Energy and Exergy Analysis and Exergy Economics Analysis of Coal Based Power Plant

Manoj Chourasiya, Suresh Kumar Badholiya

[1]*M.Tech Research Scholar*, [2]*Professor (BITS Bhopal)*

Abstract - The energy assessment must be made through the energy quantity as well as the quality. But the usual energy analysis evaluates the energy generally on its quantity only. However, the exergy analysis assessment the energy on quality as well as the quantity. The aim of the exergy analysis is to identify the magnitudes and the real energy losses, in order to improve the existing systems, processes components.

Keywords - Energy, Exergy, Coal, Power Plant, Economics.

1. INTRODUCTION

1.1 ENERGY AND EXERGY ANALYSIS:

Energy and exergy analysis for power generation systems are of scientific, interest and also essential for the efficient utilization of energy resources for this reason. The energy analysis has drawn much attention by scientific and system designers and recent year some Devoted their studies to component energy analysis and efficiency improvement.

Efficiency is one of the most frequently used terms in thermodynamics and it indicates how well and energy conversion or process is accomplished, efficiency is also one of the most frequently most used terms in thermodynamic and is often a source of misunderstanding this is because efficiency is often used without being properly defined first efficiency traditionally has been first law that is energy, in recent decades exergy analysis has been found increasingly wide spread acceptance as a useful tool in the design assessment optimization and improvement of exergy system
picture of system behavior.

1.2 ENERGY

work. For this reason, the return on our investment of heat transfer is compared with the output work transfer and attempts are made to maximum this return. Most of our daily activities energy transfer and energy change.

1.2.1 CONCEPT OF ENERGY: The concept of the energy was first introduced in mechanics by Newton when he hypothesized about kinetic and potential energies. However, the emergence of energy as a unifying concept in physics was not adopted until the middle of 19th century and was considered one of the major scientific achievements in that century. The concept of energy is so familiar to us today that it is intuitively obvious, yet we have difficulty in defining it exactly .energy is scalar quantity that cannot be observed directly but can be recorded and evaluated by indirect measurement. The absolute value of energy of system is difficult to measure, whereas its energy change rather easy to calculate. In our life the example of energy are endless. The sun of the major source of the earth's energy. It emits a spectrum of energy that travels across space as electromagnetic radiation. Energy is also associated with the emergence of civilization has been characterized by the discovery and effective application of energy to society's needs.

1.2.2 FORMS OF ENERGY: Energy manifests itself in many forms, which either internal or transient, and energy can be converted from one form to another in thermodynamic analysis, the forms of energy classified into two groups.

(1) The macroscopic forms of energy are those where a system possesses as a hole with respect to some outside reference frame such as kinetic and potential energies. The macroscopic energy of a system is related to motion and the influence of some external effects such as gravity, magnetism, electricity and surface tension.

A. The energy that a system possesses as a result of its motion relative to some reference frame is called kinetic energy.

B. The energy that a system has a result of its elevation in gravitational field potential energy and they are independent of outside reference frame.

The sum of all the microscopic forms of energy is called Determining exergy the internal energy of a system. The internal energy of a system depends on the inherent qualities, or properties, of the materials in the system , such as composition and physical form as well as the environmental variable (temperature , pressure, electric field, magnetic field, etc)

2. PREVIOUS WORK

In this study, energy and exergy analysis and exergy economics analysis are used to assess the thermal power plant. It is hoped that this analysis primarily because it includes exergy analysis and exergy economics analysis, will yield new insights into the performance of coal based thermal power plant. A complete analysis of the thermodynamics performance of a process generally requires the use of both energy and exergy analysis. Energy analysis, because it accounts for losses due to internal consumptions and external wastes, is regarded by many to give more meaningful and illuminating results than energy analysis.

