International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 1 Issue 9, November- 2012

Optimization Of Electrical Generator Output At Varying Input Conditions In Combined Cycle Gas Turbine-A Bibliography

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Abstract-This bibliography presents the critical review of literature on the performance of combined cycle gas turbine power plant (CCGT).In this paper the various issues related to CCGT in different operating conditions and mode is being envisaged .The literature survey shows that there are various models available for CCGT plant operational analysis in the context of cost, emission scheduling , restoration , frequency variation and enhancement of efficiency by inclusion of AGC .There are few studies on the aspect of Electrical Generator. The need is felt to optimize the Electrical Generator output directly by controlling the various input conditions by use of super critical HRSG, Turbine Inlet Temperature(TIT) and Exergy of the plant.Further the emphasis is understand the state of art of CCGT Technology in the context of electricity pool.

Keywords-CCGT,HRSG, Exergy, Super critical .

I .INTRODUCTION

Nowadays electrical energy is the most important form of energy used by man and the importance of its generation is quite clear to everyone. For this reason, power stations needs to be analyzed as the most important energy systems. Among the different types of power plants, thermal power plants hold a greater share in power production and combined cycle power plants based on gas turbines, as various advantages such as their high efficiency, negligible emission of environment pollutants, high availability, short repair time, flexibility in production, etc., have undergone rapid development during the last few years, and today they are recognized as the most effective large scale and industrial level power plant in the world. As a result, various efforts have been made through out the world to achieve optimal design and to boost performance of these power plants.

Designing combined cycle gas turbines (CCGT) is very complex. This is because two different power generation cycles are connected to each other via a heat recovery steam generator (HRSG), and any change in its design directly affects variables such as power, efficiency, cost, etc.

In a combined cycle power station (CCGT), the equipment used (such as compressors, pumps turbines and valves) is generally presented as standard ware in different sizes, while the heat recovery steam generator is one of the few devices that is custom made, keeping in mind the conditions of a specific power plant, and in reality is not a standard piece of equipment. Thus based on a practical point of view and not theoretical considerations, it is the only device of a combined cycle gas turbine power station in which all the parameters of steam cycle performance have been considered and can be optimized

Moreover, all the research formerly done was limited to optimization of parameters connected with the combined cycle gas turbines in isolation. Many researchers worked on the output characteristics of the Electrical Generator output in isolation. The optimized parameters of the combined cycle gas turbines were of limited use when attempted to Electrical Generator as the optimized condition was not obtained as determined for isolated Electrical Generator. So there was some lag in it. The reverse technique too did not yield the desired result.

In other words, literature shows that there has been no study on the optimization of the Electrical Generator output and effect of temperature on the performance of CCGT Generator with regards to inclusion of Automatic Generation Control (AGC) for parametric optimization of the combined cycle gas turbines. So the need is felt to optimize the matching performance characteristics of the combined cycle gas turbines and the Electrical Generator. The present work is intended to attempt to determine the optimization of Electrical Generator output based upon the optimization of the combined cycle gas turbines and determine the range of operation of the plant. In order to achieve optimum performance point, one needs to vary the parameters and accordingly design may required modification.

II. BIBLIOGRAPHY

Literature reveals that there has been little study on the optimization of the Electrical generator output with regards to. Parametric optimization of the combined cycle gas turbines, matching performance characteristics of the combined cycle gas turbine and the Electrical Generator. So the need is felt to optimize the matching performance characteristics of the combined cycle gas turbines and the Electrical Generator. Based up on the area intended research, the literature has been reviewed .Few paper have been incorporated to understand the state of art of technology / knowledge in the area of research has been summarized.

1. **W J Watson, " The success of the combined cycle gas turbine ''International Conference of Opportunities And Advances in International Power Generation ,Publication No .419, pp-87-92 , 18-20th march,1996.**

   In this paper the author has re evaluated the conventional wisdom of CCGT and its popularity due to changed market circumstances and cheep natural gas the short history of CCGT technology is also presented here. The author as indented to examine the technology it self an its attributes, the role of equipment manufacturers. As liberalization spreads to other areas of world from its origin in the USA and Europe, the newly formed Independent Power Producers are using the CCGT on many projects in Asia and elsewhere due to its low Capital Cast ,short Construction time and quick start capability during black out for Restoration of Power System Network.

