COMBINED-CYCLE INSTALLATIONS 271 pdf

1: Integrated gasification combined cycle - Wikipedia

Table of contents for Combined-cycle gas & steam turbine power plants / by Rolf Kehlhofer [et al.]. Bibliographic record and links to related information available from the Library of Congress catalog.

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2: Major Power Plants . Completed Projects . Projects . GAMA Power . GAMA

This paper intends to present an overview of gas turbine and combined gas and steam turbine cycles with and emphasis on combustion chambers with NOx reduction and Heat Recovery Generators.

It is based on a literature survey issued mostly from manufacturers data as General Electric or Alstom. The objective is highlight the need of technico-economic optimisation in the design and implementation of the installations. In order to fit the existing conception of turbines operating at 60 Hz frequency to the frequency of 50 Hz, manufacturers used with success and low risks the method of aerodynamic homothetia as for the case of General Electric MSE and MSF adapted gas turbines based on the initial MSE and MSF gas turbines, where this procedure was applied for almost all the components of the gas turbine installation except for the combustion chamber [11]. In order to increase power production in a combined cycle, additional combustion is conducted in the HRSG due to sufficient excess air in the combustion gases issue from the gas turbine. The efficiency of the combined cycle is reduced since heat of combustion obtained in the HRSG is used to produce power only in the steam cycle. Due to this handicap, additional combustion is used usually for temporary increase of the power of the combined cycle peak load. Produced power is usually lower than 50 MW and the combustion gases have low thermal potential with respect to combined cycle applications but sufficient enough for cogeneration applications. The pressure ratio varies between 27 and This thermal potential, greater than in Aeroderivative Machines, is appropriate for combined cycles applications. The pressure ratio varies between 11 and A particular case of Heavy-duty machines is sequential combustion GT where the pressure ratio can reach values comparable with the Aeroderivatives machines. For example the GT24 and GT26 gas turbines figure 1 have a pressure ratio of In order to maintain NOx emissions within acceptable limits, gas turbines manufacturers have worked on improvement of combustion chambers. Water or steam injection [14] in the combustion chamber is the most usual process in NOx reduction. However, liquid water injection under the constraint of a constant combustion temperature, needs an increase of fuel consumption in order to handle water vaporisation leading a lower efficiency of the installation despite a slight increase of the produced power due to a higher specific heat of steam present in the combustion gases. Steam injection could be arranged by using the sensible heat recuperated from turbine exhaust gases leading a slight increase of fuel consumption since only minor superheating of the steam up to the combustion temperature is needed and of power for the same reasons mentioned in liquid water injection. Hence, the efficiency is almost unchanged. Air cooling of the combustion chamber reduces the combustion air leading an increase of NOx emission. In order to overcome this inconvenient steam cooling is preferred to air cooling as the "Steam-Cooled Combustor" [2] of Mitsubishi Heavy for the MG turbines. In general, modern combustion chambers are of annular type and offer numerous advantages [6] as a uniform distribution of the temperatures The DLN burners of General Electric, of dry type in NOx reduction, have a lower flame temperature due to a poor oxygen combustion [8]. The configuration of this burners [5,6] allows a perfect centrifugal mixing of fuel and air [6]. For a combined cycle with a heavy-duty gas turbine, the electric power produced in the bottom cycle after the recuperated heat represents approximately half the electric power produced by the top gas turbine cycle table 4. In order to reduce these irreversibilities exergy destructions and still recuperate efficiently the sensible heat of combustion gases multi-pressure levels HRSG are used. From the thermodynamic view, thermal efficiency increases with the number of pressure levels, however the limiting constraints on the investment cost limit drastically this number of pressure levels, requiring a technico-economical optimisation with respect to the pressure ranges and the number of pressure levels. HRSG in combined cycles of high power use two or three pressure levels of steam production table 2, table 4, table 5 which reheating of steam between the high pressure and intermediate pressure stage of the steam Figure 2 and 3, table 5. In order to reduce the pinch point, we have to increase heat transfer surfaces which will end up with an increase of investment cost requiring again a technico-economical optimisation. For a fixed combustion gas temperature at the inlet of a single steam pressure level HRSG the combustion gas temperature at the outlet is a function of the steam pressure level and the temperature pinch. On the other hand, an increase of steam pressure at constant steam turbine inlet could have a negative effects on the turbine [13]. Optimal pressure for steam production for some combined cycle installations performances are presented in tables 2 and 5. However, in order to face with downstream steam cycle needs in combined cycle this process is constrained by an optimum gas turbine exit temperature requiring almost to double the pressure ratio [4]. In gas turbines with sequential combustion as the GT24 and GT26 Advanced Cycle System [17] the fuel is introduced sequentially in two combustion chambers separated by a zone for partial expansion of a combustion gases. The primary fuel introduced in the first combustion chamber EV burner is mixed with the compressed air and the combustion gases are expanded in the first stage of the turbine. Hence, these gases, still rich in air, enter the second combustion chamber SEV burner where secondary fuel is injected. The combustion gases are then expanded in the four stages of the turbine to a pressure still greater than atmospheric pressure. At base load, the combustion gases temperature is almost of same magnitude at the exit of the first and second combustion chambers [3] figure 1. Since the efficiency of a turbine is proportional to the shaft speed which is limited by the airfoil length , the shaft speed of the high pressure stage of the steam turbine about rpm could be higher than the shaft speed of the lower and intermediate shaft speed by means of a gearing device [18]. The cooling system is either direct cooling within the rotor General Electric [11] or indirect cooling by means of a heat exchanger for the preliminary air cooling [18] Siemens, Alstom or by injection of water in the compressed air [19]. The advantages of direct cooling are the simplicity of the mechanism and low thermal gradient [11] the material of the airfoil resists better to thermal fatigue. However it needs higher cooling air flow requirements and leads lower combustion air. This cooling system leads higher thermal gradients and investment cost. The cooling of the electric generator can be achieved with hydrogen or air [20, 21]. CONCLUSION The use of sequential combustion in gas turbines seems to be a reasonable compromise for NOx reduction but care should be made regarding the cost since higher pressure ratio may lead to higher investment costs. On the other hand, the use of multi-pressure heat recovery generators raises also the need for a technico-econmic optimisation with respect to the number of pressure levels and the optimal value of these pressures. Another question regards the part of maintenance costs in configurations with Self Shifting and Synchronizing devices. Revue ABB, 2, , 4 â€” 7. Web sites [22] http:

3: Burners - John Zink Hamworthy Combustion John Zink Hamworthy Combustion

2 U.S. DOE Combined Heat and Power Installation Database, data compiled through December 31, 3 Combined cycle CHP systems use some of the thermal energy from a gas turbine to.

Significance[edit] Coal can be found in abundance in the USA and many other countries and its price has remained relatively constant in recent years. Fossil fuel consumption and its contribution to large-scale, detrimental environmental changes is becoming a pressing issue, especially in light of the Paris Agreement. Thus, the lower emissions that IGCC technology allows through gasification and pre-combustion carbon capture is discussed as a way to addressing aforementioned concerns. Block diagram of IGCC power plant, which utilizes the HRSG The gasification process can produce syngas from a wide variety of carbon-containing feedstocks, such as high-sulfur coal, heavy petroleum residues, and biomass. The plant is called integrated because 1 the syngas produced in the gasification section is used as fuel for the gas turbine in the combined cycle and 2 the steam produced by the syngas coolers in the gasification section is used by the steam turbine in the combined cycle. In this example the syngas produced is used as fuel in a gas turbine which produces electrical power. In a normal combined cycle, so-called "waste heat" from the gas turbine exhaust is used in a Heat Recovery Steam Generator HRSG to make steam for the steam turbine cycle. An IGCC plant improves the overall process efficiency by adding the higher-temperature steam produced by the gasification process to the steam turbine cycle. This steam is then used in steam turbines to produce additional electrical power. IGCC plants are advantageous in comparison to conventional coal power plants due to their high thermal efficiency, low non-carbon greenhouse gas emissions, and capability to process low grade coal. The disadvantages include higher capital and maintenance costs, and the amount of CO2 released without pre-combustion capture. Syngas is synthesized by gasifying coal in a closed pressurized reactor with a shortage of oxygen. The shortage of oxygen ensures that coal is broken down by the heat and pressure as opposed to burning completely. The chemical reaction between coal and oxygen produces a product that is a mixture of carbon and hydrogen, or syngas. The syngas must go through a pre-combustion separation process to remove CO2 and other impurities to produce a more purified fuel. Three steps are necessary for the separation of impurities: This produces a syngas with a higher composition of hydrogen fuel which is more efficient for burning later in combustion. This can be done through various mechanisms such as absorption, adsorption or membrane separation. The resulting syngas fuels a combustion turbine that produces electricity. At this stage the syngas is fairly pure H2. Benefits and drawbacks[edit] A major drawback of using coal as a fuel source is the emission of carbon dioxide and other pollutants, including sulfur dioxide, nitrogen oxide, mercury, and particulates. Almost all coal-fired power plants use pulverized coal combustion, which grinds the coal to increase the surface area, burns it to make steam, and runs the steam through a turbine to generate electricity. Pulverized coal plants can only capture carbon dioxide after combustion when it is diluted and harder to separate. In comparison, gasification in IGCC allows for separation and capture of the concentrated and pressurized carbon dioxide before combustion. Syngas cleanup includes filters to remove bulk particulates, scrubbing to remove fine particulates, and solid adsorbents for mercury removal. Additionally, hydrogen gas is used as fuel, which produces no pollutants under combustion. In a pulverized coal plant, coal is burned to produce steam, which is then used to create electricity using a steam turbine. Then steam exhaust must then be condensed with cooling water, and water is lost by evaporation. In IGCC, water consumption is reduced by combustion in a gas turbine, which uses the generated heat to expand air and drive the turbine. Steam is only used to capture the heat from the combustion turbine exhaust for use in a secondary steam turbine. Currently, the major drawback is the high capital cost compared to other forms of power production. In the Reno demonstration project, researchers found that then-current IGCC technology would not work more than feet m above sea level. Mississippi Power began construction on the Kemper Project in Kemper County, Mississippi, in and is poised to begin operation in , though there have been many delays. IGCC is now touted as capture ready and could potentially be used to capture and store carbon dioxide. This installation had been planned, but there has been no information about it since Commercial operation is due to start in Currently, ordinary pulverized coal plants are the lowest cost power plant option. The advantage of IGCC comes from the ease of retrofitting existing power plants that could offset the high capital cost. The levelized cost of electricity was noticeably sensitive to the price of natural gas and the inclusion of carbon storage and transport costs. A report by