In 1824 **Carnot and clausius** in 1965 proposed the fundamental of Exergy method. The exergy related systems are designed and their performance is evaluated primarily by using the energy balance deduced from the first low of thermodynamics and to calculate the enthalpy balances for more than a century to quantify the loss of efficiency in a process due to loss of energy. However in the recent year the second low of analysis here in after called exergy analysis, of energy systems has more and more drawn the interest of energy the exergy concept has gained considerable interest in the thermodynamic analysis of thermal process system

Szargut(1):A deeper analysis reveals that in real processes energy is not destroyed, but rather transformed into other forms, less suitable for feeding and driving real processes. Hence besides energy, another physical quantity should be introduced to characterize the quality of the kind of energy under consideration. The ability to perform useful work in a natural environment has been suggested and investigated as a measure of energy quality by Gibbs, A Stodola, G Gouy, J.H.Keenan F. Bosnjokovic and many other researchers Z. Rant in 1956 proposed the term of exergy, Exergy analysis is based upon the second law of thermodynamics, which stipulates that all macroscopic processes are irreversible. Energy such irreversible process entail non-recoverable. Loss of exergy, expressed as the product of the ambient temperature and the entropy generated of the values of the entropy increase for all the bodies. Some of the components can be negative, but the sum is always positive. **T Ganapathy (2):** The energy assessment must be made through the energy quantity as well as the quality as well as the quality. The usual energy analysis evaluates energy generally on its quantity only. However, the exergy analysis assesses the energy on quantity as well as quality. the aim of the exergy analysis is to identify the magnitudes and the location of real energy losses, in order to improve the existing systems, processes or components. The present paper deals with an exergy analysis performed on an operating 50MWe unit of lignite fired steam power plant at thermal power station-1, neyveli Lignite Corporation limited, neyvely, Tamilnadu, India. the exergy losses occurred in the various subsystems of the plant and their components have been calculated using the mass, energy and exergy balance equations the distribution of the exergy losses in several plant component during the real time plant running conditions has been assessed to locate the process irreversibility. The first law efficiency (energy efficiency) and the second law efficiency (exergy efficiency) of the plant have also calculated. The comparison between the energy losses and the exergy losses of the individual components of the plants shows that the maximum energy losses of 39% occurs in the condenser, whereas the maximum exergy losses of 42.73% occurs in the combustor. The real losses of energy which has a scope for the improvement are given as maximum exergy losses that occurred ..

Vundela sive Reddy (3): He worked thermodynamic analysis of a coal based thermal plant and gas based cogeneration power plant has been carried out . the energy and exergy analysis has been studies for the different component of both power plants. The paper analysis the information available in the open literature regarding energy and exergy analysis on high temperature power plant has been included. A comprehensive literature review o thermal power plants, specially boiler in coal base thermal power plants and combustion chamber in gas steam cogeneration has been included. Family, explaining the procedure of analysis of thermal power plant systems by exegetical approach

Bejan (4) He studied outlines the fundamentals of the method of exergy analysis and entropy generation minimization (or thermodynamic optimization-the minimization of exergy destruction). The paper begins with a review of irreversibility, entropy generation, or exergy destruction. Example illustrate the accounting for exergy flows and accumulation in closed systems, open systems heat transfer processes, and power and refrigeration plant

Georgeand Park (5): He worked how to estimate the avoidable and unavoidable exergy destruction and investment costs with compressors, turbines, heat exchangers and combustion chambers. This general procedure, although based on many subjective decisions, facilities and improves applications of exergy economics

Kotas: He explained in this work the concept of exergy used to define criteria of thermal plants

Kamateand Gangavatis(6) He studied exergy analysis of a heat-matched bio gas cogeneration plant of a typical 2500°c sugar factory, using back pressure and extraction condensing steam turbine is presented. The analysis, exergy methods in addition to the more conventional energy analyses are employed to evaluate overall and component efficiencies and to identify and assess the boiler is the least efficient component and turbine is the most efficient component of the plant. The results show that, at optimal steam inlet condition of 61 bar and 475°c, the back pressure steam turbine cogeneration plant perform with energy and exergy efficiency of 0.863 and 0.307 and condensing steam turbine plant perform with energy and exergy efficiency of 0.68 and 0.260

