EXPERIMENTAL ANALYSIS FOR COUNTER TO CROSS FLOW AIR-COOLED HEAT EXCHANGER IN CONCENTRIC TUBE BY RECTANGULAR COPPER FINS WITH INTERNAL SPIRAL GROOVING :A REVIEW

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ABSTRACT

A heat exchangers are device which heat exchanges among two or more fluids. Heat exchanger are using for the heating and cooling systems in domestic and industrial operations. When heat exchanger devices are used in any operation than some heat losses in atmosphere**.** We studied different research paper and analyzed the performance parameter of heat exchangers. After studied of different research paper, I found new idea to get better the thermal performances of counter to cross flow by using air cooled heat exchanger[ACHE] process. Constrained geometry structures are counter to cross flow using air cooled heat exchangers process. In air cooled heat exchanger[ACHE] process are using spiral grooved aluminum concentric tube and rectangular copper fins. Hot water will be flow in spiral grooved aluminum tube and rectangular fins will be fitted on tube. A fan will be fitted perpendicular to the tube which expand cold air through the fan on tube. When the hot fluid will be flow in tube then internally spiral groove shaped of tube due to high turbulence in fluid. Rectangular copper fins will be fitted on the aluminum tube and heat will be exchanged. When the hot fluids will be flow in aluminum concentric tube inlet to outlet then the air expanded on tube due to heat exchanges. Where will be copper fins fitted on the annular tube due to increases the rate of the heat transfer. Such as the hot fluid inlet in annulus where are copper fins are fitted on the tube due to the rate of the heat transfer are also to be increases. The fans will blow the air on tube due to hot fluid will be decreases the temperature outlet of tube. We will be temperature difference found input and output of the hot fluid.

Keywords: Air Cooled Heat Exchanger, Spirally grooved tubes, Rectangular copper fins

1. INTRODUCTION

The heat exchanger are system used to heat transfer between two or more fluid. We will be experimental works on counter to cross flow by using air cooled heat exchangers[ACHE] process. Such as there are two working fluid in air cool heat exchanges[ACHE] process ,first fluid is hot water and second fluid based work as air. In which heat exchanges through the counter to cross flow by using air cooled heat exchangers[ACHE] process. When fluids will flow in tube than the temperature difference will be found in input and output of the tube . we are working on counter to cross flow by using air cooled heat exchangers[ACHE] process. In which aluminum tube are internally spiral groove and rectangular copper fins are used. Which tube will be used in air cooled heat exchanger that will be internally spiral grooved tubes. When fluid will be flow in Spiral grooving tube due to high turbulence in fluid. We will used the rectangular copper fins because its thermal conductivity will be higher. Air cooled heat exchanger is used in mostly chemical industry, refinery etc.

We will be used rectangular copper fins in air cooled heat exchanger. Fins are the extensive surface protruding from a surface or body. Fins are presented for increasing the heat transfer rate between the surface and the surrounding fluid by increasing heat transfer area. Examples of surface where fins are used Air cooled I.C. engines, Refrigeration condenser tubes, Electric transformers ,Reciprocating air compressors ,Semiconductor devices, Automobile radiator etc. There are different types of the fin materials but we will be selected copper fins materials due to higher thermal conductivity. Heat move by convection between a surface furthermore, the liquid encompassing can be expanded by connecting to the surface called blades. Subsequently the balances have handy significance since it gives greatest warmth stream per unit mass easily of production. So we are

decided rectangular fins in air cooled heat exchanger because its surface area is maximum due to heat transfer rate is high. There are different types of heat exchangers process: Parallel-flow and counter-flow heat exchanger, Finned and Unfinanced tubular heat exchanger, U-tube heat exchanger, single-pass and multi-pass heat exchanger, Plate-and-frame heat exchanger, Plate-fin heat exchanger, Micro channel heat exchanger.