2. **Zubaidy- S.AL , F. *S.* Bhinder "Towards Optimizing the Efficiency of Electrical Power Generator", IEEE Transactions on Power systems, VOL 16 , pp 1857-18621, 1996**

   The thermal efficiency of a gas turbine engine, which ranges between 28% to ***33%,*** may be raised by recovering some of the low grade thermal energy from the exhaust gas to heat the high pressure air leaving the compressor. The overall thermal efficiency of a combined power and power (CCP) cogeneration plant can be raised to about 60%. This is twice the value that may be reached by a modem gas turbine and nearly one and a half times the value that may be reached by a modem steam turbine. The work presented in this paper is an initial and preliminary study of a sponsored project that examines the effect of design parameters on overall performance of the power cycle with the view of producing **a** code that enables researchers to produce a complete computer simulation of the CCP for the purpose of developing control strategies.

3. **T.Heppenstall "Advanced gas turbine cycles for power generation: a critical review" Applied Thermal Engineering, VOL 18 ,pp 837-846, 1998.**

   The use of gas turbines for power generation has increased in recent years and is likely to continue to increase in the medium term. This paper describes and compares several power generation cycles which have been developed to take advantage of the gas turbine's thermodynamic characteristics. Emphasis has been given to systems involving heat recovery from the gas turbine's exhaust and these include the combined, Kalina, gas/gas recuperation, steam injection, evaporation and chemical recuperation cycles. Thermodynamic and economic characteristics of the various cycles are considered in order to establish their relative importance to future power generation markets.

4. **4.Yousef S.H. Najjar "Efficient use of energy by utilizing gas turbine combined systems" Applied Thermal Engineering, VOL 21, pp 407-438, 2001.**

   The gas turbine engine is characterized by its relatively low capital cost compared with steam power plants. It has environmental advantages and short construction lead time. However, conventional industrial engines have lower efficiencies especially at part load. One of the technologies adopted nowadays for improvement is the combined cycle. Hence, it is expected that the combined cycle continues to gain acceptance throughout the world as a reliable, flexible and efficient base load power generation plant. In this article, 12 research investigations, carried out by the author and associates during the last 10 years are brief reviewed. These cover 12 gas turbine systems which would contribute towards efficient use of energy. They entail fundamental studies in addition to applications of combined systems in industry including: the closed gas turbine cycle; the organic Rankin cycle; repowering; integrated power and refrigeration; cryogenic power; liquefied natural gas (LNG) gasification; and inlet air cooling.

5. **5.Franco Alessandro, Alessandro Russo "Combined cycle plant efficiency increase based on the optimization of the heat recovery steam generator operating parameters" International Journal of Thermal Sciences, VOL 41 , pp 843–859, 2002**

   In the present work, it is shown how it could be possible to reach the performances by best fitting the existing technology. In particular work attention to the optimization of the heat recovery steam generator (HRSG), as a first step in the analysis of the whole plant, according to a hierarchical strategy. Author handles this problem adopting both a thermodynamic and a thermo economic objective function instead that with the usual pinch point method. Thermodynamic optimization has the purpose to diminish energy losses, expressed on exergy basis, while the aim of the thermo economic optimization is the minimization of a cost function, sum of the cost of exergy inefficiencies and the cost of the HRSG. Proposed methods have been applied to some HRSG configurations, including some present commercial plants. The results of the application of the thermal optimization leads to a meaningful increase of the thermal efficiency of the plant that approaches the 60%, obtained with and increases of the heat surface and a decrease of the pinch-points.

