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Analyse and Evaluate the Performance Of Centrifugal Blower Using Ansys Software

Research Scholar Kumar Neeraj, Asst. Prof. Ishan Khan, Asst.Prof.Yogesh Mishra
Department of Mechanical Engineering, NIIST, Bhopal

Abstract- It is possible to increase the efficiency of an asynchronous motor's speed by managing the functioning of a cyclo-converter, which sequentially regulates the quality characteristics of a single phase (split phase) asynchronously motor. Changing the number of poles on a single phase asynchronous motor is an approach of adjusting speed, while the other is to change the frequency. First approach is not cost-effective; nevertheless, because the number of poles cannot be altered when the system is running, the overall size of the machine also rises. In the second approach, the frequency may be varied while the motor is operating, and there is no need to modify the size of the motor. This approach makes use of a frequency altering gadget to function as a step down cyclo-converter. By adjusting the firing orientations of the cyclo-converter, it is feasible to manage the amplitude and frequency of the output voltage. In situations when the frequency response is low, the amount of distortion is quite low. The cyclo-converter eliminates the necessity for a flywheel in that machine. This work explains how speed of asynchronous motor is varied in three steps f/2, f/3, and f/4 using MATLAB/ Simulink.

Keywords- Asynchronous motor, Split phase motor, Step down Cycloconverter, MATLAB, Simulink.

I. INTRODUCTION

Submarines regularly use mechanism of blowers. Nearly in all components of submarines, their air conditioning and ventilation system are fitted with blowers. Central systems' ventilating systems include exhaust and supply fans. Ventilation systems' blower fitted in it ventilate accommodation & non accommodation areas. They cool and purify the atmospheric air and smelling and harmful impurities coming out of storage batteries are removed.

Air conditioning systems contain single, compartment group and local duct systems. In accommodation & non accommodation areas, crew members are provided comfortable conditions against humidity & temperature. These systems also purify air in sanitary areas, in rooms and galleries. Also, air is mixed in compartments by these systems. All installed submarine blowers differ in noise level, capability of dynamic impacts and in high reliabilities. Since mechanism of submarine and their major portion contain blowers, following essential characteristics should be met by them.

- Any change in climate or during transportation, their service life should be maintained.
- lubrication points should be easily accessible and their repair and mounting should be convenient.
- They should withstand the impact resistance and vibration.
- While during motion of submarine, their operation should be reliable.
- Their parameters should be of minimum dimension and weight.

Types of Blowers

More high pressures can be achieved by blowers in comparison to fans. The pressure can reach up to 1.2 kg/cm^2 as far as vacuum systems used in industry are concerned, blowers can be used for producing negative pressure. Blowers of 2 main types are given below:

- Centrifugal blowers
- Positive displacement blowers

Centrifugal blowers

In comparison to fans, centrifugal blowers are similar to centrifugal pumps. Impeller of centrifugal

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blower is driven by gear. Its rotational speed is up to 15000 revolutions per minute. In case of blowers of multistage type, when air goes through every impeller, it further accelerates. As far as blowers of single stage types are concerned, they are more efficient because many turns are not taken by air. Higher pressures are achieved by centrifugal blowers even though their typical operation is in the range of .35 kg/cm^2 - 0.7 kg/cm^2. With the increase of system pressure, the tendency of air flow is that it decreases drastically. In material conveying systems, it is disadvantageous because it depends upon steady volume of air. Due to this reason application of centrifugal blowers are in no prone clogging systems. As shown in Figure1.

