

Design Modification for Vibration Reduction & Vibration Validation for Industrial Air Blower

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Abstract: This paper deals with the field complaint from the end user namely Eco-man Industries who are manufacturers of fertilizers. The problem indicated at their end for air blower (Model -HN-26) are - 1) Heavy corrosion on the impeller due to corrosive environment. 2) Though it complies with I.S.-1940 vibration norms, it creates unwanted irritating sound which can be termed as noise pollution. The root cause of noise pollution is vibration, which is the result of uneven mass distribution and can be termed as manufacturing defects. Secondly proper/inadequate clamping of the mating parts can result in vibrations. Vibrations are generally observed when a system or an element which is subjected to dynamic forces which can be periodic or random, linear or rotational. Vibrations are basically dependent on mass and the elasticity of the system which is also termed as stiffness. Vibration in any system is an indicator of malfunctioning of the system, though it is unavoidable can be kept within the permissible limits. It can result in wear and tear of the moving parts and a premature failure. Finally vibrations can be transmitted to the adjacent areas, to control the vibrations it is always advisable to control it, at the excitation source by providing devices like vibration dampers. Here we have used SS-304 as a substitute material for the impeller for improving the corrosion resistance. Our goal is to minimize the vibration level by modifying the design of the impeller casing and improving the clamping technique so that the vibrations can be reduced at the excitation. Further to validate vibrations modal analysis (Using Ansys software) was performed on the impeller of the blower having wall thickness of 2mm up to five modes to find the natural frequency for each mode of vibration of the impeller. Experimental set-up consisting of FFT analyzer coupled with "Bewe Soft" software to display the results on the screen has been used to validate the results obtained from modal analysis.

Index Terms- Impeller, Vibration Analysis, Finite Element Analysis, Modal Analysis.

I. INTRODUCTION

Vibrations are observed in all structures subjected to dynamic loading. Industrial Air Blowers are used in various process equipment's like dryers, evaporators, providing draft for boilers. The moving impeller provides kinetic energy to the fluid which can generate pressure against the resistance caused by the casing and other components in the system like ducts, dampers etc. The impeller receives the energy from the rotating shaft and transmits it to the air imparting it velocity with slight increase in pressure energy. Blowers are important in providing proper draft to the boiler, which will have an impact on the efficiency of the boilers, as adequate air is supplied to the combustion chamber to ensure proper combustion of the fuel. The blower can be installed in front of the boiler which will supply air at positive pressure against boiler pressure which can be at room temperature or elevated temperature as in case of air preheater, hence they are called as forced draft (FD). Similarly flue gases can be drawn out of the combustion chamber which can be slightly below atmosphere which is called as Induced Draft (ID). The primary air blowers (PA) are used to atomization of fuel, whereas Secondary Air Blowers are used for transferring the fuel through duct conveying system. Generally blowers which are subjected to positive pressure like FD are direct drive whereas ID are belt driven.

II. LITERATURE SURVEY

Adgale Tushar, Balkrishna et al have studied the effect of vibration using alternative materials in sequence of steel, aluminum and glass/epoxy, keeping the geometry of the impeller same. Weight reduction was achieved due to variation in density. [1].

Veeranjaneyulu et al have done static and dynamic analysis on the blower to reduce vibrations with a choice of using alternative material. The proposed design of the blower was analyzed for strength and deformation. Modal analysis was performed for both Aluminum and Composites for five natural frequencies [2].

Dr Manalhadhi Saleh et al have studied the effect of impeller blade design on sound pressure level (SPL) on shrouded & unshrouded impeller. Following conclusions were made - SPL increases with increase in velocity, with max SPL observed in the range 200-315 Hz, and the cover on the blade caused increase in pressure level [3].

O P Singhet et al This paper deals with the effect of geometric parameters of the centrifugal fan with backward and forward curved blades. Parametric study was carried out to quantify Power Coefficient, Flow Coefficient & Efficiency. The parameters considered were number of blades, outlet angle and diameter ratio. Following results were concluded with increase in number of blades increases flow and power coefficient due to better guidance and reduced losses. Forward curved blades have 4.5% lower efficiency with 21% higher mass flow rate and 42% higher power consumption compared with backward curved blades. Efficiency

of the fan increases and then decreases with diameter ratio ,with best efficiency at 0.5 with decrease in performance at high pressure [4].

P. Naveen Kumar et al.have conducted design optimization of Backward Inclined Radial Blade. The scope of this paper was to optimize the design of the backward inclined radial blade . The thickness of the blade was reduced and then the stress and deformation model of the optimized model was studied. Then the number of blades was reduced from 12 to 10 numbers with reducing the thickness from 9mm to 8mm. It was concluded that the stress and the deformation results 8mm thick ten blades is similar to 9mm thick 12 blades. Hence they are interchangeable. [5].

Manish Dadhich et al study was focused to show how fatigue and modal analysis of the centrifugal blower can be done using commercial software like catia and ansys Contours and deformation of equivalent stresses are developed to find to point of max deformation and stress. This can give us a guide line for taking preventive measures to avoid premature failure.[6].

