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EXPERIMENTAL ANALYSIS OF TIP CLEARANCE AND CHORD LENGTH FOR OPTIMUM DESIGN OF AXIAL FLOW FAN IN AIR COOLED HEAT EXCHANGER

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ABSTRACT

The heat transfer characteristics of air cooled heat exchangers (ACHE) are dependent on the ability of the axial flow fan system to delivery sufficient cooling air. However, under normal operating conditions, variable flow rate and strength often subject peripheral fans to distorted inlet condition with an attendant reduction in overall volumetric flow rate and cooling capacity. There are various consideration are taken while the design of the fan such as cost of the fan, ease in manufacture, low energy consumption, light weight, low noise level, higher fan efficiency, high volume flow rate, static pressure, space limitation, operating temperature and other parameters. From this literature review paper, we concluded that the experimental analysis of tip clearance and chord length for optimum design of axial flow fan in air cooled heat exchanger is not conducted.

***Keywords*:-Ache, Axial Flow Fan, CFD, Ansys**

I. INTRODUCTION

An air cooled heat exchanger is simply a pressure vessel which cools circulating fluid within finned tubes by forcing ambient air over the exterior of the tubes. ACHE is a device for rejecting heat from a fluid or a gas, there are two sources readily available, with relatively low cost, to transfer heat to air and water.A heat exchanger consist of heat exchanging element such as core or matrix containing the heat transfer surface ,and fluid distribution elements such as tanks or headers ,inlet and outlet nozzles or pipes etc. Usually, there are no moving parts in the heat exchanger.

Reasons for using air cooled heat exchanger as given, first its increases plant efficiency and secondly they are "green" solution as compared to cooling towers and shell and tube heat exchangers because they do not require an auxiliary water supply. Heat exchanger is a device which is used to transfer heat between a solid object and a fluid.

The fluid is to be separated by a solid wall to prevent mixing or they may be in direct contact.Heat exchangers are widely used in space heating, refrigeration & air-conditioning, power stations, chemical plants, petroleum refineries and natural gas processing.

J.F.Zhang, Y Yuan , L.T.Ye , et al [1] This paper design a small axial flow fans splitter blades at the passageway among the original long blades of impeller and the splitter blades are arranged in alternative

arrangements. The finite volume method is carried out in numerical calculations. Splitter blades improve the unsteady flow of small axial flow fans in small flow rate region. Splitter blades have positive role to increase the static pressure rise and efficiency in the higher flow rate region. Splitter blade is able to get the aerodynamic noise lower because static pressure gradient on the blade surface is well distributed and the vortex shedding is not developed. It also increases the pressure ratio of impeller and the load of the blade .It is an effective method to improve the overall performance of the impeller.

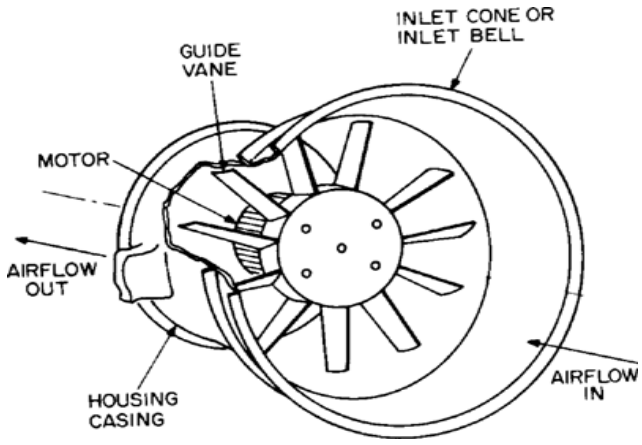
Shekhwat Sanjay P, Mahajan Vandna N. et al [2] In this study the effect of change in speed of fan on velocity pressure and mass flow rate of the axial flow fans was investigated using CFD software. It is to be seen that the significant change in mass flow rate, velocity of rotor and stator vanes as the speed of the fan is varied. The fan performance is directly based on the mass flow rate output of the fan so that there should be a moderate velocity and pressure profile as all these parameters are co-related. For the prediction of mass flow output, velocity and pressure on stator and rotor section Ansys12 software used and an idea for creating an axial flow fan model is modelled by software Catiav5.

Kennedy. I.J., Spence, S.W.T, Spratt, g.e, J.M et al [3] The main aim of the study is that inclination leads to a small increase in the thermal performance of the ACHE of approximately 0.5% for the optimum inclination angle of 30 degree, when compared with the baseline case of shallow plenum with the increase in the depth of the plenum is the effectiveness is slightly more, giving a performance increase of 1 % for a plenum 0.65 fan diameters deep. A CFD study is conducted using ANSYS CFX to investigate how the flow changes in the plenum with inclination.