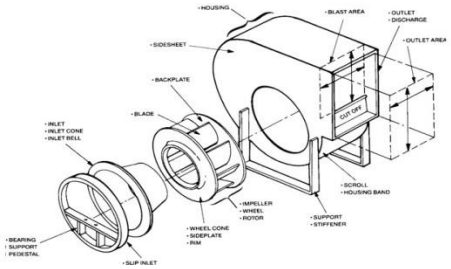

Figure 1: Centrifugal blower

Positive-displacement blowers

Through housing, air is trapped & pushed by its rotors. Even in case of variation of system pressure, constant volume of air is provided by these blowers The use of these blowers is more suitable for applications prone to clogging. This is because sufficient pressure of up to 1.25 kg/cm^2 can be produced by them which helps in blowing clogged material free. For facilitating speed changes, these blowers are often driven by belt. The speed of positive displacement blowers is much lower (3600 rpm) with respect to centrifugal blowers. A positive displacement blower has curved impeller which is kept between faces of two housing which are kept apart along axis of impeller. A housing inlet is defined by its one of the faces. Except outlet & inlet, there is a substantial close off housing.

II. LITERATURE REVIEW

Anoop raj et.al. This study will investigate the possibility of using composites rather than metals in place of those components. The capacity of a structure to reduce the transmission of vibrations that are caused by mechanical disturbances is represented by the property of damping in that structure. The damping factor of a material is a measurement of the material's damping. Composite materials have a better chance of reducing vibration when compared to metals of the same type. This is because, in comparison to metals, the damping properties of composites are significantly higher.[1]

Sunil et.al. Blowers are one of the types of turbo machinery which are used to move air continuously with in slight increase in static pressure. Blowers are widely used in industrial and commercial applications from shop ventilation to material handling, boiler applications to some of the vehicle cooling systems. As per the discussion with concern persons of Food industries primarily fruit juice producing company. It is found that they are facing many problems regarding centrifugal blower. They are using centrifugal blower for ventilation purpose, also they are using blower to maintain the temperature of food storages (Pulp storage).The present centrifugal blower is made up of from M.S. material here corrosion is a major problem. The ingredients of the same are mixing with fruit pulps, which are harmful; also, weight of the present blower is high. This paper gives the solution to above problems by optimization of centrifugal blower impeller by static and modal analysis using FEA for the material MS, SS. SS304L [2]

Yogesh R Pathak et.al. Numerical analysis of the single stage centrifugal blower is carried out for different flow coefficient. To analyze the 3-D flow field, fluid domain is created and simulation is done with the CFD software code ANSYS CFX. Three dimensional Navier-Stokes equations are used to analyze the flow. Standard k-ε turbulence model and unstructured grid is adapted to solve the Navier-Stokes equations. Results of numerical analysis suggest that the pressure coefficient at an outlet of fluid domain is continuously decreased with increase in flow coefficient. The detail flow analysis is also carried out for the practical case of flow coefficient. The flow is analyzed at different angular and axial positions inside the volute. [3]

Keyur k Patel et.al. To improve the efficiency of centrifugal fan, various analytical softwares are available which give the information about complex flow inside the centrifugal fan. The model of the centrifugal fan is made in Solid work 2009 (made by Dassault SystemCompany). Performance analysis has been carried out by experimental and ANSYS CFX

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software.For the analysis backward-swept blade centrifugal fan having12 number of blades is selected. Then experimental readings have been collected and analysis by software. Then experimental readings and software analysis results compared. Now, the parameters like inlet blade angle, outlet blade angle, number of blades have been changed for analysis.[4]

Y. Srinath et.al. Centrifugal blowers are used extensively for on-board naval applications which have high noise levels. The noise generated by a rotating component is mainly due to random loading force on the blades and periodic iteration of incoming air with the blades of the rotor. The Contemporary blades in naval applications are made up of Aluminium or Steel and generate noise that causes disturbance to the people working near the blower. The present work aims at observing the choice of E-Glass as an alternative to metal for better vibration control. E-Glass, known for their superior damping characteristics are more promising in vibration reduction compared to metals. The modeling of the blower was done by CATIA V5 R19. The blower is meshed with a three-dimensional hex8 mesh is done using HYPERMESH 10.[5]

