)-the Shahid Rajaee gas turbine exrgy, economic & environmental study is presented Iran's power generation factory. For system optimization, a new feature that includes the social cost of air pollution for power generation systems is also suggested. The new role of the operating system is based on the first law of quality, energy costs and the external social cost of air pollution. In the present tense, paper, the following unique contributions may be considered from this study results obtained in Shahid Rajaee power plant[5]:

- Entropy of gas turbine power plant output, energy and economic analysis with inlet air cooling.
- Creation of a FORTRAN-language computer program code that can be used to simulate any form of gas turbine with or without a fogging system for inlet air cooling[6].

- Calculation of the cost of energy production in two situations with and without a fogging device, taking into account the cost of environmental effects from an economic point of view.

There are ties to economic activity and environmental conditions. Production and consumption can pollute the environment, and production capacity may be impaired by the state of the environment at the same time. Therefore, under an integrated model, the analysis of external air pollution costs should be addressed. In this way, the external costs of air pollution are included in the economic analysis of these schemes. The economic component of these impacts is referred to as internalized external air pollution costs[5].

CONCLUSION

In this article, the study of energy is shown to better explain the output of coal-fired, gas-fired combined cycle thermal power plants and to identify potential efficiency improvements in the design. It offers a rational approach to increase the possibilities for power production in thermal power plants. Through the energy review, we can infer that in coal-based thermal power plant and combustion chamber in gas-fired combined cycle thermal power plant, the key energy loss in the boiler. Of course, there is some inherent irreversibility in any plant part, such as a boiler, combustion chamber, that cannot be removed due to the current state of technological growth. In addition, exergy methods are useful in determining which improvements are worthwhile and can be used along with other applicable information to direct steam power plant performance improvement efforts. The productivity of certain plant components is, of course, enhanced by increasing their scale. Heat exchangers of a given design, for instance, perform better when the areas of heat transfer are increased. This entails additional costs, however, and there is thus a restrictive size above which further development will not be economically justified.

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