6. **David M. Paine*, Senior Member, IEEE,* "Increasing the Electrical Output of a Cogeneration Plant", IEEE Transactions On Industry Applications, VOL. 38, (NO. 3), pp 726-735, 2002.**
This paper provides a technical description of the electrical system for an operating gas-turbine-based combined cycle power plant and discusses the control and electrical challenges associated with adding a steam turbine generator to the plant. Preferred option for a new plant is thought likely to continue.

7. **Chan K, A. E. Arifin, Y. C. Chew, C. Lin' and H. Ye' "Validated Combined-Cycle Power Plant Model for System and Station Performance Studies"2004 International Conference on power system technology-(POWER CON 2004), pp 1991-1997, Singapore,21-24 November 2004 .**
This paper presents the development of a simulation model of a new 650MW multi-shaft combined cycle power plant located in Malaysia. The power plant model comprises of detailed simulation models of the major equipment enabling system and plant dynamic performance studies to be carried out. These models can provide detailed electrical as well as physical information related to the generator, excitation system, gas turbine, steam turbine, heat recovery steam generator and associated controls. In order to access the physical information of the gas turbine such as outlet temperature, fue1 mass flows etc., a physical model of the gas turbine and a replica of the relevant gas turbine contro1 system have been developed.

8. **Andrew Baxter, Mark Sanford, Richard Smith and Richard Szczepanski, "Analysis of Combined Cycle Operating Patterns", 8- International Conference on Probabilistic Methods Applied to Power Systems, IOWA, pp 850 – 854, 2004.**This paper examines the historical operating patterns of combined cycle power plants and also haw these patterns have changed in recent years. A fundamental power system simulation model is used to predict future operations. Using the fundamental model to predict the maintenance and parts needs for the entire fleet of units without needing to expressly consider the uncertainty inherent in each individual unit's forecast operation is explored and discussed

Finally, the impact of these changes in combined cycle operating pattern is discussed from both an equipment owner standpoint, and the original equipment manufacturer (OEM) parts and services supplier. The advantages of sharing operating data are illustrated by some of the new products that have been introduced because of improved operating knowledge.

9. **Khaliq A., S.C. Kaushik "Second-law based thermodynamic analysis of Brayton/Rankine combined power cycle with reheat" Applied Energy VOL 78, pp 179–197, 2004**
The aim is to use the second-law approach for the thermodynamic analysis of the reheat combined Brayton/Rankine power cycle. Expressions involving the variables for specific power-output, thermal efficiency, exergy destruction in components of the combined cycle, second-law efficiency of each process of the gas-turbine cycle, and second law efficiency of the steam power cycle have been derived. The standard approximation for air with constant properties is used for simplicity. The effects of pressure ratio, cycle temperature ratio, number of reheats and cycle pressure-drop on the combined cycle performance parameters have been investigated. It is found that the exergy destruction in the combustion chamber represents over 50% of the total exergy destruction in the overall cycle. The combined cycle efficiency and its power output were maximized at an intermediate pressure-ratio, and increased sharply up to two reheat-stages and more slowly thereafter.

10.Gillian Lalor, Julia Ritchie, Damian Flynn and Mark J. O'Malley, "The Impact of Combined-Cycle Gas Turbine Short-Term Dynamics on Frequency Control", IEEE Transactions on Power Systems, VOL. 20, (NO. 3), pp 1456 – 1464, 2005.
A model suitable for studying the short-term dynamic response of a combined-cycle gas turbine (CCGT) to a system frequency deviation is developed. The model is used in conjunction with a larger system model to study the impact of increasing levels of CCGT generation on frequency control of a small island system. The study considers single contingencies and does not consider severe cascading-type events. A consequence of the results is that as the number and proportion of base-loaded CCGTs increases, frequency control may become more challenging. The results indicate that with additional CCGTs on the system large frequency excursions will be more likely, and the transmission system operators on the island of Ireland should review their frequency control strategies in the future to avoid the shedding of customers.

