Thermal analysis of steam system

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Abstract: The present day the usage of power is increasing rapidly. So in order to generate the power we have to use our resources effectively. The power is mainly generated from the power plant where the major contribution is from thermal power plants. In thermal power plant the main component is the boiler, if we make using effective of it we can increase the power generation as that the boiler converts the water in to the high pressure steam by taking heat from the furnace. If we able to make the heat transfer effectively, more amount of steam is generated. So the changes in the boiler tubes are done by adding the internal helical RIBS internally to the boiler. So that the fluids inside the boiler will travels more time in the tube and the maximum heat transfer will be taking place. So for short span of time the phase change takes place and the water will converted to steam. Here we are going to do the static and thermal analysis on the tube with the internal helical ribs and compare with the normal boiler tube, by taking the boundary conditions as of the industry. The consumption of coal can be minimised for generation of same coal as that using the normal boiler pipe.

Keywords: Design and Thermal Analysis, Boiler Tube, Internal Helical RIBS.

I. INTRODUCTION

A steam system consists of a steam-supply/generating facility, a steam and condensate return/water piping system, and a steam-use facility (Figure 1). In this section, the discussion is focused on the integration of the various equipment within the steam-generating facility. Information is offered which need be considered when designing a steam-supply system. A general guideline is provided which identifies major issues to be addressed, leading to the evaluation of system solutions and ultimately to equipment considerations for selection and design. Finally, an example of an audit and system design are provided for demonstration purposes. In many industrial processes, such as food and chemical industries both electrical power and refrigeration (at low temperatures) are required. Combined cooling heat and power systems have developed in residential and commercial sections. Solid oxide fuel cell (SOFC) and absorption refrigeration systems have been considered and analyzed as cogenerations systems. High efficiency, low emissions, no moving parts, reliability, low maintenance and fuel flexibility are advantages of using solid oxide fuel cells systems. Also high operating temperature of the SOFCs causes they are used in cogeneration power plants. Absorption refrigeration systems can work with various heat sources such as waste heat, solar thermal, geothermal and biomass. Generally absorption cycles can be used with two conventional solutions: lithium bromide-water and ammonia-water. Lithium bromide water cycle is limited to temperatures above the freezing point of water whereas the ammonia-water cycle is favorable for temperatures below 0 c. So for sub-zero refrigeration, ammoniae water absorption refrigeration system is a good option that can be integrated with SOFC system. A new CCHP system whose main fuel is methane is proposed. Overall energy conversion efficiency of this system can exceed 80% under the given conditions. Different concepts/strategies for SOFC-based integrated systems which are based on direct/indirect thermal coupling and fuel coupling schemes are studied.

Integration of SOFC and a double-effect lithium bromide-water absorption is investigated. This hybrid system can achieve a total efficiency of 84% or more in different modes. In addition electrical efficiency has a maximum value when the fuel utilization is about 0.86. An integrated 110 kW solid oxide fuel cell and lithium bromide absorption heat pump process is investigated. With integration, total efficiency (electrical, cooling and heating) can reach to 87% or more. A hybrid system containing 300 kW molten carbonate fuel cell and 140 kW direct exhaust double-effect absorption chiller is analyzed.

Three kinds of SOFC hybrid systems with carbon dioxide (CO2) capture are proposed and analyzed by energy and exergy analysis. It is concluded that the SOFC hybrid power systems still have higher efficiencies even with CO2 capture. Optimum design of an integrated solid oxide fuel cell-gas turbine process is investigated. Co- and counter-flow configurations are considered for a planar SOFC. For both configurations, effect of temperature, pressure, current density and fuel utilization on voltage and electric power are examined. Based on the 200 kW power output, optimum number of cells in co-flow configuration is found to be 2122. This article introduces a combined system containing a solid oxide fuel cell, ammonia-water single effect absorption cycle and Rankine steam cycle. The process is investigated by energy and exergy analyses methods. Also economic analysis is done in order to find the optimum operating range.

II. LITERATURE SURVEY

André Aylwin et al., [1] the Macdonald Campus of McGill University right now supplies heat through a unified power plant where a water treatment office is additionally found. The power plant has four steam boilers that were beforehand fuelled with warming oil. Just two boilers are by and by being used and now controlled through petroleum gas. They supply warming to the grounds just as a feature of John Abbott College. While it is viewed as a focal power plant, its proficiency is decreased from being situated off the edge of the grounds. All the warmth gave by the power plant is dispersed as steam through underground channels situated in burrows under the grounds. Since these establishments are around 75 years of age, heat misfortunes summarize to around 15-20% because of the out of date protection on the channels.

