

Technical Evaluation of Upgrading a Simple Gas Turbine Fired by Diesel to a Combined Cycle Power Plant in Kingdom of Saudi Arabistan Using WinSim Design II Software

Authors : Salman Obaidoon, Mohamed Hassan, Omer Bakather

Abstract : As environmental regulations increase, the need for a clean and inexpensive energy is becoming necessary these days using an available raw material with high efficiency and low emissions of toxic gases. This paper presents a study on modifying a gas turbine power plant fired by diesel, which is located in Saudi Arabia in order to increase the efficiency and capacity of the station as well as decrease the rate of emissions. The studied power plant consists of 30 units with different capacities and total net power is 1470 MW. The study was conducted on unit number 25 (GT-25) which produces 72.3 MW with 29.5% efficiency. In the beginning, the unit was modeled and simulated by using WinSim Design II software. In this step, actual unit data were used in order to test the validity of the model. The net power and efficiency obtained from software were 76.4 MW and 32.2% respectively. A difference of about 6% was found in the simulated power plant compared to the actual station which means that the model is valid. After the validation of the model, the simple gas turbine power plant was converted to a combined cycle power plant (CCPP). In this case, the exhausted gas released from the gas turbine was introduced to a heat recovery steam generator (HRSG), which consists of three heat exchangers: an economizer, an evaporator and a superheater. In this proposed model, many scenarios were conducted in order to get the optimal operating conditions. The net power of CCPP was increased to 116.4 MW while the overall efficiency of the unit was reached to 49.02%, consuming the same amount of fuel for the gas turbine power plant. For the purpose of comparing the rate of emissions of carbon dioxide on each model. It was found that the rate of CO₂ emissions was decreased from 15.94 kg/s to 9.22 kg/s by using the combined cycle power model as a result of reducing of the amount of diesel from 5.08 kg/s to 2.94 kg/s needed to produce 76.5 MW. The results indicate that the rate of emissions of carbon dioxide was decreased by 42.133% in CCPP compared to the simple gas turbine power plant.

Keywords : combined cycle power plant, efficiency, heat recovery steam generator, simulation, validation, WinSim design II software

Conference Title : ICCCECP 2018 : International Conference on Chemistry, Chemical Engineering and Chemical Process

Conference Location : Venice, Italy

Conference Dates : April 12-13, 2018