11.Ning C. N., C. N. Lu, "Effects of Temperature Control on Combined Cycle Unit Output Response" IEEE Transctions On Power Systems, VOL 105, pp 152-155, 2006
In this study, fuel flow and air flow controllers are controlled according to a pre-determined exhaust gas temperature values which are defined as a function of the gas turbine power outputs. This direct temperature control scheme has the advantage of quick response and it can maintain proper exhaust

gas temperature at gas turbine loading-up period. The calculate procedure used in this paper is helpful for understanding the unit output response of a combined cycle unit. It also provides useful information for setting minimum/maximum operating ranges of AGC participating units.

A combined cycle power plant consists of gas turbines, heat recovery steam generators, steam turbines and power generators. The power output of a gas turbine depends on the ambient temperature. Temperature control is important for preventing excessive temperature in the turbine. A single shaft combined cycle unit is used in this study to investigate the effect of temperature control in its output control response when operates near its rated capacity. Gas turbine thermodynamic relations obtained from practical combined cycle unit operations are used to develop a flow diagram to simulate the steady state gas turbine parameters variations and unit load change curves can be obtained. Simulation results obtained in this study are helpful for understanding the temperature effects on the combined cycle unit outputs.

12.M. Sanchez Parra and C. Verde, "Analytical Redundancy for a Gas Turbine of a combined Cycle Power Plant", Proceedings of the 2006 American Control Conference Minneapolis, Minnesota, USA, pp 4442 – 4447, 2006.

This paper studies the structural properties related with the supervision of a gas turbine unit of a combined cycle power plant with sensors faults. The analysis is carried on using the structure defined by constraints and variables contained in a non-linear complex dynamical model. Considering the model described by 37 algebraic and differential equations, the structural analysis based on the matching procedure of the Boolean incidence matrix is used to study the analytical redundancy of the turbine and its redundancy degrees for fault diagnosis. The conclusions obtained with the analysis allows to suggest which sensors and variables have to be considered as the most critical in the turbine from integrity point of view.

13.C. Albanesi, M. Bossi, L. Magni, J. Paderno, F. Pretolani, P. Kuehl and M. Diehl, "Optimization of the Start-up Procedure of a Combined Cycle Power Plant", Proceedings of the 45th IEEE Conference on Decision & Control USA , pp 1840-1845, 2006.

The growing diffusion of Combined Cycle Power Plants (*CCPPs*), together with the increasing energy demand and grid regulation difficulties due to the energy market liberalization, require the participation of Combined Cycles to the load modulation and thus an increase in the frequency of the start-up and shut-down. The aim of this work is to carry out the optimization of the start-up of the Combined Cycles using a model-based approach. The comparison between a standard start-up procedure applied to a real plant in Italy and some simulation experiments show the potential advantages of this approach.

14.Robertovich Kvrivishvili Arseny, "Features of a choice of technical design parameters of combined steam-cycle power unit high temperature Sets", IEEE Transactions On Power Systems, VOL 10 , pp 353 – 358, 2007

In a foreseeable prospect the coal will keep being the basic source of the electric power generation. In many developed countries within the framework of national programs (ATS USA, "THERMIE" - the European Community, etc.) new highly effective coal technologies based on integrated gasification combined-cycle (IGCC) plants, combined-cycle plants (CCP) with pressurized fluidized bed combustion, CCP with external (indirect) combustion In the coal-fired CCP with external combustion the combustion chamber of a gas turbine is substituted for the air boiler, in which the hot air under pressure is heated, and then it is fed into the gas turbine and after that passed into the heat recovery steam generator to produce steam for a steam turbine. The coal firing and flue gas treating are at atmospheric pressure (as in conventional boilers). 12.5 MW gas turbine generation sets with indirect combustion are operated in coal fired power plants located in Saint-Denis (France), Dundee (Scotland), Oberhausen (Germany). Kashir power plant (Russia) includes 10 MW power unit, fired with lignite. The construction of a demonstration installation with external staged combustion of the coal is planned in Barren power plant (Pennsylvania). Working medium is -hot air. are developed. The efficiency of such installations attains 45-50 %.