Kristin et at., [2] present focusing on a 7% decrease in vitality utilization by 2010. Also, the plan is to lessen utilization of non-sustainable power sources (oil and gas) and reduction the general ozone depleting substance discharges. To accomplish this objective, McGill University Services has expressed that they are happy to consider all conceivable vitality use choices, including changing over/overhauling Macdonald Campus steam kettle framework or even a decentralized way to deal with dispose of misfortunes because of transportation. Moreover, frameworks taking a shot at a sustainable power source are additionally being assessed. The frameworks are getting old, as much as vitality wasteful. With regards to an Environmental Campus in a time of reasonable advancement, it turns out to be naturally and financially basic to improve these establishments. Supplanting gaseous petrol by a sustainable 7 source would diminish the grounds' ozone harming substance outflows while a decentralizing methodology could decrease vitality misfortunes.

Habib et al. [3] have examined first and second-law strategy for the streamlining of the warm weight level in warm recovery warm power plants in subcritical run. The system is general in structure and is applied for a warm power plant having two warm weight levels (low and high weight levels) and two open-type feed water radiators. The second-law effectiveness of the steam generator, turbine cycle and plant were assessed and streamlined the warm weight proportion in both the weight levels. The irreversibility in the various parts of the steam generator and turbine cycle segments were assessed and talked about.

Khan [4] depicted the second-law evaluation of regenerative-warm coal-terminated power age plant as far as irreversibility examination. He revealed decrease in irreversible misfortunes with the expansion of in reverse, course type feed water warmer. He presumed that, joining warming in a regenerative steam control cycle in subcritical range can additionally improve its productivity and the all-out irreversible misfortunes in the plant. These upgrades become slower as the quantity of feed water radiators increment. The decrease in the all-out irreversible rate because of in reverse course feed water warming is about 18%, which compare to a 12% improvement in warm proficiency. These appraisals were expanded to 24% and 14% separately, with consolidation of warm notwithstanding feed water warming. The second-law demonstrates that most extreme exergy is annihilated in the evaporator and these thermodynamic misfortunes are fundamentally decreased by the joining of feed water warming. The thermodynamic deviations coming about in non-perfect or irreversible working of different steam control plant segments have been distinguished by Hermann. He reasoned that known exergy supplies and streams inside our range of authority are all that anyone could need to give vitality administrations to the expanding populace and action of mankind.

Siva Reddy V et al. [5] have audited on vitality examination and exergy investigation of warm power plants. They checked on a thermodynamic examination of a coal based warm power plant and gas based cogeneration control plant as far as vitality and exergy investigation for the various parts of the power plants in subcritical run. They presumed that, the significant vitality misfortune was found to happen in condenser. The exergy examination demonstrated that burning chamber in both steam and gas turbine warm power plants is principle wellspring of Irreversibility. The Irreversibility in condenser is immaterial as the low quality vitality is lost in the condenser. An Exergy technique for streamlining gives legitimate arrangement improving the power generation openings in warm power plants.

Rosen [6] has broken down the vitality investigation and exergy examination based correlation of Coal-terminated and Nuclear Steam Power Plants in subcritical extend. Sciubba et al. [28] have contemplated the parametric impact of second law examination of warm power plants in sub basic range. Stecco 25 et al. [29] have built up a PC program for exergy misfortune in steam turbine influence plants.

Shinzo Shibayama and Shinichi Morooka [7] tentatively and hypothetically considered as far as possible, for example, the greatest warmth move limit in a warmth pipe as for wick attributes, contact misfortunes and hairlike properties. Pruzan et al (1990) diagnostically anticipated the relentless state heat transition restricts in a sintered wick heat pipe, with different geometrical parameters in the wick structure, for example, the wick thickness, compelling narrow span of ebb and flow, porosity and warmed wire breadth. The systematic outcomes are contrasted and the test results. They reasoned that the dry out heat motion increments with the expansion in every single geometrical parameter in the wick structure, with the exception of in the tilt point. The dry out warmth motion diminishes with an increment in the tilt point. Kim and Peterson researched the entrainment marvel in a hairlike driven warmth pipe, tentatively and systematically. Besides, a PC model was created to research the slender confinement, entrainment farthest point and bubbling constraint at various work numbers in the adiabatic district and at various fume temperatures.