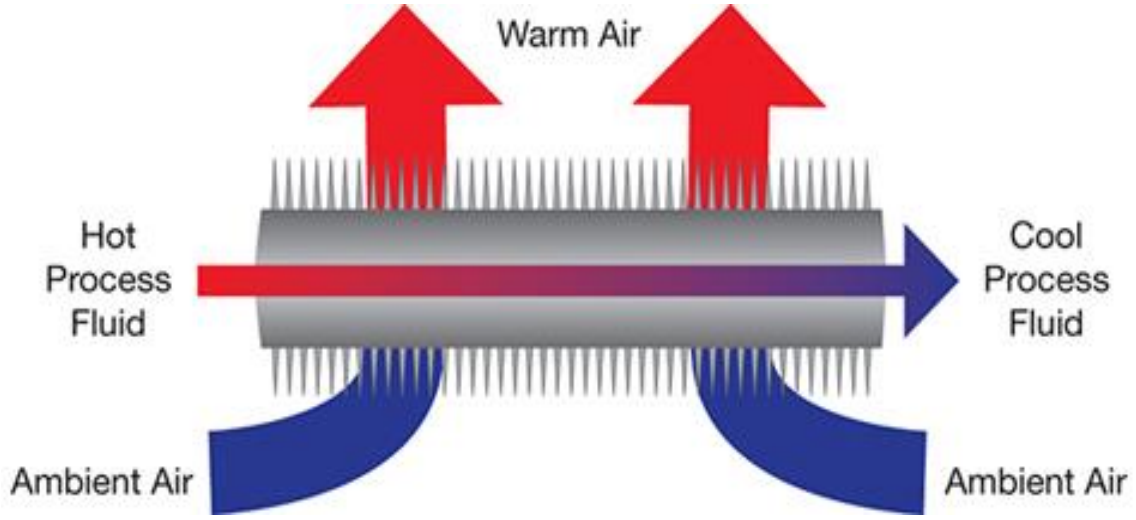


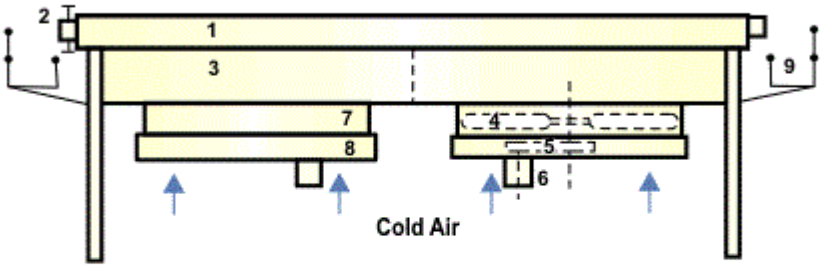
Fig. 1 Operating principle of ACHE

In Air cooled heat exchanger process tube and fan will be fitted perpendicular to each another. There are also to be heat exchanges between hot fluid and air. When the hot fluid enter inlet of tube bundle then the fan is blow air on tube bundle due to heat exchanges on tube wall and minimum temperature decreases the hot fluid. Whereas heat exchanges between the hot fluids and air due to outlet of the tube is temperature difference found in hot fluid. Such as heat exchanges between hot fluid and air in the Air cooled heat exchanger process. The Air Cooled Heat Exchangers comprise of the accompanying the parts :One or more packages of warmth move surface comprising of finned or exposed cylinders associated by headers, An air-moving gadget, for example, a pivotal stream fan, blower, or stack. Unless it is a characteristic draft application, a driver (more often than not an electric engine) and power transmission gadget (generally belt or rigging) to precisely pivot the air-moving gadget .A plenum between the bundle(s) and the air-moving gadget .A bolster structure sufficiently high to enable air to enter underneath the ACHE at a sensible flow rate. Optional header and fan support walkways with stepping stools to review .Optional louvers for procedure outlet temperature control .Optional distribution channels and chambers for security against solidifying or cementing of high-pour-point liquids in chilly climate .Optional variable-pitch fan center or variable-recurrence drive for temperature control and power reserve funds. Air cooled heat exchangers have heat transfer rates are very high compared to air cooling. In air cooled heat exchangers more heat is removed because liquid have higher heat capacity. Air cooled heat exchanger process are easy mechanism. Air cooled heat exchanger are very suitable for massive engines ,which need to be large amount of heat is removed. In Air cooled heat exchanger no extra power required. in which less equipment involved. Air cooled heat exchanger are not suitable for the stagnant engines. Example:-laboratories, power plants.