15.R.K.Kapooria, S.K. Kumar, K.S. Kasana , "An analysis of a thermal power plant working on a Rankine cycle: A theoretical investigation". Journal of Energy in Southern Africa , Vol 19 No 1 ,pp 77-83,2008

The efficiency of a simple Rankine cycle is improved by using intermediate reheat cycle, enabling improved thermal conditions of the working fluid. However, it cannot reach the thermal conditions as in the case of the Carnot cycle where heat addition and heat rejection occurs at a specified temperature range. The regeneration is vital to improve the efficiency as it uses the sensible heat of exhaust steam for the preheating of feed water. Inclusion of a FWH also introduces an additional pressure level into the Rankine cycle. Hence, the extraction pressure level is another parameter under the control of the designer. The control of steam condenser pressure i.e. condenser vacuum and supply of condenser tube cooling water is another parameter which affects the steam thermal power plant efficiency.

16.Boonnasa S, P. Namprakai ''Sensitivity analysis for the capacity improvement of a combined cycle power plant (100–600 MW)'' Applied Thermal Engineering VOL 28 ,pp 1865–1874, 2008.

Power improvement of a combined cycle power plant using inlet air cooling was analyzed in this paper. The corresponding CC capacities in a range of 100–600 MW were examined. The CC performance can be improved by decreasing an inlet air temperature and humidity
to 15°C (ISO) and 100% RH before entering air compressor of a gas turbine (GT). This research used a steam absorption chiller (AC) to cool intake air to the desired temperature level and no storage unit was needed. The CC uses a cooling tower (CT) for cooling purpose. In the 400 MW power plant as an example, it could increase the power output of the GT by 9.32% and the CC by 5.8%, while the ST power decreased by 3.42% annually, as some steam was supplied to the AC. Additionally, sensitivity analysis concerning output performance and environmental impact of the plants were also studied.

17.Soon Kiat Yee, Jovica V. Milanovic, and F. Michael Hughes, "Overview and Comparative Analysis of Gas Turbine Models for System Stability Studies", IEEE Transactions on Power Systems, VOL. 23, (NO. 1) , pp 108 – 118, 2008

Gas turbines have become increasingly popular in the different power systems, due to their lower greenhouse emission as well as the higher efficiency, especially when connected in a combined cycle setup. With increasing installations of gas turbines scheduled in different countries, the dynamics of the gas turbines become increasingly more important. In order to study such dynamics, accurate models of gas turbines are needed. This paper presents a comparative analysis and an overview of various models of gas turbines published in different literature.

18.L.X.Niu and X.J.Liu, "Multivariable Generalized Predictive Scheme for Gas Turbine Control in Combined Cycle Power Plant", Proceedings of the 45th IEEE Conference on Decision & Control 2008, pp 791 – 796, 2008

The major dynamics of the gas turbine in combined cycle power plant(CCPP) include nonlinearities behavior, time delays, and uncertainties. Traditional control strategy could not offer satisfactory result. Using the linearization modeling technique, this paper deals with the velocity and power control by multivariable generalized predictive control method.

Comparisons of generalized predictive control with conventional PID approaches were made under different load condition. Simulation results show the effectiveness of the proposed method.

19.Sanjay, Mukul Aggarwal, Rajay, "Energy and Exergy Analysis of Brayton-Diesel Cycle", Proceedings on the World Congress on Engineering on 2009 V0l II WCE 2009, July 1-3, 2009, London, U., pp 79-84, 2009

In this work the energy and exergy analysis of a hybrid gas turbine cycle has been presented. The thermodynamic characteristic of Brayton-diesel cycle is considered in order to establish its importance to future power generation markets. Mathematical modeling of Brayton-diesel cycle has been done at component level. Based on mathematical modeling, a computer code has been developed and the configuration has been subjected to thermodynamic analysis. Results show that, at any turbine inlet temperature (TIT) the plant specific work initially increases with increase of pressure ratio (rp,c), and but at very high values of pressure ratio, it starts decreasing. For a fixed value of rp,c (more 6 than 10) with the increase in TIT, plant efficiency and specific work both increase. The cycle is best suited for applications where power requirement ranges between 700-900 kJ/kg.

