Thermal and Economic Analysis of Gas Turbine Using Inlet Air Cooling System

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Abstract: A basic goal of operation management is to successfully complete the life cycle of power systems, with optimum output against minimal input. This document intends calculating both, the performance and the life cycle cost of a gas turbine fitted with an inlet air cooling mechanism. Correspondingly, both a thermodynamic and an economic model are drawn up, to present options towards computing the cooling loads and the life cycle costs. The primary observations indicate that around 120MWh of power is derived from gas turbine power plants incorporating the cooling mechanism, compared to 96.6 MWh for units without the mechanism, while the life cycle cost is lower for units incorporating the cooling process. This indicates benefits in having the mechanism incorporated in the architecture of a gas turbine.

Keywords: Gas turbine; life cycle cost; cooling system, inlet air; power output.

1. Introduction

Considering an increased consciousness on the range of global warming challenges and the corresponding requirement for more cost efficient power production solutions, there are wide ranging studies on formulating new processes and systems to increase the output from gas turbine generators [1].

The gas turbine performance is functional to the ambient condition. As increase of the ambient air temperature arises, the compressor of the gas turbine can be compressed less air since the withdrawing capacity of compressor is given, and so the power output of the gas turbine is decrease at a given entry temperature of the turbine [1]. Additionally, the consumption work for the compression processes was increases because the volume of the air increases in proportionality to increase the ambient air temperature. Inlet air cooling system is important method for increase power output of gas turbine cycles.

Malewski and Holldorft [2], made studies on the effects of attaching an aqua-ammonia absorption chiller to gas turbines for cooling the inlet air, with a direct contact heat exchanger circulating the exhaust gases for the heat requirements. Subsequently, Johnson [3] recommended improving the efficiency levels in gas turbine generators by utilizing evaporative coolers. Ondryas and Haub [4] analyzed the utilization of vapour compression and aqua-ammonia absorption chillers to cool the inlet air, while DeLucia et al. [5] compared the impact on a cogeneration gas turbine power plant by doing away with the cooling system in its entirety. Jan [6] evaluated the impact of ambient temperatures affecting the operational indices of the gas turbines, concluding that a low inlet air temperature had an inverse effect on the flow rate of the combustion gases, ultimately contributing to power output