Types of air cooled heat exchanger[ACHE]:

- Induced draft ACHE
- Forced draft ACHE
- Natural draft ACHE

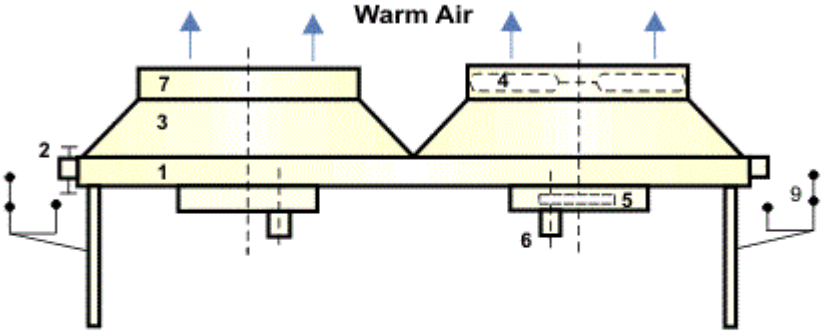
  - **Forced draft ACHE** - In air cooled heat exchanger the fan is situated underneath the procedure pack and air is constrained through the tubes.



1 Tube bundle
2 Header
3 Plenum
4 Fan
5 Belt drive
6 Motor
7 Fan ring
8 Fan bridge
9 Walkway

Fig.2 Forced Draft ACHE

- **Induced draft ACHE** - In air cooled heat exchanger the fan is situated over the procedure pack and air is pulled, or prompted, through the tubes.



1 Tube bundle
2 Header
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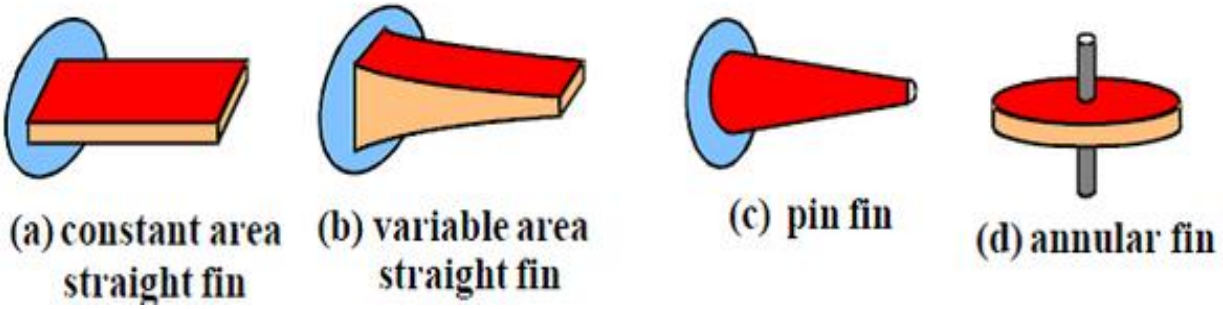
8 Fan bridge
9 Walkway

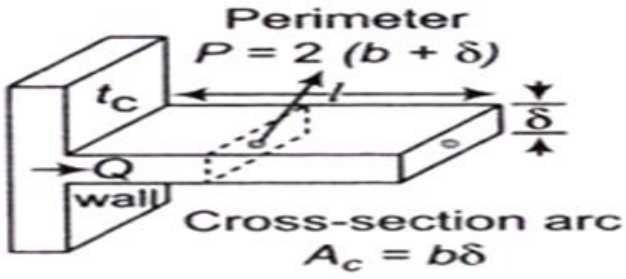
Fig.3 Induced Draft ACHE

- **Natural draft ACHE-** Natural draft air cooled heat exchanger are synonymous. There are no used fans to drive air. In the natural draft air drive through the tubes group. Its logic are comparable to induced draft.

FINS: In analysis of heat transfer, fins are device which are used to enhance the rate of heat transfer of surface that expand from things to increases the rate of heat transfer. The rate of heat transfer depends on :Shape and geometries of the outer surface, the Surfaces area of body, velocity of the any fluids in other case, temperature of surroundings etc. There are various type of fins applications to enhance the rate of heat transfer from the surfaces. Which fin are used to be enhance the rate of heat transfer of surface the fin material should be higher thermal conductivity. The blade is presented to a streaming liquid, which cools or warms it, with the high warm conductivity permitting expanded warmth being directed from the divider through the balances.