20.Yee.S.K, J.V.Milanovic, F.M. Huges "Phase Compensated gas turbine governor for damping oscillatory modes" Electric Power System Research, Vol.79, pp 1192-1199 , 2009. In this paper the stringent operations of the power system for gas turbine for damping oscillatory modes is carried out the phase compensation method is applied to validate models of gas turbines in order to demonstrate the applicability of the proposed method. This paper concentrated on the operation of an open cycle gas turbine in order to present a more transparent and improved performance analysis.

21.Finn Joshua, John Wagner , Hany Bassily , "Monitoring strategies for a combined cycle electric power generator" ,Applied Energy , VOL 87 ,pp 2621–2627, 2010.

Electric power generation systems require continuous monitoring to ensure safe and reliable operation. The data available from plant sensors supplied to the control systems may also be analyzed to verify proper operation and predict future behavior. In this paper, a combined cycle electric power plant has been monitored using limit and trend checking, reconstructed phase planes, and regression curves for transient and steady-state power generation. Representative experimental results are presented and discussed to illustrate the strengths of the proposed analysis strategies on a 510MW combined-cycle system and a 180 MW steam turbine. The phase space analysis provides a means of visual inspection of operational anomalies and also offers a context for numerical analysis of the anomalous behavior. The statistical prognostic method provided regression errors below 2.0% for two of the three proposed plant signal combinations. However, all signal combinations offered the opportunity for system monitoring and diagnosis in terms of threshold violations which varied from 2.7% to 5.4% for these two signal sets. Overall, the monitoring strategies exhibited great promise for power generation system applications and merit further study.

22.H. E. M. A. Shalan, M. A. Moustafa Hassan and A. B. G. Bahgat, "Comparative Study On Modelling Of Gas Turbines In Combined Cycle Power Plants", Proceedings of the 14th International Middle East Power Systems Conference (MEPCON'10), Cairo University, Egypt, December 19-21, 2010, Paper ID 317, pp 970 – 976, 2010.

Gas turbines are important for electric power generation specially the *Combined Cycle Power Plants (CCPP*). For this electric power generation, the dynamics of the gas turbines become increasingly more important. In order to study such dynamics, accurate models of gas turbines are needed. Recently, several gas turbine models have been proposed with different degree of complexity and success. The purpose of this work is concerned with understanding, modeling, and analyzing the behavior of the gas turbine based plants to investigate the power system problems. This purpose is achieved by a complementary and comparative study of different dynamic models response that published in different literature for Combined Cycle Power Plants (CCPP).Among these models, there are three models were completely simulated using **Matlab/Simulink**. It is easy to conclude that the obtained results via these simulations in this study are highly matched with the results presented in the related scientific articles. The study illustrates the effectiveness and accuracy of frequency dependant model as well as the detailed model of gas turbines in CCPP.

23.T Srinivas "Thermodynamic modelling and optimization of a dual pressure reheat combined power cycle" Indian Academy of Sciences, Vol. 35, Part 5, pp 597– 608, 2010

In this work, attention was focused on a dual pressure reheat (DPRH) HRSG to maximize the heat recovery and hence performance of CC. Deaerator, an essential open feed water heater in steam bottoming cycle was located to enhance the efficiency and remove the dissolved gasses in feedwater. Each of the heating section in HRSG is solved from the local flue gas condition with an aim of getting minimum possible temperature difference. For high performance, better conditions for compressor, HRSG sections, steam reheater and deaerator are developed. The CC system is optimized at a gas turbine inlet temperature of 1400◦C due to the present available technology of modern gas turbine blade cooling systems. The exergetic losses in CC system are compared with each other.

24.Giuffrida Antonio , Matteo C. Romano, Giovanni G. Lozza "Thermodynamic assessment of IGCC power plants with hot fuel gas desulfurization" Applied Energy, VOL 87, pp 3374–3383, 2010.

