

EXERGY ANALYSIS OF THE KELANITISSA COMBINED CYCLE POWER PLANT

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Declaration

Under the guidance of Prof. J.G.A.S Jayasekara, I completed the work detailed in this thesis, and I have not submitted a report on it, in whole or in part, to any university or other institution for the purpose of earning another degree or diploma.

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Date:28/6/2024

Under my direction, the aforementioned applicant completed research for his master's degrees dissertation.

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Signature of the supervisor: ...

Date: 12/8/2024

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N.C Tantrigoda

Abstract

Understanding the level of exergy destruction of each component is very important in both optimum operation as well as thermal performance enhancement of a power plant. A detailed study of exergy destruction of major components of the Kelanitissa Combined Cycle Power Plant and sub-components have been carried out. After a careful study of significance of enthalpy and entropy in relation to the exergy destruction and identification of relevant thermodynamic equations, time variation of exergy destruction and exergetic efficiency of each sub-component over a period of twenty hours have been computed.

According to the results of the study, total exergy destruction of the power plant is 146.8 MW excluding few modules for which reliable data are not available. Average exergy destruction of three major components of the power plant namely Gas Turbine, Heat Recovery Steam Generator (HRSG) and Steam Turbine are 116.6 MW, 27.8 MW and 2.4 MW respectively. In the gas turbine, the component which is responsible for highest exergy destruction is its combustion chamber. In this sub-component, it has been calculated that there is an average exergy destruction of 70 MW. The second highest exergy destruction has been observed in the turbine component of the gas turbine and it has an average value of 42.4 MW. Second lowest exergy destruction is found to be in the HP Superheater-1 module of the HRSG and it is associated with an average exergy destruction of 16.6 MW. The Lowest exergy destruction was found to be associated with the HP Superheater-2 module where there is an average exergy destruction of 0.7 MW. Rest of the modules of the gas turbine and the HRSG have an exergy destruction of around 5 MW.

Exergy destruction of the Kelanitissa Combined Cycle Power Plant has been compared with similar power plants in tropical countries and found its exergy destruction is at an acceptable level if not better.

Problems that would arise due an inevitable error in the calculation of pressure drops across various modules of the HRSG has been highlighted. After a careful analysis of the effect due to simulated pressure drops, it has been illustrated that this would not cause a serious error in the calculation of exergy destruction.

How the variation of mass flow rate of air taken into the compressor due to the variation of ambient temperature affects the final net output of gas turbine and steam turbine has been studied and a method of reducing this reduction using a evaporative cooler has been proposed.

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