Bankston and Smith [8] depicted the progression of fume in a round and hollow warmth pipe with different evaporator Reynolds number and condenser Reynolds number. The outcomes acquired were utilized to settle the total axisymmetric Navier – Stokes condition for the relentless, laminar fume stream in roundabout warmth pipes with different lengths of evaporator and condenser. Rohani and Tien investigated the exhibition of a gas stacked heat pipe with various fume – gas blends, for example, water – air, and sodium argon. In this examination, the warmth conduction through the channel divider, and the fluid – wick is insignificant, contrasted with the warmth move because of the idle warmth of the fume diffusing into the non condensible gas locale.

Faghri et al [9] numerically examined the Nusselt number, interface temperature, and interfacial warmth motion, by shifting the warm conductivity proportion and cylinder divider thickness. Amir Faghri numerically broke down the weight drop in the evaporator and condenser segment of the concentric annular warmth pipe, with an alternate stream models. Faghri and Chen numerically broke down the conjugate warmth move, fume compressibility and gooey scattering in heat pipes, with various warm conductivity proportions, and evaporators, and condenser outspread Reynolds number model with sodium and water as the working liquids. The outcomes indicated that if the warm conductivity proportion is expanded, the interfacial warmth motion changes due to the pivotal conduction. The distinction between the compressible and incompressible models in compressibility impacts, for example, external divider temperature dissemination, fluid and fume pressure drop and mach number is high, at a higher evaporator outspread Reynolds number. The greatest weight recuperation and stream inversion happen at a higher condenser outspread Reynolds number.

Chen and Faghri [10] examined both single and different warmth sources though in a two dimensional axisymmetric tube shaped warmth pipe. A coupled examination of the divider, wick and fume locales was led. Both sodium and water were considered as the working liquids. The arrangements were looked at against the trial results for the fume and divider temperature at high and low working temperatures for the working conditions considered. The compressibility impacts were seen as significant.

III. PROPOSED METHOD

Thermal analysis

Thermal analysis comprises a group of methods with which the physical and chemical properties of substances and substance mixtures are measured as a function of temperature at a defined heating rate (dynamic) or as a function of time at a constant temperature (isothermal or static). Thermal analysis in coating system and painting technology the thermal analysis (TA) called a group of methods where physical and chemical properties a substance or a substance and / or reaction mixture as a function of Temperature or time are measured while the substance is regulated Temperature program is subjected Dynamic processes include:

Thermogravimetry (TG)

With the TG, the weight change of the sample is measured during a given temperature-time program in a defined atmosphere (Hemmiger and Cammenga, 1989). A change in weight occurs through thermal decomposition or through reaction of the sample with the gas phase.

Differential thermogravimetry (DTG)

The differentiation of the TG thermogravimetry curve enables a better resolution of closely consecutive weight changes.

Differential thermal analysis (DTA)

The temperature difference between the sample and a (inert) reference sample is measured. The temperature difference serves as an indication of heat flow changes between the furnace and the sample, which u. a. caused by reactions, phase transformations and changes in the state of matter in the sample. A distinction is made between reactions in which heat is consumed (endothermic) or released (exothermic). It generally applies that thermal decomposition is endothermic and oxidations and phase transformations are exothermic.

Emission gas thermal analysis (EGA)

EGA is mostly used simultaneously with other methods of thermal analysis to determine the type and amount of volatile gaseous reaction products.

A Netzsch 449 F3 Jupiter thermal balance with coupling to a Netzsch QMS 403 C Aeolus mass spectrometer (Fig. 1) is available for dynamic thermal analysis. With this system, DSC differential scanning calorimetry and TG curves of a sample can be recorded simultaneously. Samples up to approx. 100 mg can be examined in a temperature range from room temperature to a maximum of 1500 ° C under vacuum, in a static or flowing atmosphere (air or nitrogen). The STA is connected to a quadrupole mass spectrometer (Thermostar from Balzers) via a heated quartz glass capillary. The mass spectrometer enables gases released during the reaction (especially water vapor, CO2, SO2 but also volatile organic molecules) to be detected simultaneously.

The static methods of thermal analysis in mineralogy include the determination of water content and loss on ignition. The sample is annealed to constant weight at a defined temperature (105 or 550 ° C) for several hours or days and then the mass loss is determined, to which a certain phenomenon is assigned by definition (release of the adsorbed water or oxidation of the organic substance).