In this paper attention is paid to the potential improvements of the overall energy balance of the complete power station, along with the requirements of the sorbent regeneration process, to the influence of the desulfurization temperature and to the different solutions needed to control the NOx emissions (altered by the presence of HGD). The net performance of complete IGCC power plants (with HGD or with conventional desulfurization) were predicted, with reference to status-of-the-art solutions based on an entrained flow, dry-feed, oxygen- blown gasifier and on an advanced, FB-class combined cycle. The net efficiency experiences about 2.5% point improvement with HGD, even if a small reduction in the power output was predicted, when using the same combustion turbine. An exhaustive sensitivity analysis was carried out to evaluate the effects of different working conditions at the HGD station, e.g. desulfurization temperature and oxygen content in the gaseous stream for sorbent regeneration. Hence, different strategies to achieve acceptable NOx emissions (e.g. steam dilution) and their impact on the performance are investigated in the paper.

25.Regulagadda.P, I. Dincer, G.F. Naterer "Exergy analysis of a thermal power plant with measured boiler and turbine losses" Applied Thermal Engineering, VOL 30 ,pp 970–976, 2010

In this paper, a thermodynamic analysis of a subcritical boiler–turbine generator is performed for a 32 MW coal-fired power plant. Both energy and exergy formulations are developed for the system. A parametric study is conducted for the plant under various operating conditions, including different operating pressures, temperatures and flow rates, in order to determine the parameters that maximize plant performance. The exergy loss distribution indicates that boiler and turbine irreversibility's yield the highest exergy losses in the power plant. In addition, an environmental impact and sustainability analysis are performed and presented, with respect to exergy losses within the system.

26.Xiaojun Shi , Brian Agnewb, Defu Che, Jianmin Gao "Performance enhancement of conventional combined cycle power plant by inlet air cooling, inter-cooling and LNG cold energy utilization" Applied Thermal Engineering,VOL 30, pp 2003-2009 ,2010

This paper has proposed an integrated advanced thermal power system to improve the performance of the conventional combined cycle power plant. Both inlet air cooling and inter-cooling are utilized within the proposed system to limit the decrease of the air mass flow contained in the given volume flow as well as reduce the compression power required. The latent heat of spent steam from a steam turbine and the heat extracted from the air during the compression process are used to heat liquefied natural gas (LNG) and generate electrical energy. The conventional combined cycle and the proposed power system are simulated using the commercial process simulation package IPSEpro. A parametric analysis has been performed for the proposed power system to evaluate the effects of several key factors on the performance. The results show that the net electrical efficiency and the overall work output of the proposed combined cycle can be increased by 2.8% and 76.8 MW above those of the conventional combined cycle while delivering 75.8 kg s_1 of natural gas and saving 0.9 MW of electrical power by removing the need for sea water pumps used hitherto. Compared with the conventional combined cycle, the proposed power system performance has little sensitivity to ambient temperature changes and shows good off design performance.

27.Franco Alessandro "Analysis of small size combined cycle plants based on the use of supercritical HRSG" Applied Thermal Engineering Vol 31, pp 785-794. 2011

The paper is orientated at assessing the potential of using supercritical steam cycles in combined cycle power plants. The interaction between gas turbine and HRSG thermodynamic is mainly focused. The analysis is based on minimizing total energy losses in order to optimize the performance of the HRSG-steam turbine system. In the paper the alternative design of combined cycle power plants in which a supercritical (SC) HRSG is present has been analyzed. The analysis includes a comparison of three different supercritical HRSG configurations with single (SC1RH) and double reheaters (SC2RH) with simple HRSG single pressure configurations and advanced double and triple pressure HRSG structures.

