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A REVIEW OF LITERATURE ON DESIGN OF AXIAL FLOW FAN

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ABSTRACT

The Axial Flow Fans are used everywhere in the world during a wide verity of industries and a number of the necessary applications are in the steam power plant, ventilation, refineries, and a lot of cooling purposes. Several researchers are devoted their effort to design fans to fulfills the actual demand of application within the most effective manner. There are various consideration are taken in mind for 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. Many studies are obtained from various researchers by the analysis and simulations of axial flow fans. Performance of axial flow fans and design of various sections are obtained from experimental and numerical analysis on the different parameter variations.

Key words: Axial Flow Fan, ANSYS12, CFD

I. INTRODUCTION

Axial Flow Fans are the devices that discharge the operating fluid parallel to its axis of rotation. The operating fluid is air and mostly they are operated within the incompressible region. Axial flow fans are usually employed in mines, tunnels, underground transportation, all types of vehicles and industrial facilities for air conditioning and ventilation functions in normal and emergency conditions. In an axial flow fan, it is desired to possess ideally axial flow that there is no radial velocity component. The pressure rise is provided by the rotation of the blade that imposes a tangential velocity component to the flow and therefore the diffusion after the flow passes the impeller. The system needs are usually specified by a pressure rise and a corresponding volumetric flow rate. For every volumetrically flow rate and pressure loss, a particular design should be used to match the requirements of the system. There are basically three types of axial fans. They are propeller fans, tube axial fans, vane axial fans. Another application is multi stage axial fans. By use of multistage axial fans, it's possible to possess higher pressure rise with the same volumetric flow rate.

II. TYPES OF AXIAL FLOW FAN

2.1Propeller Fans

Propeller fans are used for high volume flow rate with low pressure rise. This axial flow fans are cheap due to comparatively simple construction. Near the free delivery the maximum efficiency is achieved. These types of

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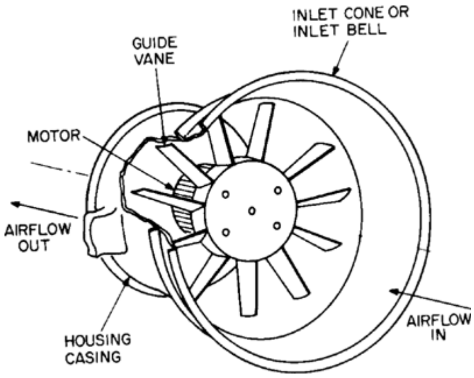
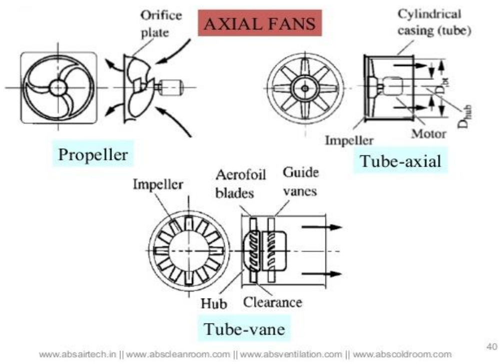
fans are used for rooftop ventilation or as panel are mounted on the walls of the structures. They can generate in reverse direction that is appropriate for ventilation applications. The energy efficiency is low compared with different varieties of axial flow fans. They are considered to be noisy. The drive systems are often either direct drive that is the motor is directly couples to impellers or indirect drive that's the mechanical motion is transferred by the belt to the hub.





2.2. Tube Axial Fans

Tube axial fans are primarily propeller fans placed within a cylindrical shell, which is regarding one diameter long generally. Tube axial fan will generate higher pressure rise and operate at better efficiencies than the propeller fans. They are employed in ducted HVAC applications. It will generate flow in reverse direction, which is incredibly helpful for many ventilation applications. The hub diameter is regarding half hour to five hundredth of the blade diameter. Tube axial fan performs higher when it is used in exhausting fans. The motor orientation will be either upstream or downstream of the blade. The cost of the tube axial fans are more compared to propeller fans however comparatively less noisy. The Energy efficiency is about 65 %.

2.3.Vane Axial Fans

A vane axial fan is incredibly like a 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. The hub diameter is five hundredth to eightieth percent of the impeller diameter. Vane axial fan will generate high volume flow rate and fairly high static pressure rise compared to the previous axial fan varieties. The shell is generally one diameter long. In some application the motor is buried in a tail cone that will increase aerodynamically efficiency by a controlled diffusion of the flow. The tolerance between the tip of the impeller blades and therefore the shell has an impact on efficiency. Also using aerofoil blade has a positive result on performance and efficiency .The overall efficiency of the well designed vane axial will exceed 85%.