P. Srinivasulu et.al. A centrifugal blower is a mechanical device for moving air or other gases. The terms "blower" and "squirrel cage fan" (because it looks like a hamster wheel) are frequently used as synonyms. Rotating impellers increase the speed of the air blowing from another end. Centrifugal blowers are used in naval applications and motors. The Contemporary blades in Centrifugal Blower used in naval applications are made up of Aluminum1060 or Steel now we replaced the composite material (carbon fiber).In this thesis the centrifugal blower modeling in Solid works software and analysis in ANSYS software with different materials in static analysis and different velocities in CFD analysis to find the fluid flow .In this thesis the static analysis to determine the stress, deformation and strain with different materials (aluminum alloy, graphite and carbon fiber)CFD analysis to determine the pressure drop, velocity, heat transfer coefficient and mass flow rate at different velocities (14, 16, 18, 20 and 22m/s).[6]

Jiangnan Zhang et.al. In this paper, we present the design and optimization of a centrifugal fan with requirements of maximizing the total-to-static pressure rise and total-to-static efficiency at two operating points and the maximum torque provided by the motor power using a 3D inverse design method, a DOE (design of experiment) study, an RSM (response surface model) and a MOGA (multi-objective genetic algorithm). The fan geometry is parametrized using 13 design parameters, and 120 different designs are generated. The fan performances of all the designs at two operating conditions are evaluated through steady-state CFD simulations. The resulting design matrix is used to create an RSM based on the Kriging method and MOGA is used to search the design space using the RSM and find the optimal design.[7]

Tesfaye Barza et.al. This paper is concerned the flow simulation and performance analysis of the Centrifugal Compressor Using CFD - Tool. The complex internal flow of centrifugal compressor can be well analyzed, and the unique design system needs to be developed. It should be early to use the interface and flexible for input and output. A 3-D flow simulation of turbulent - fluid flow is presented to visualize the flow pattern in-terms of velocity, streamline and pressure distribution on the blade surface are graphically interpreted. The standard K- e turbulence model and the simple model algorithm were chosen for turbulence model and pressure distribution well determined. The simulation was steady Heat transfer and moving reference frame was used to consider the impeller interaction under high resolution. Furthermore, A computational Fluid Dynamics (CFD) 3-D simulation is done to analyze the impeller head and efficiency required of centrifugal compressor. [8]

III. METHODOLOGY

The basis of FEA relies on the decomposition of the domain into a finite number of sub-domains (elements) for which the systematic approximate solution is constructed by applying the variational or weighted residual methods. In effect, FEA reduces problem to that of a finite number of unknowns by dividing the domain into elements and by expressing the unknown field variable in terms of the assumed approximating functions within each element. These functions (also called interpolation functions) are defined in terms of the values of the field variables at specific points, referred to as nodes. The finite element method is a numerical procedure that can

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be used to obtain solutions to a large class of engineering problems involving stress analysis, heat transfer, electro-magnetism, and fluid flow.

ANSYS is general-purpose Finite Element Analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user designed size) called elements. The software implements equations that govern the behaviour of these elements and solves them all; creating a comprehensive explanation of how the system acts. The ANSYS Workbench environment is an intuitive up-front finite element analysis tool that is used in conjunction with CAD systems and/or Design Model. ANSYS Workbench is a software environment for performing structural, thermal, and electromagnetic analyses. The Workbench focuses on attaching existing geometry, setting up the finite element model, solving, and reviewing results.

IV. RESULT AND DISCUSSIONS

Here ANSYS software is used to present harmonic, modal & static analysis. Through FEA, composites and aluminium's blowers are chosen for analysis. Aluminium Blower's Static Analysis The deformation of aluminium blower is shown in Figure7.1 presents aluminium blower's deformation. 0.09140 millimeter is the maximum deflection obtained. 3.4830 N/mm^2 is the maximum normal stress achieved. Figures 8.2 to 8.7 illustrates displacements & stresses in x-, y- & z-directions. Aluminium blower's induced stresses & deformations are shown in table-1.

