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The Relationship of Air Conditioning Science to Increasing the Efficiency of Gas Turbines and their Operating Mechanism

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Abstract: ***In this work, the design models of the gas turbine (GT), as well as the thermodynamic models in which the turbine operates, were passed in order to be able to calculate the rates of thermal energy and energy leaving the system and the thermal efficiency of the system in various climatic conditions. Variable atmospheric air (temperature and specific humidity of the air entering the turbine) we chose the evaporative cooling system (VCS) because the climatic conditions of desert regions with high temperature lack moisture, which requires a significant reduction in temperature to reach the required humidity ratio meaning greater cooling loads this problem was solved by sprinklers. It works to moisten the inlet air at the expense of reasonable cooling loads. The results showed that when the temperature of the air entering the turbine is reduced to (10°C), the percentage of useful work of the turbine will increase to (18%) and the thermal efficiency of the system will increase to about (4%). From these data it can be said the development of the gas turbine with the initial cooling of the air entering the turbine gives the best performance of the system compared to the old systems***

Keywords: GT, thermodynamic, efficiency, development, VCS

1. Introduction

It has been noticed recently that the energy produced by the turbine decreases with the increase in the temperature of the air entering the turbine, as in the summer and vice versa in the winter. Therefore, this proposal depends o n reducing the temperature of the inlet air by pumping a quantity of atomized water into the face of the air entering after the air filter and then passing it On a cooling file, thus lowering the air temperature and increasing its humidity before entering the compressor, and this helps to increase the efficiency and performance of the required power generation process. In this research, we calculated the efficiency of the turbine based on the operational data of the gas turbines at the power supply station of the Zueitina Oil Company for the month of January 2022. The expected efficiency of the same station was calculated if the air temperature was reduced at the intake line.

2. Experimental Procedures

In this research, we will discuss a detailed explanation of the link between the science of air conditioning and refrigeration in increasing the efficiency of internal combustion turbines and the mechanism of their operation. This research is designed in three main steps

In the first step: We studied the basics of the internal combustion turbine with an understanding of its working principle, its internal design, and a detailed understanding of the unit's systems such as the cooling, lubrication, fuel and ignition system so that it is easier for engineers to discover errors and problems for old systems and work to find simplified solutions to them.

In the second step: we learned about the relationship of the science of adaptation and refrigeration in increasing the efficiency of gas turbines, and we presented you with a number of solutions to some common problems in turbines in areas with a desert climate to obtain stable operating conditions

In the third step: We presented you with a proposal to increase the efficiency of gas turbines by placing an air cooler at the intake line of the system

3. Results and Discussion

The results were divided into two parts. In the first section, the difference between the efficiency and performance of the old system and the new system after development was presented. In the second section, some of the advantages and disadvantages expected after development were presented, and the following was concluded.

3.1 The difference between the two systems:

It was noted that the isotropic efficiency of the compressor increases as the air temperature decreases at the intake line, and the thermal efficiency will also increase with the initial cooling of the air. As indicated in the following table:-

Comparison of the system results before and after the cooling process

Table 1

Description	Code	Value before cooling	Value after cooling
Isotropic efficiency of the compressor	ηis$c$	4580	458
Isotropic efficiency of the turbine	ηisT	458	458
Thermal efficiency of the system	ηth	45..0	45.8
System useful work ratio	WR	0.205	0.252

Advantages and disadvantages of the new system

First / Advantages of the system:

1) This system increases the useful work of the turbine to about 19%, which varies according to the design and production capacity of the turbine.
2) It increases the thermal efficiency of the system to approximately 17%, which varies according to the calorific value and the rate of fuel consumption
3) It increases the efficiency of combustion, making it more environmentally friendly, because this system reduces harmful permissions such as nitrogen oxides and carbon dioxide.
4) Increasing the useful life of the turbine compared to the old systems
5) It works to increase the humidity of the air entering the turbine to ensure the entry of an appropriate amount of moist air whose density is higher than the dry air and thus the flow rate is higher
6) This system works to stabilize the heat content, meaning that the cooling process is adiabatic and not reversible, meaning there is no heat loss or gain

Second / Disadvantages of the system:

1) Water must be constantly available near the place of the turbine, with high specifications, and free of salts and impurities
2) The additional equipment of this system increases the costs of preventive and curative maintenance of the system, as it needs a larger area than it was before the development
3) You need accurate calculations of the initial costs of the project and compare them with the expected benefits

4. Conclusion

Each system has a number of advantages and disadvantages that must be taken into consideration before starting any project. Therefore, the air cooling project at the turbine intake line has many advantages at the expense of a small number of disadvantages. Therefore, I advise large power generation companies with this proposal.

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