the U. Pulverized coal and NGCC costs did not change significantly since However, the past year has seen Wabash River running reliably, with availability comparable to or better than other technologies. First, the project was initially shut down because of corrosion in the slurry pipeline that fed slurried coal from the rail cars into the gasifier. A new coating for the pipe was developed. Second, the thermocoupler was replaced in less than two years; an indication that the gasifier had problems with a variety of feedstocks; from bituminous to sub-bituminous coal. The gasifier was designed to also handle lower rank lignites. Third, unplanned down time on the gasifier because of refractory liner problems, and those problems were expensive to repair. The gasifier was originally designed in Italy to be half the size of what was built at Polk. Newer ceramic materials may assist in improving gasifier performance and longevity. This is an unpublished paper from Harvard University General Electric is currently designing an IGCC model plant that should introduce greater reliability. Eastman, a fortune company, built the facility in without any state or federal subsidies and turns a profit. Several factors help this performance: None of these facilities use advanced technology F type gas turbines. All refinery-based plants use refinery residues, rather than coal, as the feedstock. This eliminates coal handling and coal preparation equipment and its problems. Also, there is a much lower level of ash produced in the gasifier, which reduces cleanup and downtime in its gas cooling and cleaning stages. These non-utility plants have recognized the need to treat the gasification system as an up-front chemical processing plant, and have reorganized their operating staff accordingly. The owner, NUON, was paid an incentive fee by the government to use the biomass. Mitsubishi Heavy Industries has been awarded to construct the power plant. Because of high gas prices in the Netherlands, two of the three units are currently offline, whilst the third unit sees only low usage levels. A new generation of IGCC-based coal-fired power plants has been proposed, although none is yet under construction. In Delaware, the Delmarva and state consultant analysis had essentially the same results. The high cost of IGCC is the biggest obstacle to its integration in the power market; however, most energy executives recognize that carbon regulation is coming soon. Bills requiring carbon reduction are being proposed again both the House and the Senate, and with the Democratic majority it seems likely that with the next President there will be a greater push for carbon regulation. Environmental Protection Agency et al. However, the industry needs a lot more experience to reduce the risk premium. IGCC with CCS requires some sort of mandate, higher carbon market price, or regulatory framework to properly incentivize the industry. It runs on air-blown not oxygen dry feed coal only. It employs not only F type turbines but G type as well. The main feature is that instead of using oxygen and nitrogen to gasify coal, they use oxygen and CO_2. The main advantage is that it is possible to improve the performance of cold gas efficiency and to reduce the unburned carbon char. As a reference for powerplant efficiency: Latest development of Frame G gas turbines, ASU air integration, High temperature desulfurization may shift up performance even further. Using a closed gas turbine system capable of capturing the CO_2 by direct compression and liquefication obviates the need for a separation and capture system. During pre-combustion in IGCC, the partial pressure of CO_2 is nearly times higher than in post-combustion flue gas. Physical solvents work by absorbing the acid gases without the need of a chemical reaction as in traditional amine based solvents. The solvent can then be regenerated, and the CO_2 desorbed, by reducing the pressure. The biggest obstacle with physical solvents is the need for the syngas to be cooled before separation and reheated afterwards for combustion. This requires energy and decreases overall plant efficiency. Selection of the test code to be used is an agreement between the purchaser and the manufacturer, and has some significance to the design of the plant and associated systems. Senator Hillary Clinton from New York has proposed that this full risk disclosure be required of all publicly traded power companies nationwide. Senate told the Clean Energy Summit that he will do everything he can to stop construction of proposed new IGCC coal-fired electric power plants in Nevada. Reid wants Nevada utility companies to invest in solar energy , wind energy and geothermal energy instead of coal technologies. Reid stated that global warming is a reality, and just one proposed coal-fired plant would contribute to it by burning seven million tons of coal a year. The long-term healthcare costs would be far too high, he claimed no source attributed. There is cleaner coal technology, but there is no clean coal technology. However, the majority of the H2S treating plants utilize the modified Claus process, as the sulphur market infrastructure and the transportation costs of sulphuric acid versus sulphur are in favour of sulphur production.