There are various type of fins:





Rectangular Fin Diagram

Such as there are various type of the fins but we will be used constant area straight fin[rectangular fin] because its surface are equal due to heat transfer are equal at every point of the fins surface due to enhances the rate of heat transfer of the surface. Such as rectangular fins will be used in air cooled heat exchanger because rectangular fins material will be copper due to its thermal conductivity are high. In air cooled heat exchanger when hot fluid will be flow in aluminum tube than the rectangular copper fins are brazing on the aluminum tube due to rectangular copper fins will be the heat transfer rates will be increased on the surface of tubes .

Fins profile and material properties:

There are various type of fins profile: Rectangular fin, triangular fin, rectangular fin, pin fin circular section, pin fin conical section. But rectangular fin is better than other fins profile because surface area of rectangular fins are higher as possible. Such as fins are commonly used where the value of convective heat transfer coefficient(h) are comparatively low. Rectangular fin has the heat transfer effectiveness is more than other fins profile. The fin material should be made by particularly conductive materials. So copper fins are preferred in counter to cross flow ACHE. Because copper fins have high thermal conductivity and resistance to corrosion. Its cost and weight are low. Such as the rectangular copper fins efficiency are performance best overall.

2. LITERATURE REVIEW

Bayram Sahin et al. [1] In this investigated paper the design parameter of a heat sink on which hollow trapezoidal baffle is mounted on the base surface. This experimental design are used Taguchi method. Where Nussle numbers and friction factors are considered as performance parameter. In which an orthogonal arrays are selected as investigational plan for the six parameter: the curve angles(α), the inclination angle (β), the baffle heights(H), the baffle lengths(L),the baffle width(S) and Reynolds numbers. First of each goal has been optimized individually and after that all the goals have been optimized together. The baffle lengths(L) are found on the friction factor. The baffle length will in flow direction. Where are the best parameters on the exchange warmth is Reynolds number. The result showed that the heat transfer was obtained at Re=17,000, H=36 mm, L=45 mm, S=26 mm, α=0°, β=0°. It can be conclude higher heat transfer rates are achieved with lower pressure drop.

Jie Qu et al.[2] This research paper discussed the heat transfers of PCM and enhance the thermal performances of PCM used two type of novels are 3D-OHPs (4 layers 3D-OHP and 3 layers 3D-OHP) and PCM coupled with multiple 2D-OHPs. Phase change materials(PCM) have been mostly use in thermal managements because its have high latent heat and low price . Phase change materials are use Oscillating heat pipes(OHP) and effective thermal transfer devices for heat transfer. Its due to enhance the thermal performances. In this experimental manuscript both novels 3D-OHPs and regular OHPs are hired for the PCM thermal performance. By knowing this research paper Results shows that paraffin wax/3D-OHP systems are needed extra times for finally melting of paraffin wax than paraffin wax/OHPs system. In the solidification process two systems are performed better than simply paraffin wax. The solidification times of the pure paraffin wax and paraffin wax/4-layers 3DOHP are taken only 0.29 times where as the paraffin wax/4 OHP systems are 0.48 times taken. Such as the paraffin wax/3D-OHP systems are superior performances.

Hassan Jafari Mosleh et al.[3] This novels are focused on experimental and numerical investigation of pulsating heat pipes(PHPs) as substitutes for fins in a representative air-cooled heat exchanger(ACHE). Because of low temperatures difference between the cooling air and internal airflow. In which R134a was selected as the best working fluid from the heat transfer standpoint. When heat transfer has been done by conduction throughout the wall of the PHP-tube. Than PHPs are filled with working fluid, the coefficient of heat transfer and temperature difference have been increased. In this condition the performances of the PHP-tubes are noted without working fluids are similar to the fin tube. When the axial fans are stopped due to small gap between the fins and produce poor thermal performances of the fin. By knowing this research paper results shows that using PHPs instead of fins improves heat transfer efficiency. In which Firstly fins and PHP-tubes are tested without any exterior flow over the main tubes and the tests are conducted in natural convection situations.