Thermal Analysis of Steam Pipes

A thermal analysis calculates the temperature distribution and related thermal quantities in steam turbine casing.

Typical thermal quantities are

- The temperature distribution
- The amount of heat lost or gained
- Thermal fluxes
- Thermal gradient

Thermal simulations play an important role in the design of many engineering applications, including internal combustion engines, turbines, heat exchangers, piping systems, and electronic components. In many cases, engineers follow a thermal analysis with a stress analysis to calculate thermal stresses (that is, stresses caused by thermal expansions or contractions).

The basis for thermal analysis in ANSYS is a heat balance equation obtained from the principle of conservation of energy. The finite element solution you perform via ANSYS calculates nodal temperatures, and then uses the nodal temperatures to obtain other thermal quantities.

Pipeline planning

After creating the system circuit diagrams and defining the pipeline-specific data, the Planning of the pipelines in the overall system. This has been taking place since the end of the twentieth century planning of all trades, mainly in a 3D model. Software from various companies is offered, in Power plants are currently (2013) the systems PDS, PDMS and Smart Plant 3D widely used. A prerequisite for pipeline planning in 3D is that all required components are in the library of the respective software are available.

The automated control runs can be carried out at any time to check for freedom from collisions (Clash Checks) can be initiated. The evaluation of the issued test results is however complex and requires experience, since only a small part of those reported by the system "Clashes" represents an actual collision between pipes or with other trades.

Depending on the type of customer contract, the company structure of the general contractor and the respective processing model will be that required to process a pipeline system Processing steps to a greater or lesser extent for the general contractor, for the customer carried out at the suppliers. The following main types of customer contracts can be distinguished become:

Turnkey / turnkey: the customer (owner, "owner" in the English-speaking world) orders planning, Delivery, turnkey construction and commissioning of the entire power plant (or defined, delimited plant areas) at a general contractor (GU).

Components business: The customer coordinates the processing of his power plant himself and orders the individual components from various suppliers. The component "Turbo set" includes in usually also the pipes of the turbine and generator auxiliary systems (KKS of the system groups: MA, MB and MK)

Advice (supplement to the component business): The customer orders the delivery and assembly himself the pipeline system, but hires a "consultant" to do the necessary Coordination and test work. The customer thus retains the decision-making authority, but needs it fewer staff.

The main activities for the GU variant from the start of processing to Settlement shown. The representation applies above all to the handling of the most important (2013) in the global power plant market Power plant types "combined cycle power plant" and "steam power plant". The coordination of the numerous participants is the job of the pipeline manager mentioned above. It has to be emphasized here that after the order has been placed by the customer, processing by the contractor is not zero starts. In the case of the GU variant, the version is based on a predecessor system already built or a largely developed and with the customer as part of the offer phase and contract

In contrast to the previously usual procedure for two-dimensional planning, the 3D planning in the model, the possibility of including all small pipes (drains, vents, sampling and dosing lines, pressure tapping lines). This led to improvements Requirements for ordering materials and assembly. Pipe planning is the most time-consuming section in the technical processing of a Pipeline installation. It essentially comprises the following tasks: Generally: coordination with all other trades (e.g. concrete construction, steel construction, electrical and control technology, Turbo set, various components) Development of an optimal pipeline routing (safe, functional, inexpensive) Keep escape and access routes clear.

IV. RESULTS AND DISCUSSION

In general, it is quite clear from these figures that the experimental data were under predicted for the first 30 min. This was attributed to the fact that the heat flux diminishes faster than the rate of heat transfer predicted by the model especially as the ice reaches the tank walls. However, after 2 h the heat transfer rate stabilized at 0 and 38 kW for up to 10 h. At this point the heat transfer rate diminished during the next 5 h until the cooling cycle ends.

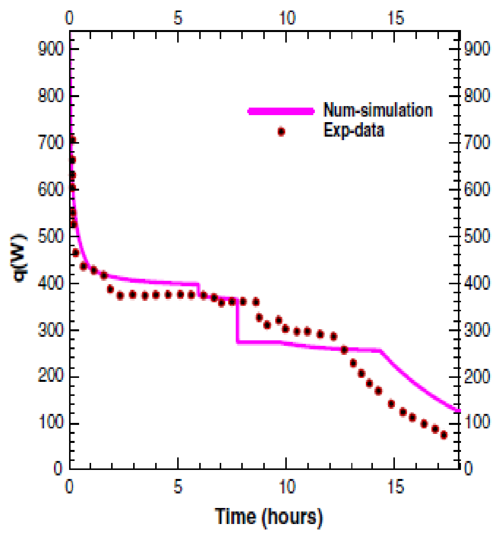

Fig. 3. Heat rate transferred to the storage tank versus time for /in = 75%, Tair_in _ 24 _C and m_ ¼ 0:0766 Kg s_1.