Dattaetal (7) He was presented work on exergy analysis of a coal based thermal power plant is done using the design data from a 210 MW thermal power plant under operation in India. The exergy efficiency is calculated using the operating data from the plant art different conditions, viz. at different loads, different condenser pressures, with and without heaters and with different setting of the turbine governing load variation is studied with the data at 100, 75 ,60 and40 % of full load. Effects of two different condenser pressures, i.e 76 and 89 mmHg(abs.) are studied. It is observed that the major source of irreversibility in the power cycle is the boiler, which contributes to exergy destruction of the order of 60% part load operation increase the irreversibility's the cycle and the effect is more pronounced with the reduction of the load. Increase in the condenser back pressure decrease the exergy efficiency. Successive withdrawal of the high pressure heater shows a gradual inherent in the exergy efficiency of the control volume excluding boiler.

Aljundi (8) He was presented in this study, the energy and exergy analysis of AL-Hussein power plant Jordan is presented. The primary objectives of this paper are to analyze the system components separately and to identify and quantify the sites having largest energy and exergy losses. In addition, the effect of varying the reference environment state on this analysis will also be presented. Energy losses mainly occurred in the condenser where 134MW is lost to the environment while only 13 MW was lost for the boiler system. The percentage ratio of the exergy destruction to the total exergy destruction was found to be maximum in the boiler system(77%) followed by the turbine (13%), and then the forced draft fan condenser (9%). In addition, the calculated thermal efficiency based on the lower heating value of the fuel was 26% while the exergy efficiency of the power cycle was 25%. For a moderate change in the reference environment state temperature, no drastic change was noticed in the performance of major components.

Daietal (9): He was done exergy analysis for each cogeneration systems is examined, and a parameter optimization for each cogeneration system is achieved by means of genetic algorithm to reach the maximum exergy efficiency. The cement production is an energy intensive industry with energy typically accounting for 50-60% of the production costs. In order to recover waste heat from the preheated exhaust and clinker cooler exhaust gases in cement plant, single flash steam cycle, dual- pressure steam cycle, organic Rankin cycle (ORS) and the kalina cycle are used for cogeneration in cement plant. The optimum performance for differences cogeneration systems are compared under the same condition. The result shows that the exergy losses in turbine, condenser, and heat recovery vapor generator are relatively large.

Rosen (10) He is reported results were of energy and exergy based comparisons of coal-fired and nuclear electrical generating stations. A version of a process-simulation computer code, previously enhanced by the author for exergy analysis, is used. Overall energy and exergy efficiencies, respectively, are 37% and 36% for the coal-fired process, and 30% and 30% for the nuclear process. The losses in both plant exhibit many common characteristics. Energy losses associate with emissions (mainly with spent cooling water) account for all of the energy losses, while emission-related exergy losses account for approximately 10% of the exergy losses, the remaining exergy losses are associated with internal consumptions

Dincer and Rosen (11) He worked effects on the result of energy and exergy analyses of variations in dead-state properties, and involve two main tasks: (1) examination of the sensitivities of energy and exergy values to the choice of the dead-state properties and (2) analysis of the sensitivities of the results of energy and exergy analyses of complex systems to choice of dead-state properties. A case study of a coal fired electrical generation station is considered to illustrate the actual influences. The results indicate that the sensitivities of energy and exergy values and results of energy and exergy analyses to reasonable indeed-state properties are sufficiently small.