Jian Wang et al.[4]In this research paper experimentally study of the heat transfers and flow individuality of the three new finned copper head heat sinks are subjected to the impingement chilled by rectangular slot jet and axial fan. These experimental process are used for the fast development of electronic devices has imposed higher requirements for thermal supervision and cooling technology. In this experiment taken effect of heat sink heights (H, 15, 30, 45, 60 mm), the pore density of the inserted copper head(PPI, 10, 20, and 30) and the gas flows Reynolds number(*Re*, varying from 2053- 12737) are scientifically investigated. Where are two types of conventional fin heat sink with 8 and 22 fins but without copper heads are tested for judgment. Such as Experimental results expose that inserting copper heads are completely enhance the thermal performances of finned heat sinks. Finned copper foams and conservative heat sinks with the same numbers of fin but finned copper foams are better heat transfer performance. By knowing this experimental research paper ,when the height of heat sinks decreases than pressure drop for all five kinds of heat sinks increases.

De-Shau Huang et al.[5] In this investigate paper experimental and numerical simulations of 30W LED automotive headlights using for heat indulgence. In this experiment, we required to enhance the efficiency of heat transfer of LED take on fins with a grooved heat pipe on the heat sinks. ANSYS Fluent software is used just before model of the heat transfer mechanisms and aid in the design of heat pipes and heat sinks. The temperature distribution of the LED headlights are computer-generated for various material of the heat sinks and printed circuit board (PCB), and fins are designed with a heat pipes. It was found increases the coefficient of thermal conductivity of the substrate due to decreases in the LED junction temperatures, however higher thermal efficiency was not essentially enough. In this trial demonstrated that the reconciliation of 76-mm-since quite a while ago furrowed warmth channels with a compelling warm conductivity of 6000 W/(m•K) and 2-mm arduous plate heat dissemination balances on the warmth sink with an AlN Ceramic having a 180 W/(m•K) demonstrated successful in scattering heat from powerful LED headlights inside a profoundly constrained space. By knowing this research paper enhance the coefficient of thermal conductivity of the substrate due to results

are decreases in the LED junction temperature. However the higher thermal efficiency are not necessarily sufficient.

Hai Wang et al.[6] This investigated papers are thermal performance of the oscillating heat pipes(OHP) designed, temperature distribution and explanation profiles of LED array are experimentally tested and evaluated. In this experiment the thermal management of high-powered LED chips are designed and fabricated, where are the tubular oscillating heat pipes(OHP) with sintered copper particles(SCPs) are inside of the flat-plate evaporator. The thermal performances of designed OHP, temperature giving out and explanation profiles of LED array were experimentally tested and evaluated. A low substantial ratio of 30% are preferred for the designed OHP practical in high-power LED cooling. By knowing this research paper, heat sink of tubular OHP with SCPs inside the flat plate evaporators are developing for the cooling of high power density array. The performances of LED heat sinks are experimentally investigation of the effect of evaporators with SCPs, power input, inclination angle and filling ratio. When the addition of the sintered copper particles(SCPs) with oscillating heat pipes(OHP) due to appreciably enhance the vapor bubble generation rate. The temperature division of the LED array at input power and low filling ratio have different inclination angles are instant or less than 70 °C. The filling ratio affect the OHP put in place performance. The low filling ratio are ideal for the OHP practical because the thermal management of high-power LED. In this experimental setup , the temperature of LED array are inversely proportional to the explanation intensity.

Demis Pandelidis et al. [7] in this research relative study of the sloping evaporative exchangers are worked as heat recovery units, given configurations are counter flow and cross flow. In this experiment presented analysis are accepted out with particular importance on the condensation process that occurs in the product air channels of the exchangers. In which various aspects are related to the water vapor condensation and manage. Which aspects are taken in the classification factors that control the condensation process. Those analyzing factors are forced on dissimilar IEC exchanger arrangement. There are a variety of inlet parameter and operating condition for judgment of the counter and cross flow exchangers. Those performed analysis are based on numerical simulations with mathematical e-NTU models of heat and mass transfer. By knowing this research paper found result showed that the counter flow configuration has high reasonable and latent cooling potential than the cross flow unit. The technical limitation of counter-flow configuration due to the cross flow exchangers are achieved higher Energy Efficiency Ratio and lower investment cost. Whenever, the structure of the counter-flow design that requires supplementary input or output branch of the results are increased size of the counter flow components and higher pressure drop balance with the cross flow exchangers.