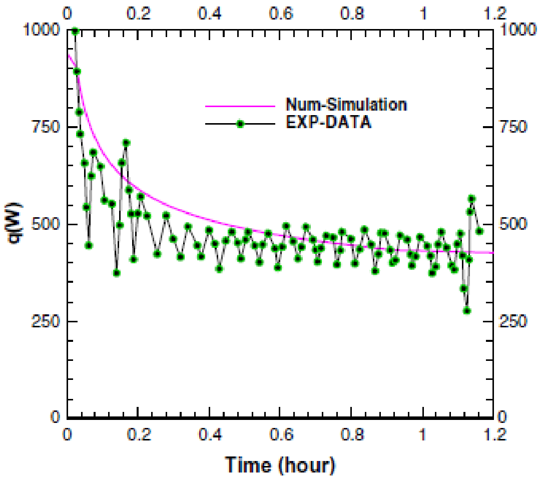

Fig. 4. Heat rate transferred to the storage tank versus time for /in = 75%, Tair_in _ 24 _C and m_ ¼ 0:0766 Kg s_1.

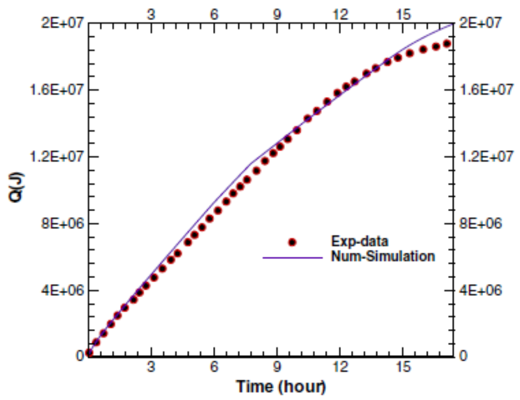

Fig. 5. Total of heat rate transferred to the storage tank versus time for /in = 75%, Tair_in _ 24 _C and m_ ¼ 0:0766 Kg s_1.

Numerical prediction was in general very representative and depicts the heat exchange rate between the condenser of heat pipes immersed in the reservoir and ice. Initially, the heat exchange was very high between the heat pipes and the ice for about 1 h and 12 min, then the heat exchange diminished as the ice melts. The numerical model's prediction showed that the ice was fully melted after 12 h and 48 min after the cooling cycle started.

Furthermore, the model predicted that the heat transfer with air was reduced to 100W at 16 h and 12 min. This was in fair agreement with the experimental data.

The heat transfer rate absorbed from the air flow and transferred to ice in the reservoir has been plotted as a function of cooling cycle time and compared to the model's prediction in Figs. 4 and 5. These figures showed that the model fairly predicted the heat transfer rate under various inlet conditions. Furthermore, Fig. 3 also showed that in general the model prediction of the system thermal characteristics, temperatures and heat transfer rates was satisfactory.

V. CONCLUSION

In order to prevent the deficiency of coal energy we have to extract more energy from the coal as maximum as possible. In the boiler to produce the steam, coal is used as the burning agent. In order to reduce the coal the boiler should make more efficient. So the boiler pipe is concentrated to make it work more efficient. As providing the internal helical ribs in the boiler tube the pressure variations occurred are in the optimum range when compared to the normal boiler tube. The temperature distribution is high at the outlet of the pipe when compared to the normal boiler pipe. By providing the internal helical ribs the heat will transfer more in to the boiler pipe and make the water into steam quickly. So that the length of the pipe will decreased which reduces the production cost of excess pipe.

During the course of this study, the heat transfer characteristics of heat pipes in storage process have been modeled, presented and analyzed. An experimental setup has been constructed and various tests of thermal storage cooling cycle have been carried out under different inlet conditions. In general, the presented numerical model fairly predicted the heat transfer characteristics and interactions between the ice and heat pipes as well as air flow and compared well with the experimental data.

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