2.4. Importance of Axial Flow Fan Designs

In the axial flow fans the blade of the fan forces the air parallel to the shaft about which the blade rotates and due to the air movement from the axial flow fan there is the pressure rise and the pressure difference is to be created. The volume flow rate of this fan is high and the low pressure with flow parallel to the axis of fan. It has

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various shapes of blade including paddle, sickles, aerofoil and variable pitch. Axial flow fans are selected for simple cooling application with low system resistance. The axial flow fan has low manufacturing cost, light weight propylene aerofoil section, lower operating temperature, compact structure, low installation noise level and high efficiency performance. The axial flow fans are operated at high static pressure, low stack height, efficiency does not change with speed and the horse power is flat and non-overloading. Fewer and wider blades will results in a better fan efficiency and lower noise level. 5 to 12 blades have good for practical application.

III. DESIGN OF AXIAL FLOW FANS

3.1 Experimental Studies

The fan of the heat exchanger was designed and with modified dimensions, the fan was fabricated and installed in heat exchanger .the experimental set up was developed to test air flow velocity of both the type of duct is circular duct at inlet and rectangular duct at the outlet [1] .The result showed that the maximum volume of air flow rate is obtained in existing, required and modified fan. The cooling effect was maximum with modified fan.

Counter rotating fans have been used in application requiring a higher pressure point that can be achieved in a single stage fan. In this paper presents a single motor concept with one shaft driving both fan impellers. The motors internal rotor is connected to one fan stage and the external rotor of the motor is connected to the other [2]. Performance of the new contra rotating fan concept was both experimentally .Fan efficiency was found to b. higher than a single stage fan with guide vanes.

3.2 Numerical Studies

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 [3]. With the increase in the depth of the plenum 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.

The finite element method has been used 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 bladestructure.Fortran-77 codes are used to all the formulations and computations [4] .The desired work is achieved by modeling the fan blade as a rotating shell. The effect of centrifugal forces on stresses and deformations of rotating fan blades are investigated. An extensive analysis has been done for various values, thickness skew angle. The effect of the curvature on the stress,deformation and the speed of rotation. The numerically investigated results shown a good agreement compared with the available investigations using other method.

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 [5]. The fan performance is directly based on the mass floe 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 is used and an idea for creating an axial flow fan model is modeled by software CatiaV5.

The small axial flow fans, splitter blades at the passageway among the original long blades of impeller .the long and the splitter blades are arranged in alternative arrangements. The finite volume method is carried out in numerical calculations [6]. Splitter blades improve the unsteady flow of small axial flow fans in small flow rate region. Splitter blade has a 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. For simulation the Gambit Software is applied to divide grids and the centre of hub is set as the coordinate origin.

An axial flow fan and heat exchanger model is implemented within CFD codes and developed an axial flow fan model based on actuator disc theory to simulate the effect of an axial flow fan on the air stream. The numerical investigation indicates that the axial flow fans used in a particular forced draught ACHE can have a significant influences on the flow field within ACHEs plenum chamber and as a result on the performance characteristics of ACHE [7]. The point of maximum fan static efficiency is also seen to not necessarily coincide with the maximum Krec -Value associated with a particular forced draught ACHE.

An attempt was made to find the best angle of attack and rotational velocity of a flat blade at a fixed hub to tip ratio for maximum flow co-efficient in an axial fan in steady and turbulent conditions. The blade angle differs from 30-70 degree and the rotational velocity is varied from 50-200 radians per sec for the number of blades from 2 to 6, at fixed hub to tip ratio [8]. He numerical and experimental results shows that , the maximum flow coefficient is achieved at the blade angle of attack between 45-55 degree when the number of blade was equal to 4 at most rotational velocities the flow coefficient remained constant.

The 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 is studied by the CFD simulation [9]. 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.

The design validation was done by CFD analysis. A relation between volumetric flow and pressure is established with graphical approach which is an analysis of performance parameters efficiency has been increased when compared with the existing machine from 52 % to 63% of total to total efficiency [10]. Performance on the new design has been verified with commercial CFD software, ANSYS CFX.

Computation and measurement of the flow in axial flow fans with skewed blade has been conducted to study the three-dimensional flow phenomena pertaining to this type of blade shape [11]. The results were analyzed, leading to a design method for fans with swept blades. Forward swept fans designed accordingly exhibited good aerodynamic performance.

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IV. CONCLUSION

The outcomes of this literature review are that with the modifications in the higher cooling effect. The two stage fan efficiency was more the single stage. Many researchers worked on the angle of attack, sizes, weight, mass flow rate energy consumption and higher efficiency of the fan.

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