Lei Wang et al. [8] In this study paper author focus on the article in presented a new mathematical model that combined the law of energy conservation and the principle of the irreversible thermodynamic theory. In this investigation the wet bulb indirect evaporative cooling(IEC) achieved through M-Cycle is a difficult thermodynamic process. Heat and mass transfer for advance understanding occurs in a dew point indirect evaporative air cooler with M-Cycle counter flow configuration. The research paper are represented mathematical model. The model comprising of various energy, mass and entropy equations are uses to take out the study of the dew point air cooler below various operational and structural conditions. The entropy creation numbers are establish to be a show potential indicator for the optimized designs. The mutual analysis are energy efficiency and thermodynamic irreversibility of the intention IEC system. The optional average air velocities of dry channels should be less than 1.0m/s. In this experimental setup the channel length should be in range of 1e1.75m and channel gap should be controlled to 3e5 mm. Whereas the working to intake air ratio must be around 0.3e0.4. By knowing this research paper, for better and advance understand of the heat and mass transfers are occurred in a dew point indirect evaporative air cooler with M-Cycle counter flow configuration. Based on this experimental study has been proved that the entropy production numbers are used for the useful parameters in the optimization designs of the HMX for a dew point IEC.

Anna Pacak et al. [9] In this study paper, the investigation of the heat and mass transfers in counter flow heat exchangers are performing on the foundation of organized to order e _ NTU model. The rate of specific heat and mass transfers zones was conventional for different exhaust airflow parameters and the heat exchanger efficiency. The local reasonable and latent heat transfers rate are sharing out analyze for the different values of heat exchanger efficiency. The experimental investigations are approving away to confirm the original mathematical model of plate heat exchangers. The successful results are judgment between effective and experimental data showed that the numerical models are accomplished to calculate effectively of the plate heat exchangers operating performance. There are two freeze safety method, for example preheating and bypassing of the outdoor airflow are taking into reflection. By knowing this research paper, Bypass freeze protection method is characterize by low heat improvement efficiency for the a large amount characteristic judgment range of the return air relative humidity RH2i ¼ ð20 . . . 50Þ%. Such as Bypass freeze protection method provides

higher total power demand compared to the preheating method. The problems of water air heater freezing are done through the bypass method treatment. The investment cost of bypass methods are higher than the preheating method. Bypass method are taken into accounts as soon as makes final decision.

Ali Pakari et al.[10] This research paper are the mathematical model of the heat and mass transfers procedure in counter flow dew point evaporative cooling systems are developed. The measured input prepared parameters are inlet air temperature, inlet air velocity, inlet air relative humidity, and extraction ratio. Which measured geometrical parameters are the canal length and canal width of the cooling system. The chosen output responses are outlet air temperature, outlet air relative humidity, and wet-bulb efficiency. These experimental measurements are based on numerical model. The input factors are inlet temperature, inlet relative moisture, inlet velocity, removal ratio, canal length, and canal width. The output response of the cooling system are exit temperature, exit virtual moisture, and wet bulb efficiency. There are using the CCD, second order degeneration models are built-in to the selected responses. The degeneration models speak about the six input factors to the three selected responses. The degeneration models used for forecast of the presentation and the optimization of the aim of counter flow dew point evaporative cooling systems.

Xia Song et al. [11]In this research paper logical methods and simulation of work has analyzed the association between the temperature levels of heating and cooling source and the air state in a typical LD systems regenerated by arrival air. The circulating solutions are the media to transfer the heat and mass. Where are the transfer heat and mass between the air heating and cooling sources. The logical results show that certain air states (clean air, supply air, and return air) keep in touch to one particular solution circulation. Such as the certain air can only be expert by a certain pair of temperatures for heating and cooling sources. The suppled air has additional influenced in the last with regard to the temperature of heating and cooling sources. By knowing this research paper at a set temperature, a minor humidity ratios of the suppled air demand, A momentous enhances in the temperature of heating sources and minor decreases in the temperature of cooling source. The lower temperature of suppled air require low temperature for both source on fixed humidity ratio. The moisture ratio of the clean air is the main factor that determine the temperature of two sources. The dehumidifier is the very significant component and its outlet air is unwavering by the inlet solution less than a confident inlet air, in step heat capability flow rates and a confident NTU m.

