Estimation of Actual Performance of Gas Turbines of the Compressor Station in the Southern Iran Operational Region by Using Process Data

Mohammadreza Farrokhnia[1,*], Morteza Farrokhnia[2], Abdul Mohammad Koohpeyma[3], Davood Jafarian[3] and Aliakbar Safekordi[1]

[1] Department of Chemical and Petroleum Engineering, Sharif University of Technology, Tehran, Iran
[2] School of Mechanical Engineering, College of Engineering, University of Tehran, Tehran, Iran
[3]South Zagros Oil & Gas Production Co., Iranian Central Oil Fields Co., National Iranian Oil Co., Shiraz, Iran

ABSTRACT

The purpose of this study is modeling and simulation of twin-shaft gas turbine of the compressor station in the Southern Iran Operational Region and estimating their actual performance in the current situation in order to provide a maintenance plan for prioritizing the repair time for 4 rows of SGT-400 turbo compressor of gas compressor station. In this research, the information of twin-shaft gas turbine, SGT-400, (Siemens Company, Germany) and measurable process data from the gas compressor station were collected. In this project, Aspen HYSYS software was used for modeling and simulation of the gas compressor station process. In the simulation environment, the gas turbine was parted based on the constituent elements including 1) Air Compressor, 2) Combustion Chamber, 3) Gas Generator Turbine 4) Power Turbine and each were modeled separately. The process gas compressor that its driving force is provided by the gas turbine also was modeled. By using collected process data of turbo compressors and process gas compressors from the compressor station, required output parameters such as power consumption or power production of each elements and their efficiency were obtained at operation conditions. According to modeling, the overall framework for prioritizing repair and maintenance time for gas turbines at this gas compressor station was provided on the basis of performance efficiency, which facilitates gas turbines repair process and reduces costs. In addition, the gas turbine process was simulated and effect of process parameters on the performance of gas turbine at operating conditions was investigated. The results showed noticeable effects of environmental conditions and temperature of inlet air to the combustion chamber on the gas turbine's performance efficiency.
Keywords: SGT-400 Gas Turbine, Simulation, Actual Performance, Compressor Station, maintenance plan

1. INTRODUCTION

In recent year, Gas Turbines are one of the significant parts of modern industry. They have widely utilized in various industries, such as power generation, aeronautical industry and main mechanical drivers for huge pumps and compressors[1]. Numerous gas turbines are being generally used as the main driving components of the gas compressor station in several countries all over the world [2]. This high improving demand in the past 50 years, is because of their low weight, compactness and multiple fuel applications[3].These vast applications turned them to one of the most important engineering subjects[4].

Gas turbine is considered as an internal combustion engine which uses the gaseous energy of air to convert chemical energy of fuel to mechanical energy[5]. This means that gas turbine engines derive their power from burning fuel in a combustion chamber and utilizing the high speed of flowing combustion gases to drive a turbine[6].

A typical gas turbine mainly comprises of three main components namely compressor, combustion chamber and turbine. The three main components of a gas turbine are illustrated in figure 1. Fresh atmospheric air flows through a compressor that brings it to higher pressure. Energy is then added by spraying fuel into the air and igniting it so the combustion generates a high temperature flow. This high-temperature high-pressure gas enters a turbine, where it expands down to the exhaust pressure, producing a shaft work output in the process.As a result, the turbine produces shaft work to the surrounding [6]. Some fraction of that produced work is consumed by the air compressor while the balance shaft work can be considered as the net work. The useful shaft work can be used by process gas compressor as the mechanical driver. The energy that is not used for shaft work comes out in the exhaust gases, so these have either a high temperature or a high velocity[1].

The thermodynamic process used by the gas turbine is known as the Brayton cycle. The Brayton cycle (or Joule cycle) is the thermodynamic cycle which is used to explain the principle and operation of a gas turbine engine[4]. The Brayton cycle efficiency is maximised by increasing the pressure difference across the machine. A property of these gas power cycles is that the fluid throughout the cycle remains a gas. Energy is provided by means of internal combustion