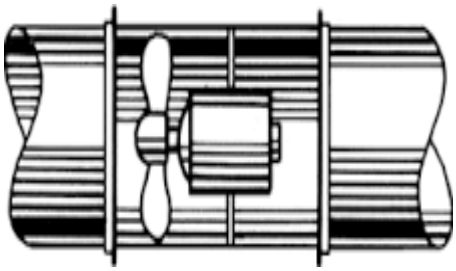
Wahiba Yaici , Mohamed Ghorab, Evgueniy Entchev et al [4] In the present paper a numerical study was performed to predict the influences of the inlet air flow distribution on the performance of heat exchangers. The ranges and values of the geometry of the heat exchanger are studied by the CFD simulation. The comparisons between experimental and the software data implies that the model used in the present study is reliable and can predict the thermal performances satisfactorily for heat exchanger. This study has significant contribution on the optimum design of header and distributor configuration of heat exchanger to minimize misdistribution.

II. TYPES OF AXIAL FLOW FAN

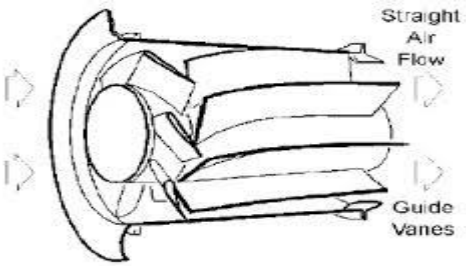
2.1 Propeller Fans:-They are used for high volume flow rate with lower pressure rise. These types of fans are cheaper in construction as compared to other fans and maximum efficiency carried out at deliver section of fan. Propeller fans are used in rooftop ventilation or as panel mounted on the well of structure. Even though, they operated in reverse direction in order to achieve ventilation application. They have low energy efficiencies as compared to other axial flow fans as well as noisy in operations. They are directly driven by motor with the help of belt to the hub.



2.2 Tube axial fan: - Tube axial fan primarily propeller fan placed within the cylinder shell and its one diameter long generally. They generate higher pressure and better efficiencies as compared to axial fans. They are used in HVAC application. Its motor orientation will be either upstream or downstream of the blade. They are costly in construction and less noisy in operation as compared to axial flow fan. They are 65% energy efficient.



2.3 Vane Axial Fan: - Vane axial fans are like tube axial fan, except it has an extra guide vane to direct the flow into an additional appropriate path to the impeller or to the swirl component of the speed to possess extra gain of static pressure. Vane axial fan will generate high volume flow rate and fairly high static pressure rise compared to the previous axial fan varieties. There aerofoil blades have a positive results on the performance and efficiency. They have overall efficiency about 85%.



VANEAXIAL FAN

III. IMPORTANCE OF AXIAL FLOW FAN DESIGN

In axial flow fans, the blades of the fan forces the air parallel to the shaft about which the blade rotates and due to this air flow from the axial flow fan which create pressure rise and the pressure difference. Axial flow fan should be design with proper specifications in order to maximize the cooling effect in the air cooled heat exchanger. It should have high volume flow rate and the minimum tip clearance between the tip of blade and the

casing. The axial flow fan has low manufacturing cost, light weight propylene aerofoil section, lower operating temperature, compact structure. Even though they have noise and power consumption optimum in operating conditions and having high efficiency.

IV. DESIGN OF AXIAL FLOW FANS

4.1 Study of Experimental Approach:- The fans were used in heat exchanger were designed with some modifications in dimensions in order to increased the air flow rate in the both ducts i.e circular duct as well as rectangular duct. The results showed the maximum air flow rate with 60^0 tilted opening duct of heat exchanger and also got the cooling effect maximum.

4.2 Study of Numerical Approach: - Numerical approaches were studied on the basis of two methods. First one was the CFD (computational fluid dynamics) and other one was FEM (Finite element method). CFD, its branch of fluid mechanics that uses numerical analysis and data structures to solve and analyze problems that involve fluid flows. The effect of change in speed of fan on velocity pressure and mass flow rate of the axial flow fans was investigated by using CFD software. It was seen that the significant change in mass flow rate, velocity of rotor and stator vanes as the speed of the fan is varied [7]. The influences of the inlet air flow distribution on the performance of heat exchangers. The ranges and values of the geometry of the heat exchanger are studied by the CFD simulation.

FEM, it's a numerical method for solving problems of engineering and mathematical physics. Typical problem areas of interest include structural analysis, heat transfer, fluid flow and mass transport. FEM also used in design and performance of axial flow fans in order to determine the stresses and deformations of an axial fan blade. 3D – finite element method have been developed using 8 -node super parametric shell element as a discretization element for the blade structure.Fortran-77 codes are used to all the formulations and computations [9].

V. CONCLUSION

The outcomes from the above literature review are that different modifications were done on with the axial flow fan in order to obtain maximum cooling effect. Even though, it's proved the above literature review that many researchers worked on the angle of attack, no. of blades, mass flow rate, energy consumption and higher efficiencies of fans. From the above conclusion, the experimental analysis of tip clearance and chord length for optimum design of axial flow fan in air cooled heat exchanger is not discussed.

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