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Exergy and Energy Analysis

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ABSTRACT

In this paper, the energy and exergy analysis of Reliance Ultra Mega Project (3960MW) in Singrauli ,Madhya Pradesh 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. The performance of the plant was estimated by a component- wise modeling and a detailed break-up of energy and exergy losses for the considered plant has been presented.
Keywords: water desalination; HDH systems; direct contact heat and mass transfer; bubbler humidifier

I. INTRODUCTION

Power plays a great role wherever man lives and works-in industries, agriculture transportation etc. power provides our homes with light and heat. The living standard and prosperity of a nation vary directly with increase in use of power.

As technology is advancing the consumption of power is steadily rising.This necessitates that in addition to existing sources of power such as coal, water, petroleum etc. other sources of power should be searched out and new and more efficient ways of production energy should be devised. Nuclear energy has enlarged the world's power resources. The energy released by burning one kilogram of uranium is equivalent to the energy obtained by burning 4500 tonnes of high grade coal. Under the severe impact of the global crisis, the Indian economy registered a growth of 6.7% in 2008-09 after having registered over 9% rates of growth for three successive years.

By any standards, the Indian Economy was able to protect itself reasonably well in the turbulent conditions of the financial crisis. Economic growth slowed from 7.7% in the first half of 2011-12 to 5.95% in the second half, and 6.0% in the first quarter of 2011- 12 However, in the second quarter it grew strongly at 8.6%. it again declined to 6.5% in the third quarter primarily because of the drought.

The economy recovered in the fourth quarter and grew by 8.6%. the order of loss in growth momentum in the first half of 2011-12 was not only much smaller than that of the rest of the world, but the important point was, that the economy continued to grow at close to 7%, which itself is higher than in many years past. Nowadays, there are a few methods to measure the performance of a power plant.Some researchers use the conservation of mass and the conversation of energy (first law of thermodynamics) principles: however the evaluation is actually not complete. The exergy analysis based on the second law of thermodynamics should be included in order to provide the information, which is useful for engineers or managers to know about the power plant performance. Although the method of exergy is often considered to be a new method for analyzing energy systems, the underlying fundamentals were introduced as early as in the 1940. For examples a paper by Thing, (1944) 1 describes the virtue of energy which is essentially what we call today as exergy. Some authors call it availability but the term most widely accepted and used in a lot of publications is exergy The term availability in the context of power plant may he confused with the availability of the plant or machine.

As energy analysis is based on the first law of thermodynamics, it has some inherent imitations like not accounting for properties of the system environment, or degradation of the energy quality through dissipative processes. An energy analysis does not characterize the irreversibility of processes within the system. In contrast, exergy analysis will characterize the work potential of a system. Exergy is the maximum work that can be obtained from the system, when its state is brought to the reference or "dead state"; i.e. standard atmospheric conditions. Exergy analysis is based on the second law of thermodynamics Energy analysis of a steam power plant, in order to assess the distribution of irreversibilities and losses which contribute to loss of efficiency in system performance.

II. LITERATURE REVIEW

The concept of energy was first introduced in mechanics by Newton when hypothesized about kinetic and potential energies. However, the emergence of energy as a reifying concept in physics was not adopted until the middle of the 19th century and was considered one of the major scientific achievements in that century. The concept of energy is so familiar today, we have difficulty in defining it exactly. Energy is a scalar quantity that cannot be observed directly but can be recorded and evaluated by indirect measurements. The absolute value of energy of system is difficult to measure, whereas its energy change is rather easy to calculates. In our life the examples of energy are endless. The sun is 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 structure of matter and can be released by chemical and atomic reaction. Throughout history, the emergence of civilizations has been characterized by the discovery and effective application of energy to society's needs.

It simply states that during an interaction, energy can change from one form to another but the total amount of energy remains constant. That is, energy cannot be created or destroyed.

THE STEADY FLOW PROCESS

The term steady implies no change with time. A large number of engineering devices operate for long periods of time under the owe conditions. And they are classified as steady-flow devices. Process involving such devices can be represented reasonably well by a somewhat idealized process, called the steady-flow process.

EXERGY

The second law analysis of a power cycle enables us to identify the major sources of loss and shows avenues for performance improvement. Practical devices involving energy conversion and transfer always observe energy conservation law, but the quality of energy degrades i.e. work potential is lost or exergy is destroyed. Degradation of energy is equivalent to the irretrievable loss of exergy due to all real processes being irreversible The loss of exergy or irreversibility provides a quantitative measure of process inefficiency. This method provides the information, which is useful for engineers or managers to known about the power plant performance. Exergy is the maximum possible work that can be produced by a system as it is brought into equilibrium with a specified reference environment. It is important that the Performance monitoring of a power plant includes exergy analysis besides the conventional energy analysis.

DEFINITION OF EXERGY

It is the maximum possible useful work that could obtain from the system at given state in a specified environment. The work potential of the energy contained in a system at a specified sate is simply the maximum useful work that can be obtained from the system. The work done during a process depends the initial state, the final state, as well as the condition of the environment. In an exergy analysis, the initial state is specified, and thus it is not a variable

EXERGY OF A FLOWSYSYEM

The property exergy is the work potential of a system in a specified environment and represents the maximum amount of useful work that can be obtained by the system is broug to equilibrium with the environment, Unlike energy, Value of exergy depends on the state of the environment and the state of the system. The property exergy is the work potential of a system in a specified environment and represents the maximum amount of work that can be obtained as the system is brought to equilibrium with the environment.

$$X_{flow} = PV$$

Where V is the specific volume of the fluid, which is equivalent to the volume change of a unit mass of the fluid as it is displaced during flow. The flow work is essentially the boundary Work done by a fluid on the fluid downstream, and thus the exergy associated with flow work is equivalent to the exergy associated with the boundary work, which is the boundary work in excess of the work done against the atmospheric air at Po to displace it by a volume V. Nothing that the flow work is PV and the work done against the atmosphere is PoV, the exergy associated with flow energy can be expresses as:-

$$X_{flow} = PV - P_o V$$

Therefore, the exergy associated with flow energy is obtained by replacing the Pressure p in the flow work relation by the pressure in excess of the atmospheric pressure, P-Po. Then the exergy of a flow stream is determined by simply adding the flow exergy relation above to the exergy relation for anon flowing fluid

$$\Psi_{flowing\ fluid} = \Psi_{nonflowing\ fluid}\ \Psi_{flow}$$

III. CONCLUSION

The exergy analysis has been carried out for each and every component of the system, and we calculate the exergy losses in the each and every components and then analysis is performed on the overall individual subsystem. Finally the exergy analysis for the overall plant has been calculated. The energy and exergy losses of the components of each system have been determined using their mass, energy and exergy balance equations.

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