4: Combined Cycle Operations and Maintenance Course Bundle | Martech Media

This title provides a reference on technical and economic factors of combined-cycle applications within the utility and cogeneration markets. Kehlhofer - and hos co-authors give the reader tips on.

In Solid State contaminants are: Sodium and potassium are alkali metals that can combine with Sulfur to form a highly corrosive agent and that will attack portions of the hot gas path. The contaminants are removed by passing through various types of filters which are present on the way. Gas phase contaminants such as ammonia or sulfur cannot be removed by filtration. Special methods are involved for this purpose. Turbine Cycle The air which is purified then compressed and mixed with natural gas and ignited, which causes it to expand. The pressure created from the expansion spins the turbine blades, which are attached to a shaft and a generator, creating electricity. Heat Recovery Steam Generator In Heat Recovery Steam Generator highly purified water flows in tubes and the hot gases passes a around that and thus producing steam. The steam then rotates the steam turbine and coupled generator to produce Electricity. The hot gases leave the HRSG at around degrees centigrade and are discharged into the atmosphere. The steam condensing and water system is the same as in the steam power plant. The single-shaft system consists of one gas turbine, one steam turbine, one generator and one Heat Recovery Steam Generator HRSG , with the gas turbine and steam turbine coupled to the single generator on a single shaft. Multi-shaft systems have one or more gas turbine-generators and HRSGs that supply steam through a common header to a separate single steam turbine-generator. The primary disadvantage of multiple stage combined cycle power plant is that the number of steam turbines, condensers and condensate systems-and perhaps the cooling towers and circulating water systems increases to match the number of gas turbines. By combining both gas and steam cycles, high input temperatures and low output temperatures can be achieved. The efficiency of the cycles adds, because they are powered by the same fuel source. To increase the power system efficiency, it is necessary to optimize the HRSG, which serves as the critical link between the gas turbine cycle and the steam turbine cycle with the objective of increasing the steam turbine output. HRSG performance has a large impact on the overall performance of the combined cycle power plant. The electric efficiency of a combined cycle power station may be as high as 58 percent when operating new and at continuous output which are ideal conditions. As with single cycle thermal units, combined cycle units may also deliver low temperature heat energy for industrial processes, district heating and other uses. Supplementary firing is arranged at HRSG and in gas turbine a part of the compressed air flow bypasses and is used to cool the turbine blades. It is necessary to use part of the exhaust energy through gas to gas recuperation. Recuperation can further increase the plant efficiency, especially when gas turbine is operated under partial load. Combined cycle plants are usually powered by natural gas, although fuel oil, synthesis gas or other fuels can be used. To control the emissions in the exhaust gas so that it remains within permitted levels as it enters the atmosphere, the exhaust gas passes though two catalysts located in the HRSG. Low capital costs The capital cost for building a combined cycle unit is two thirds the capital cost of a comparable coal plant. Commercial availability Combined cycle units are commercially available from suppliers anywhere in the world. They are easily manufactured, shipped and transported. Reduced emission and fuel consumption Combined cycle plants use less fuel per kWh and produce fewer emissions than conventional thermal power plants, thereby reducing the environmental damage caused by electricity production. Comparable with coal fired power plant burning of natural gas in CCPT is much cleaner. Potential applications in developing countries The potential for combined cycle plant is with industries that requires electricity and heat or stem. For example providing electricity and steam to a Sugar refining mill. Demerits The gas turbine can only use Natural gas or high grade oils like diesel fuel. Because of this the combined cycle can be operated only in locations where these fuels are available and cost effective. Conclusions Combined cycle power plants meet the growing energy demand, and hence special attention must be paid to the optimization of the whole system. Developments for gasification of coal and use in the gas turbine are in advanced stages. Once this is proven, Coal as the main fuel can also combined cycle power plants meet the growing energy demand, be used in the combined cycle power plant.