Erdental (12) He analyzed comparatively the performance of nine thermal power plants under control governmental bodies in turkey, from energetic and energetic view point. The power plants are mostly conventional reheat steam power plant fed by law quality coal. Firstly, thermodynamic models of the plants are developed based on first and second law of thermodynamics. Secondly, some energetic simulation results of the developed models are compared with the design values of the power plants in order to demonstrate the reliability. Thirdly design point performance analyses based on energetic and exegetic performance criteria such as thermal efficiency, exergy efficiency, exergy loss, and exegetic performance coefficients are performed for all considered plants in order to make comprehensive evaluations

Vidaletal (13):He analyzed exergy method was applied in order to evaluate the new combined cycle proposed by Goswami, using Hassan-Goswami-vijayaraghavan-parameters. This new combined cycle was proposed to produce both power and cooling simultaneously with only one heat source and using ammonia-water mixture as the working fluid. At the irreversible process two cases were considered, changing the environmental temperature. However, in order to know the performance of the new cycle at different conditions of operation, the second irreversible case was analyzed varying the rectification temperature of the chilled water. Exergy effectiveness values of 53% and 51% were obtained for the irreversible cycles, with heat input requirements at temperature of 125 and 150°c. solar collector or waste heat are suggested as heat source to operate the cycle

Amirabedin Ehsaan, M. Zeki Yilmazoglubfo (14) He worked to design a 240MWel thermal power plant (TPP) to be operated with ten different types of Turkish lignite and fulfill an exergy analysis including the determination and comparison of the performance reach type of lignite. Additionally an examination of the effect of the ambient temperature on the power plant exergy efficiency and calculation of the CO2 emissions of each lignite type is carried out. Exergy destruction of each component is investigated by using conservation of mass, conservation of energy and exergy destruction in an open system at steady state. Sivas Kangal lignite is selected for designing. Net energy and exergy efficiency plant are as 37.16 and 34.84% respectively. The analysis of the case study revealed that the boiler is the major source of exergy destruction with 299.10MW and 83.29% of the total exergy destruction of the overall plant point is that, fuel consumption and CO2 emission of the TTP increase with rising ambient temperature. For thermal technologies exergy can be particularly effective in identifying ways to improve the performance of existing operations, and designing the future plant

3. PROPOSED METHODOLOGY

3.1 ENERGY ANALYSIS OF POWER PLANT

Power consumption per capital indicates the individual and economical growth of the country and thereby represented the living standard of the people of the same. The whole world is in grip of electrical energy crisis and pollutions due to the power plants. The overall power scene in India shows heavy shortages in almost all the states. The government of India has advocated “energy for all” by the year 2012. Even though the Indian power sector is at the forth place of the power production in the world. The significant role of thermal power station in India’s power generation scenario can be gauged from the truth way they supply about 66% of the total installed capacity. Some of the available options are to evaluate overall and individual component efficiencies and identify losses, thereby improving the energy efficiencies of the system. Energy like many other commodities should be evaluated and the conventional energy analysis, based on the first law of thermodynamics, evaluates energy mainly on the quality. Very careful analysis of the problem and proper planning and execution is necessary to solve the power crisis in India. So in thesis, a detailed energy study is shown for 200MW, unit-of coal fired thermal power plant at NTPC thermal power station to evaluate the plant and subsystem {feed water heater (high pressure and low pressure),etc} efficiencies. The first law analysis is used to assess the overall plant performance. In operation and maintenance of a power plant, the feed water heater are practically neglected compare with other components. Efficient and reliable service from feed water heaters requires more care in both operations and maintenance than care that has been taken for many other components of power plant.