Mirco Rampazzo et al.[12] This research, measured an Indirect Evaporative Free Cooling System. The experiment are based on mathematical modeling and given transmission of explore in shorter time and smaller costs. In this term paper first we grow a First Principles data driven models for an Indirect Evaporative Cooling system with Free Cooling and then we consequently design a mat labs based process environment. Evaporative Cooling and Free-Cooling technology have obtain a increasing interest in air-conditioning systems and they are appropriate in different air conditioning applications: commercial, industrial, residential, and data centers. Such as, the Evaporating Cooling technology is eco friendly and this technology could offer tremendous cooling and exposure to air through least energy consumptions. Evaporative Cooling technology has a very little global warming impacts. By knowing this research paper, we have given attention an Indirect Evaporative Free Cooling System. The main aspects of an Indirect Evaporative Free Cooling System are heat exchanges, air and water temperatures, etc. The physical phenomena and experimental datas are developed by the First-Principle Data-Driven model. The fixed stirring boundary methods for telling the input constituents of the system, i.e. the heat exchangers, have provided a good quality balances between model's complexity and accuracies.

3. LITERATURE SUMMARY

After study of different research paper, I understood about different types of grooved pipe, fins , air cooled heat exchanger configurations using is presented by different authors. By Bayram Sahin research, In this Optimization of intend parameter for heat transfer and friction factors in heat sinks with hollow trapezoidal baffle exploratory investigation, the impact of various structure parameters on warmth move and weight drop qualities in a warmth sink furnished with trapezoidal astounds were examined by applying Taguchi trial plan strategy. In this research papers experimental investigations on thermal performances of phase changed materials attached with three-dimensional oscillating heat pipe (PCM/3DOHP) for thermal management application analysis by Jie Qu. In this paper, two sorts of frameworks (PCM/3D-OHP and PCM/ OHPs framework) for warm administration application have been made and tried during liquefying and cementing process. By author Anna Pacak investigation of power demand calculations to freeze prevention method of counter flows heat exchanger used in energy revival from exhaust air. In which state that a hypothetical

examination of heat and mass exchange in a counter-stream heat exchanger utilizes for energy retrieval in air taking care unit (AHU) under below zero working conditions is displayed. In other follow a line of investigation by author Jian Wang investigate the heat transfer and flow characteristic in fin copper foam heat sink subjected to jet impingement cooling. in this research states that the heat move and weight drop of five sorts of warmth sinks showing to impingement cooling by rectangular space flow and fundamental fan. From the above research paper, various authors explained the operation on different tube and fins material and tube in different grooving profile with different fluid flow

4. RESEARCH GAP

When I study of various research paper of many others heat exchangers based than I found that different type of fins and pipe profile used that have different results. In the various research paper I had been study that parallel flow, counter flow and cross flow of heat exchanger in which different material of tubes and fins are used. In the tubes different profile such as circular, trapezoidal grooves found. So after study of different research paper of heat exchangers based I understood idea that research paper In which some profile on which works are not completed than I had been found that new ideas on which works are possible. So after study of various research papers related to heat exchanger I decide that I will be works on counter to cross flow in air cooled heat exchangers [ACHE]. In which fins are used copper for best thermal conductivity, pipe grooved profile are spiral groove for high turbulence and pipe material are used aluminum because its thermal conductivity is good and much preventive of corrosion. Thus after various research paper study, we found an idea and decide research on counter to cross flow in concentric tube air cooled heat exchanger [ACHE].

5. OBJECTIVES

In present paper, we center on the computational and experimental investigation on various parameters of heat exchangers utilizing counter to cross stream with and without internally spiral groove aluminum concentric tube with attached rectangular copper fins forced convection air cooled heat exchanger [ACHE].
The primary objectives of this research paper are following:
[1] To enhance the rate of heat transfer ACHE by internal spiral grooving tube with rectangular copper fins.
[2] To improve the thermal efficiency of ACHE by using aluminum concentric tube in which internally spiral grooves with rectangular copper fins.
[3] To evaluate the properties of fluid (like velocity, pressure loss etc.) inside the concentric tube.
[4] To evaluate the performance of ACHE with different materials and fins.
[5] Error analysis.
[6] Cost estimation.

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