The HRSG structures (steam pressure, maximum temperature and mass flow rate) are designed considering as objective function the minimization of the total exergy losses in the system composed by HRSG and steam turbine (ST). The optimization procedure is based on combination of random search and simplex method. The evaluation shows that even if the use of supercritical HRSG is non particularly convenient in the perspective of efficiency increase it can be a valid technical solution aiming to the development of medium size (50-120 MW) combined cycle power plants. Four different commercially available gas turbine cycles have been tested for this specific purpose obtaining efficiency level approaching in particular cases the state of the art results with simpler technical solutions

28.Sanjay, "Investigation of effect of variation of cycle parameters on thermodynamic performance of gas-steam combined cycle" Energy, VOL 36,pp 157-167, 2010

It is suggested that the combined cycle power plants with a gas turbine topping cycle and a steam turbine bottoming cycle are widely used due to their high efficiencies. Combined cycle cogeneration has the possibility to produce power and process heat more efficiently, leading to higher performance and reduced green house gas emissions. The operating conditions are gas turbine pressure ratio, process heat loads and process steam extraction pressure.

Further the fuel consumption dependency on turbine inlet temperature increase of rational efficiency is also reported it is suggested to carry out further study on combustor to reduce maximum exergy destruction. The gas turbine pressure ratio significantly influences the performance of the combined cycle cogeneration system. The process heat load influences combined cycle efficiency and combined cycle cogeneration efficiency in opposite ways. The gas turbine pressure ratio has a strong influence on the performance of the combined cycle cogeneration system. High pressure ratios have a positive effect on the gas turbine cycle, a negative effect on the steam turbine cycle, and the pressure ratio for maximum work output is between 35 and 40 for the present range of investigations.

29.H. Emam Shalan , M. A. Moustafa Hassan and A. B. G. Bahgat, "Parameter Estimation and Dynamic Simulation Of Gas Turbine Model In Combined Cycle Power Plants Based On Actual Operational Data" Journal of American Science, VOL 7(5),pp 303 – 310, 2011

Gas turbines are very important nowadays for electric power generation specially that used in the *Combined Cycle Power Plants (CCPPs*). For this electric power generation, the dynamics of the gas turbine and parameters estimation are very essential. In this article, a simple procedure is used for estimating the parameters of Rowen's model for HDGTs in dynamic studies for analysis purposes. The parameters of Rowen's model for a 265- MW HDGT are derived and several simulated tests using Matlab/Simulink are presented. The way of obtaining the parameters are based on simple physical laws. It explains briefly how to extract the parameters of the model using the operational and performance data. The obtained results via simulations using Matlab/Simulink are highly matched with the involved scientific articles that published in different literature. Furthermore, the obtained results verifies the operational results of the considered HDGT. However, the procedure here is applied on a practical HDGT. The same procedure could be applied for any scale (size) of gas turbines.

30.T.Srinivas, A.V.S.S.K.S.Gupta, B.V.Reddy, "Parametric simulation of combined cycle power plant" Int. Journal of thermodynamics vol.14(No.1), pp 29-36 ,2011

In this paper a thermodynamic evaluation has been carried out on an existing actual combined cycle plant the analysis is carried out at HP pressure of 90bar and 200 bar it is concluded that the gas cycle pressure ratio decreases in triple pressure at HRSG the study is also carried out to optimized pressure for LP&IP heater at 200 bar the pressure obtain for the gas cycle at 1200 C with the variation in input conditions.

III. CONCLUSION:

The main objective of this bibliography is to study methodology and, various parameters coupled with, which effect the performance of combined cycle power plant and consequently Load Frequency Control of the power system. Further the study has been done to locate the critical parameters, to understand complexity of the problem and to study the state of art of the Technology being used in the context of:

Parameters ,Methodology (experimental/analytical)

- Delimitations of the work/Boundaries
- Critical parameters, which effect the electrical generator output
- Further work, where further research can be carried out. Therefore it is concluded with the remark as

Depending upon CCGT model in the parametric investigation in context of operating variables with matching performance are to be constrained leading to a particular type of new CCGT model.

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[3] T.Heppenstall "Advanced gas turbine cycles for power generation: a critical review" Applied Thermal Engineering, VOL 18 ,pp 837-846, 1998.

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