5: Table of contents for Library of Congress control number

Product Code F The Market for Steam Turbines for Combined-Cycle Installation Â© Introduction Due to their thermal efficiency, rotary motion, and power-to-weight ratio, steam turbines continue to be a.

6: U.S. DOE Combined Heat and Power Installation Database

Since , Martech has evolved into the premiere worldwide training company with a highly sophisticated menu of workforce training and development programs serving companies in electrical generation, oil and gas production, public utilities, paper and pulp, and other general process facilities.

7: On gas turbines and combined cycles | Adrian Badea - www.enganchecubano.com

The Combined Cycle Power Plant or combined cycle gas turbine, a gas turbine generator generates electricity and waste heat is used to make steam to generate additional electricity via a steam turbine. An overview of Combined Cycle Power Plant (photo credit: www.enganchecubano.com) The gas turbine is one.

8: An Overview of Combined Cycle Power Plant

3 Combined cycle strategy It also shortens the planning phase and reduces the construction time. For example, all of our plants are designed with either axial or side-exhaust.

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2005 yamaha r6 service manual Smythe Sewn Kasba Mini Sketch Unlined (Paperblanks Mini Sketch Series) Linear systems analysis The moon of the gray wolves Carrying (Small World) The horses of the Royal Canadian Mounted Police Abolition in the U.S.A. by 2050 : on political capital and ordinary acts of resistance Bernard E. Harcour Biomechanics of Soft Tissue in Cardiovascular Systems The thre bookes of Tyllyes offyces Qualities of life Victorian Women Poets (Longman Critical Readers) Embracing the questions. Machine generated contents note: Profogue Part One Restructured and restrung: Charles Wrights Zone journals Vol. 1. Prehistory to 1520. Queen of gods scarlett dawn Interviewing financially sophisticated witnesses Mapping the storm Mystery books Dermatoglyphics in medical disorders Surgical modalities Creo parametric 3.0 tutorial toogood Stainless steel main gate design catalogue The national picture: Thai media and cultural identity Annette Hamilton What makes gravity? Beginnings of science, biologically and psyhcologically considered Lets go United States of America. V. 1. Manuscript revelation books. Foot and mouth disease. Letter from the Secretary of the Treasury relative to the foot and mouth disease The stalking moon. List of direct expenses and indirect expenses V. The 4 war aims : at Mt. Vernon, 4 July, 1918. Press review magazine T.R.O.G.S. Book Two Constructing your program On the Cauchy problem 12. The New Eighth Army 155 Ms excel 2003 tutorial Inquiry teaching in the sciences Principal stresses and principal planes