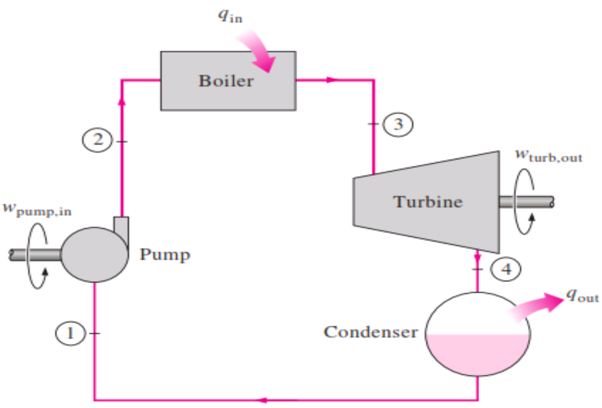

Figure 1.1 Rankine cycle

3.2 THE PRINCIPAL TYPE OF POWER PLANT

THE PRINCIPAL TYPES POWER PLANTS ARE AS BELOW

1. Steam plants using coal, oil, or nuclear fission.
2. Internal combustion engine plant
3. Gas turbine plant
4. Hydroelectric plant In steam power plant coal or oil is used as a fuel for generation of high pressure and high temperature steam in the boiler / the steam generator steam is produced and then utilized. To drive the steam turbines which are couple to generator to get electricity? The furnace may employee grates burning of solid fuel in burner of furnace oil in oil burners.

3.3 ABOUT POWER PLANT:

The Rankine cycle is the basic cycle for operation of steam power plant. Thermal power station means a factory for conversion of chemical energy of fuel into electrical energy. Coal-fired unit produced electricity. The steam is condensate and converted back into water, and the returned to the boiler to complete the closed cycle. The basic requirements of thermal power plant are.

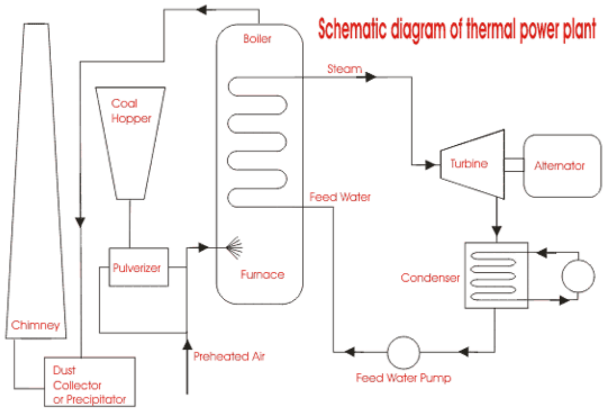

Figure 1.2 Thermal power plant

Raw material should be available continuously, generated energy should be utilized properly and qualified staff should be available as per requirement and proper provision of removal ash and other byproducts during power generation. Basic point to be considered during site selection are as fallows type and cost of the land, availability of fuel, transportation facility, service water facility, availability of staff, near to the load center, ash disposal facility, away from residential area

3.4 CLASSIFICATION OF STEAM GENERATOR OR BOILER:

Classification of steam generator or boilers can be made in different ways. From the point of view of application, they can be;

a) Utility steam generator

b) Industrial steam generator

c) Marine steam generator

4. CONCLUSION.

This review paper is present a method of exergy economics analysis and its application to a power. An exergy analysis identifies the location, cause and magnitudes of the real thermodynamics losses. An exergy economics evaluation identifies the location and cause of the cost sources, calculates their magnitude and compares their effects on the cost of the product. All this information and judgment assist in the improvement of the efficiency and reduction of the costs in thermal power systems. Decisions about the design. Operation and repair or replacement of the equipment is facilitating.

5. SCOPE OF THE PRESENT WORK

The scope of present work includes the study of energy and exergy analysis exergy economics analysis of coal based thermal power plant. It includes experimental study of energy and exergy analysis and exergy economic analysis of coal based thermal power plant. Finally comparative assessment of experimental and numerical results is presented.

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AUTHOR'S PROFILE

Manoj Chourasiya has received his Bachelor of Engineering degree in Mechanical Engineering from BITS Engineering College, Bhopal in the year 2012. At present he is pursuing M.Tech. With the specialization of Thermal Engineering from BITS Engineering College Bhopal. His area of interest Thermal engineering and Power plant.

Suresh Kumar Badholiya he is working as an Associate Professor at Bhopal Institute of Technology and science Bhopal in mechanical engineering department. He has received his master degree in Energy Management .He has great experience in teaching.