A Review of Effect of Various Parameters on the Performance of Combined Cycle

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I. INTRODUCTION

The interest in the combined cycle operation was aroused through the world in mid 1970’s. During the last two decades a number of alternative combined cycle concepts have been developed. In this paper, a detailed review of literature on combined cycle power plant has been undertaken, which evaluates various gas/steam combined cycle arrangements consisting of a gas turbine coupled to an alternative bottoming cycles. In addition the methods of thermodynamic analysis and simulation of these power plants available in the literature have been briefly reviewed.

II. LITERATURE PAPERS

These papers are in chronological order and basic review which I have find from these papers also discussed.

A paper “A Comparative Evaluation of Advance Combined Cycle Alternatives” authored by “Olav bolland” in 1990 in this paper he want to make a comparison of measures to improve the efficiency of combined gas and steam turbine cycles. For the increase in the electrical efficiency of CCs in their experiments they did it by gas turbine a improvement which is used in the combined cycle. They improved the performance of gas turbine used in cc by which overall performance of the complete cycle increased.

Increased firing temperatures have been introduced for gas turbines with relatively moderate pressure ratios, which has resulted in exhaust gas temperatures above 500 °C. This type of gas turbine improvement has a positive influence on the electrical efficiency of the steam cycle.

This paper deals with the potential for improving the steam cycle efficiency in a large CC (>400 MW), and thereby increasing the CC electrical efficiency.

Introducing reheat improves the efficiency by 0.2-0.4 percentage points compared to the non-reheat cycles, both for the dual and triple pressure cycles. The difference in efficiency between dual and triple pressure cycles is about 0.5-0.6 percentage points except for smaller HP-pressures where this difference tends to decrease. Supercritical reheat cycles give a higher efficiency than the subcritical cycles.

A paper “Power augmentation of combined cycle power plants using cold energy of lique®ed natural gas” by T.S. Kim in 1999 in which he study the feasibility of using inlet air cooling by virtue of the cold energy of lique®ed natural gas (LNG) to increase power output of gas/steam combined cycle power plants during warm seasons is analyzed. For which by his study he find that Gas turbines have numerous advantages, but they also have several disadvantages, one of which is the high dependence of their performance on ambient temperature.

During the hot season in particular, gas turbines produce less power due to their operational characteristics, while demand for electricity is possibly higher than in other seasons. This research proposes the use of low temperature LNG as source of cold energy for the gas turbine inlet air cooling process in the conventional combined cycle power plant. And find a result that 10 degree C rise in ambient temperature causes a more than 6% power reduction on the average, nearly 4% of which is due to the decline in air mass the dependence of the condensing pressure on the ambient temperature gives rise to a remarkable reduction in steam turbine power with increasing ambient temperature as in The exhaust loss also affects the results.

As the condensing pressure declines, the annulus velocity increases due to reduced density. Therefore, the exhaust loss becomes larger.

After that giving his conclusion that If the humidity is low enough for warm ambient air, water vapor in the air does not condense and the corresponding increase in power is larger than 8% on average, without considering the reduction in air side pressure.

A paper “Effect of supplementary firing on the performance of an integrated gasification combined cycle power plant” publish by “S De and P K Nag” they found that the performance of an integrated gasified combined cycle. For which they done some experiments the results are presented with respect to a simple ‘unfired’. It is found that the most favourable benefit of supplementary firing can be obtained for a low
temperature ratio $R_T$ only. In a basic combined cycle plant, the bottoming cycle operates with the exhaust heat from the open cycle gas turbine and no additional fuel is added to it. Thus, the link between the two cycles, i.e. the heat-recovery steam generator (HRSG) is only a ‘heat exchanger’ that couples the two cycles. The work output and overall efficiency of the power cycle with different degrees of supplementary firing (DSFs) and operating parameters of the gas cycle (such as pressure ratio and temperature ratio) are discussed.

After various analysis they find that the The performance of an unfired IGCC power plant depends largely [6] on the two most important operating parameters, namely the pressure ratio $R_p$ across the compressor and the temperature ratio $R_T$ across the combustor before the gas turbine (CC-I). In addition to these parameters, the amount of fuel burned in the combustor after the gas turbine (CC-II) also has a strong influence on the performance of the plant. They concluded that the effect of supplementary firing on overall efficiency of the plant (expressed as the ER) is very sensitive to $R_T$.

A paper “Combined cycle plant efficiency increase based on the optimization of the heat recovery steam generator operating parameters” publish by “Alessandro Franco, Alessandro Russo” their main objective to do this research was to increase the performance of the combined cycle by the improving and by analysis of the heat recovery steam generator or in other words the condition of steam generation. To accomplish this aim it has been proposed also the use of heat exchange sections with two or more parallel flows of water exchanging simultaneously with the same gas stream, and the removal of any constraint on the highest pressure of steam.

In this paper, two different optimization criteria are taken into account, so two different objective functions are needed. The first one is a measure of the thermal efficiency of the HRSG; the second one represents a total cost of the HRSG, sum of the cost of exergy losses and the cost of its sections.

They concluded that A method to optimize the operative parameters of a HRSG has been proposed, in order to attempt to improve the overall efficiency of combined cycle plants. Actually two different objective functions have been considered: one given by the exergetic losses due to the heat transfer between fluids; the other represented by a cost, sum of the cost of the HRSG and the cost of the exergy losses. The minimization of the former objective function allows to find the best configuration of the HRSG, though if it is not actually realizable, because of the infinite exchange surfaces obtained.

The paper publish on “Combined cycle dynamics” by F M Mansour, A M Abdul Aziz to describing the dynamic behaviour of each major component of the combined cycle is presented for which they done. The investigation of the combined cycle dynamics goes in parallel with the investigation of the steam cycle dynamics due to the common components existing between the two cycles. These investigations were dedicated to developing the cycle design and the control problem both from opera-tional and economical points of view, and consequently the cycle performance for this they do mathematical analysis of 1-Combined cycle components 2- Steam–water drum and downcomer–riser 3- Steam–water drum 4- Steam turbine 5- Control loops

They find result The simulation is applied to Unit 4 in Cairo South Combined Cycle Power Plant. Maximum continuous rating is 180 MW; one-third of it is produced by the steam turbine.

A paper “Thermodynamic performance evaluation of combustion gas turbine cogeneration system with reheat” publish by “A. Khaliq S.C. Kaushik” in This communication they present thermodynamic methodology for the performance evaluation of combustion gas turbine cogeneration system with reheat and they find that Combined production of different types of energy can lead to a greater efficiency of fuel use compared to separate production. On the other hand it is more difficulty to satisfy simultaneously.

The utilization of primary energy in fuel at cycles with combustion gas turbine is as high as 91%, it produces 48–64% of primary energy as heat energy and from 25% to 37% in electric power.

Along with this information the data from Keenan et al. [12] have been used to calculate enthalpy values for the gas mixture. They concluded that It has been observed that the power-to-heat ratio increases with an increase in the pinch point which is expected because a larger pinch point will result in a higher temperature in the flue gas.

III. CONCLUSION

After reading all this literature reviews I have reach to a conclusion that the performance of combined cycle is depend on a large number of parameter and to find a optimum value of the effect of each parameter should be analysis on various conditions.

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