Table-1 Aluminium blower's Static analysis results

Aluminium Blower	Results
Deflection in millimetre	0.0914 millimetre
Max. Normal stress, Newton/millimeter^2	3.483 Newton/millimeter^2
1st principal stress, Newton/millimeter^2	13.234 Newton/millimeter^2
2nd principal stress, Newton/millimeter^2	1.345 Newton/millimeter^2
3rd principal stress Newton/millimeter^2	0.9047 Newton/millimeter^2

In metallic blower, 0.0914 millimeter is maximum deflection caused by induction. It is within the limit of safe value. Thus, the design based on rigidity is safe. The maximum induced stress is 13 Mpa. 160 Mpa stress is allowed. It is less than that. Therefore, considering the strength, it is safe design.

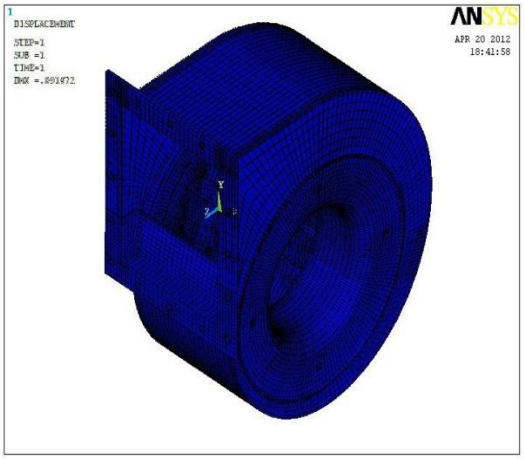

Figure 2: Aluminium Blower deformation in millimeter

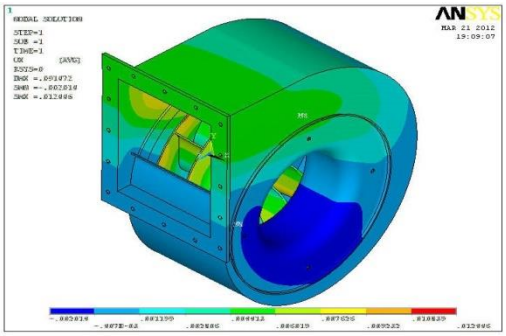

Figure 3: In X direction aluminium blower displacement in millimeter

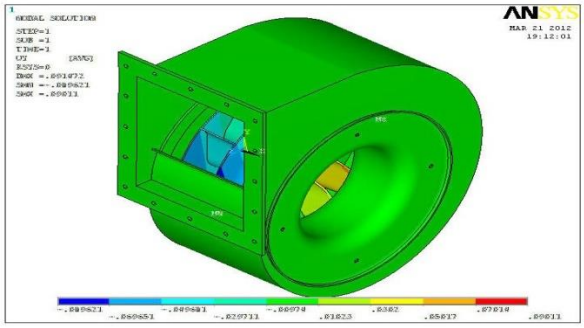

Figure 4 Displacement of aluminum blower in Y-direction, mm

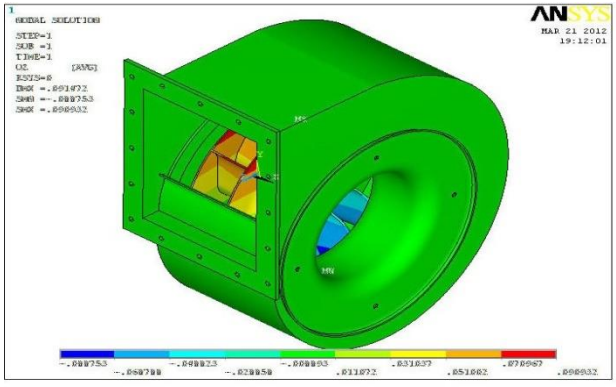

Figure 5 Displacement of aluminium blower in Z-direction, mm.

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V. CONCLUSIONS

Present work draws conclusion as given below:

1.The stresses of composite blower obtained in static analysis 4.534 N/mm^2 are within the allowable stress limits.

2.Since layup sequence and stiffness of the blower is high, therefore, the natural frequency of composite blower is reduced The weight of the Composite blower is less than that of the blower made of aluminium

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