



# Exergoeconomic optimization of a trigeneration system for heating, cooling and power production purpose based on TRR method and using evolutionary algorithm

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## ABSTRACT

In the present study, exergoeconomic optimization of a trigeneration system for cooling, heating and power purposes has been carried out. The system is made up of air compressor, combustion chamber, gas turbine, dual pressure heat recovery steam generator and absorption chiller in order to produce cooling, heating and power. The design parameters of this study are selected as: air compressor pressure ratio, gas turbine inlet temperature, pinch point temperatures in dual pressure heat recovery steam generator, pressure of steam that enters the generator of absorption chiller, process steam pressure and evaporator of the absorption chiller chilled water outlet temperature. The economic model used in this research is according to the total revenue requirement (TRR) and the cost of the total system product was defined as our objective function and optimized using a Genetic Algorithm technique. Results of exergoeconomic optimization are compared with corresponding features of the base case system. It has been seen that objective function was modified about 15 percent after optimization. Furthermore, a sensitivity analysis has been presented in order to investigate the effects of decision variables on the different objective functions. Decision makers may find the methodology explained in this paper, very useful for optimal comparison and selection of trigeneration systems.

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## 1. Introduction

Energy and energy saving are one of the crucial items all around the world. Problems with energy supply and its use are related not only to global warming, but also to environmental concerns such as air pollution, acid precipitation, ozone depletion, forest destruction, and emission of radioactive substances [1]. These issues must be taken into our consideration simultaneously if humanity is to achieve a bright energy future with minimal environmental impacts [2–4]. Therefore, cogeneration systems are one of the best energy saving methods to make a more efficient usage from fuels to achieve environmental improvements. Cogeneration systems make it possible to produce electricity and useful thermal energy from a same energy resource. The requirements of a cogeneration may be met in many ways, such as steam and gas turbines, fuel cells and Stirling engines. Sometimes, a part of heat production of a site may be used for handling an absorption chiller and thereby the cooling demand of the site will be covered. In fact, in such a case the most beneficial way is applied for using primary energy, because system

can produce power, heat and cold; simultaneously (CCHP) [5]. Due to the high prices of energy and decreasing fossil fuel resources, the optimum application of energy and the energy consumption management methods is very important [6].

Recently, trigeneration energy systems have attracted a lot of attention because they have higher efficiency as well as low environmental impacts [7]. Trigeneration is a simultaneous production of heating, cooling and electricity from a common energy source [8]. Trigeneration utilizes the waste heat of a power plant to improve overall thermal performance, essentially utilizing the “free” energy available via waste energy. In a trigeneration system, waste heat from the plant’s prime mover e.g., gas turbine or diesel engine or organic Rankine cycle. Energy analysis which is based on the first law of thermodynamics does not provide enough details about losses and the location in which they occur. Second law of thermodynamic provides a good insight for thermal energy systems including CHP and dtrigeneration energy systems [9]. On the other side, energy and exergy analysis are not sufficient to design a system properly this is why economic must be taken into our consideration. Thermoeconomic provides a powerful tool for an economic and optimization of energy systems [10]. There are several studies carried out in the literature about trigeneration

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