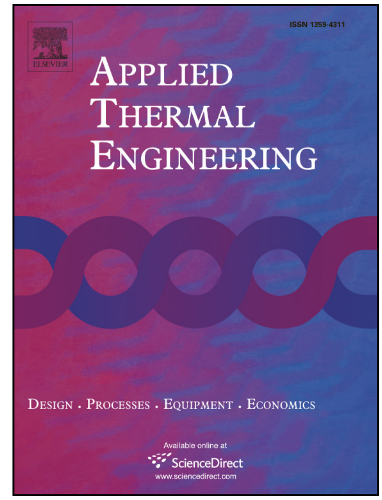
Accepted Manuscript



Research Paper

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PII: S1359-4311(17)34847-0
DOI: https://doi.org/10.1016/j.applthermaleng.2017.12.077
Reference: ATE 11598

To appear in: *Applied Thermal Engineering*

Received Date: 24 July 2017
Revised Date: 18 December 2017
Accepted Date: 20 December 2017

Please cite this article as: A. Chaibakhsh, S. Amirkhani, A Simulation Model for transient behaviour of Heavy-duty Gas Turbines, *Applied Thermal Engineering* (2017), doi: https://doi.org/10.1016/j.applthermaleng.2017.12.077

A Simulation Model for transient behaviour of Heavy-duty Gas Turbines

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Abstract

In this study, an analytical model is developed to characterize the transient behaviour of a heavy-duty gas turbine unit. While deriving models based on mass and energy conservation, the lack of essential variables such as air mass flow rate is a major problem. Constrained nonlinear optimization problems were served to obtain the unknown parameters based on experimental data. The objective functions were defined as the mean square of errors on compressor pressure ratio, compressor outlet temperature, gas fuel flow, the unit thermal efficiency, corrected outlet temperature and the generated power. The accuracy assessment was performed by comparing the responses of the model and the responses of real plant which indicated that the modelling error was less than 0.2 percent. The effect of changes in ambient conditions were also investigated by simulating open-loop model over a certain period of time. The results confirmed the accuracy of the developed model over a wide range of operations.

Keywords: Heavy-duty Gas Turbine; Modelling; Parameter Adjustment; Optimization; Genetic Algorithm; Simulation.

1. Introduction

Industrial gas turbines have been known as one of the most valuable prime movers extensively used for power and electricity generation worldwide [1]. The inherent sensitivity of the gas turbines to the changing of operational and ambient conditions, has gained efforts to enhance the efficiency of gas turbine systems by reaching the optimum operating conditions [2].

Recent improvements in the computational capabilities have made it possible to analyse and optimize the operational conditions of power generating systems based on analytical simulation models. This can reduce the costs for process optimization and remove the needs for performing experimental tests on the in-services systems that may be expensive [3]. Gas turbine models may be used as the main tool for condition monitoring [4, 5], performance assessment [6-8], control system design [9, 10], fault detection and fault diagnosis [11, 12], sensor validation [13, 14] and process optimization [15, 16].

In recent years, many different identification techniques including neural network [17], fuzzy logic [18] , neuro-fuzzy systems [19] or a combination of these techniques [12], have been employed for developing mathematical models for gas turbine systems. The capability

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