"PARAMETRIC EXERGY ANALYSIS OF CROSS FLOW SHELL AND TUBE CONDENSER AT WANAKBORI THERMAL POWER PLANT"

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I. Abstract of Entire Review :- Heat exchangers are of considerable importance, and widely used in various types of applications, therefore, the design of heat exchangers continues to be a centrally important issue in energy conservation. To determine the optimal design and operational conditions of heat exchangers, the performance of heat exchangers should be evaluated correctly, thus the usage of accurate and reliable performance evaluation methods is the key to the successful design and optimal use of heat exchangers. Reviews includes Energy and Exergy analysis of Thermal Power Plant system based on advance Thermodynamic topics .Exergy analysis which is the combination of first law and second law of Thermodynamics and highlights inefficiencies of a system. In entire reviews the need for the systematic design of heat exchangers using a second law-based procedure is recalled and discussed, and then, second-law based performance evaluation criteria for heat exchangers are presented. These criteria have been grouped into two classes: the criteria that use entropy as evaluation parameter and the criteria that use exergy as evaluation parameter. They present the entropy as an evaluation parameter in the following forms Entropy generation rate; Entropy generation number; Augmentation entropy generation number; Heat exchange reversibility norm (HERN); Local entropy generation number, and also use of exergy as evaluation parameter in the forms of various analysis of operating conditions of the systems.

II. Energy Scenario :- Energy consumption is one of the most important indicator showing the development stages of countries and living standards of communities. Population increment, urbanization, industrializing, and technologic development result directly in increasing energy consumption. This rapid growing trend brings about the crucial environmental problems such as contamination and greenhouse effect. Currently, 80% of electricity in the world is approximately produced from fossil fuels (coal, petroleum, fuel-oil, natural gas) fired thermal power plants, whereas 20% of the electricity is compensated from different sources such as hydraulic, nuclear, wind, solar, geothermal and biogas. Usually, the performance of thermal power station is evaluated through energetic performance criteria based on first law of thermodynamics, including electrical power and thermal efficiency.

III. Concept of Exergy :- In this section we define exergy, additionally, two essential underlying concepts, the environment and the dead state, are discussed. The matter presented in this chapter is adapted from the reference book of R. Yadav .The bulk of High grade energy in the form of mechanical work or electrical energy is obtained from sources of Low grade energy, such as fuels, through the cyclic heat engines. The complete conversion of low grade energy ,heat, into the high grade energy ,shaft-work, is impossible by virtue of the second law of thermodynamics.That part of the low grade energy which is available for conversion is referred to as available energy or Exergy ,while the part which , according to the second law , must be rejected ,is known as unavailable energy or Exergy.

IV. Environment And Dead State :- Any system, whether a part in a huge system such as a steam turbine in a power station or the large system (power plant) itself, works within environment of some kind. It is important to differentiate between the environment and the system's surroundings. The term surroundings refer to everything not included in the system. The term environment applies to some portion of the surroundings, the intensive properties of each phase of which are invariable and do not change significantly as a result of any system under consideration. The environment is regarded as free of irreversibilities. All notable irreversibilities are placed within the system and its immediate surroundings. Internal irreversibilities are those located within the system. External irreversibilities reside in the immediate surroundings.

V. First Law And Second Law Efficiency :- A common measure on energy use efficiency is the first law efficiency, η_I .The ratio of the output energy of a device to the input energy of the device is known as the first law efficiency. The quantities of energy is parameter which concerned with first law of thermodynamics, and disregards the forms in which the energy exists .It does not also distinguish between the energies available at different temperatures. It is the second law of thermodynamics which provides a means of assigning a quality index to energy .The concept of available energy or exergy provides a useful measure of energy quality .with this concept it is possible to analyze means of minimizing the consumption of available energy to perform a given process, thereby ensuring the most efficient possible conversion of energy for the required task.

Installed Capacity of Wanakbori Thermal Power Station

Unit Number	Installed Capacity (MW)	Dateof Commissioning	Status
1	210	March,1982	Working
2	210	January, 1983	Working
3	210	March, 1984	Working
4	210	March, 1986	Working
5	210	September, 1986	Working
6	210	November, 1987	Working
7	210	December, 1998	Working

VI. Objective of Project Work :- There are many investigations carried out to improve the design of shell and tube heat condenser. But most of the researches are related to the optimization of the geometrical dimensions of the heat exchanger. It is seen that only few papers are available on analysis and optimization of operating condition of the heat exchanger and particularly condenser.The present study focuses on the analysis of operating conditions of cross flow shell and tube condenser. Minimization of the exergy destruction is considered as objective of analysis which is subjected to condensation of entire mass flow rate of steam.

VII. Problem Identification :- The Exergy efficiency and exergy destruction is to formulate for various operating conditions of shell and tube condenser. First of all, formulation and model to analyses the given system is defined mathematically. In the next section, calculation procedure is discussed to find out values of given different operating conditions.

Effect of various steam mass flow rate on exergy analysis

m_v (kg/s)	E_d (kW)	η
151	14250	0.2718
152	14380	0.27
153	14510	0.2682
154	14640	0.2665
155	14770	0.2648
156	14900	0.2631
157	15030	0.2614
158	15160	0.2597
159	15290	0.2581
160	15420	0.2565

VIII. Result For Exergy Analysis of Shell And Tube Condenser :- There are seven units of 210 MW each at Wanakbori thermal power station. In this chapter result of exergy analysis of shell and tube condenser for six units of thermal power station are described. Result of exergy analysis of six units of power plant can be achieve by using actual data of power plant for every unit at same ambient temperature and also Saturated water steam tables appendix-DI for evaluation of unknown thermodynamic properties of the process streams at various operating parameters of condensers.

IX. Results for Exergy analysis of condensers :-The present chapter contains the results of exergy analysis in terms of exergy efficiency and exergy destruction under different operating condition of the Shell and tube type condenser of WTPS. In this chapter, Analysis of exergy efficiency and exergy destruction for various operating conditions results in the form of Tables given.

Particulars	Sym	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6

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Mass flow rate of steam	m_v	Kg/sec	148.61	150.55	147.77	148.55	150	147.22
Specific heat of Vapor	Cpv	KJ/kg K	2.0536	2.0536	2.0536	2.0536	2.0536	2.0536
Inlet temp. of Vapor	Tv1		55	55	53.5	54.50	54.70	54.5
Condenser temp.	Tcond.		51.2	50.0	50	50.20	50.50	50.5
Ambient temp.	T_o		27	27	27	27	27	[illegible]
Saturation temp.	T_s		47.80	47.2	45.6	45.5	44.5	[illegible]
mass flow rate of cooling water	m_c	Kg/sec	7408	7450	6514	7100	6147	7362
Specific heat of cooling water	Cpc	KJ/kg K	4.185	4.185	4.185	4.185	4.185	4.185
Cooling water temp. at inlet	Tc1		36	31.20	31.5	36.5	31.10	[illegible]
Cooling water temp. at outlet	Tc2		43.0	38.62	39.3	44.5	39	37.6
Exergy Destruction	E_d	kW	10918	14694	13377	13092	14527	13937
Exergy Efficiency			0.4427	0.2469	0.3017	0.4385	0.2643	0.279

X. Conclusion:- The exergy destruction and exergy efficiency depend upon several operating parameters, that are the cooling water inlet temperature, mass flow rate of cooling water and mass flow rate of steam and also atmospheric temperature (dead state). From the present study following points are concluded: Exergy analysis in terms of exergy destruction and exergy efficiency of 6 units of condenser of power plant concludes that exergy efficiency of all condensers are lesser then design value of 60%. Performance of unit no. 1 and 4 condensers are work satisfactory because their exergy efficiency are nearer to design efficiency, while condenser unit 2, 3, 5 and 6 are not working efficiently. Reasons for lower exergy efficiency are cooling water temperature difference than design value. Mass flow rate through condenser directly effects on exergy efficiency. Higher inlet cooling water temperature in condenser leads to lower exergy efficiency. From the result of exergy efficiency of six units of power plant it is also conclude that condenser of unit no.2 has a lower exergy efficiency and higher exergy destruction compare to other units of power plant and its about 0.2469 exergy efficiency and 14694 kW. Effect of variation of cooling water temperatures on exergy analysis of condenser conclude that with decrease of condenser cooling water temperature from 31.20 to 28.84 at 27 ambient temperature, exergy destruction also decrease from 14694 kW to 14193 kW. So it is better to operate the condenser at as low as possible cooling water temperature.

XI. **REFERENCE**

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