Adam Adamkowski, et al.On the basis of analysis and studies carried out for the main cause of fracture on the shafts of pumps installed in the cooling system of two diesel generator sets in coastal power plant was investigated . It was discovered that due to torsional vibration of the shaft were observed due to accountable loss in impeller mass due to cavitations erosion during normal operation. This mass imbalance caused by cavitations can favour racks. [7].

AtrePranav , et al this paper deals with a Detailed. Design Methodology for aerofoil high efficiency impellers which includes numerical design calculations and the results are validated using CFD analysis to improve the static pressure and efficiency [8].

KarthikMattaet al. This paper represents static and dynamic analysis for the entire centrifugal blower to find out the prone sites for max deformation stresses. Different types of impellers with varying sizes and number of blades were modeled along with different materials. Which lead to conclusion that composite material has less stress and deformation.[9].

III .OBJECTIVES :-

- 1) To use a corrosion resistant material as an alternative material as the blower is subjected to a highly corrosive environment. Hence we have used SS-304 in place of MS.
- 2) To reduce the vibration by design modification of the casing & improving the clamping technique at the exisiation source i.e. prime mover electric motor.
- 3) Validation of the vibration using experimental set-up of FFT analyzer with “Bewe Soft” software and comparing the results obtained from modal analysis.

IV.AIR BLOWER SPECIFICATION

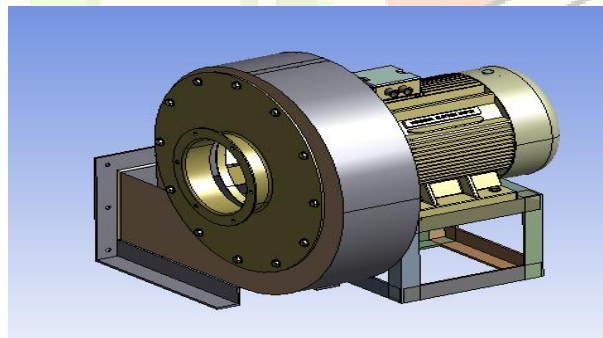


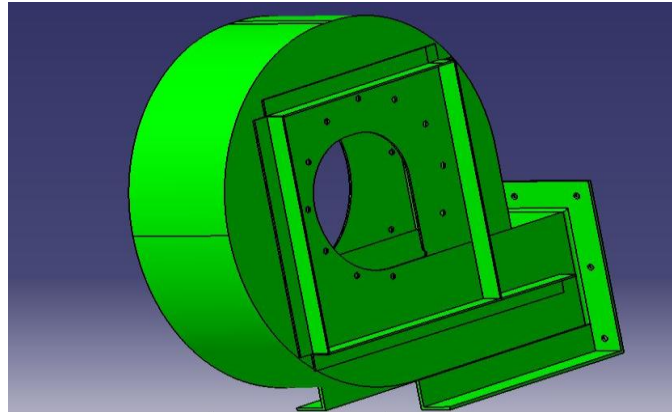
Fig. No.1 Air Blower

FAN MODEL	HN-26
CAPACITY (m3/Hr)	2000
STATIC PRESSURE (MMWG)	40
FAN RPM	2770
MOTOR SPECIFICAION	0.75KW
OPERATING TEMPRETURE°C	20
TOTAL OPERATING PRESSURE (MMWG)	42

V. VIBRATION REDUCTION -

A) DESIGN MODIFICATION OF THE CASING –

The basic concept used in design modification was to increase the stiffness of the casing by providing stiffener's at the rear side of the casing.



Square frame of “C” channels has been welded to increases the rigidity of the casing of the blower

B)IMPROVISING CLAMPING TECHNIQUE :-

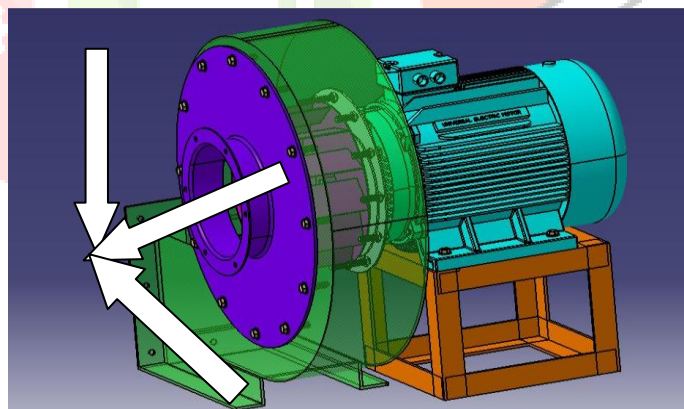
i)Using “UNBRACO” CLASS 12.9 (High Tensile Fasteners) -

Clamping process was redefined by using “Un-braco” make Class:- 12.9 high tensile fasteners , using high tension split washers to ensure positive clamping against normal local made fasteners. Effort has been made to reduce the excitation at the source which is the prime mover (Electric Motor).

ii) Redefining Clamping Process –

Also the clamping was done uniformly at all the four ends to ensure that the base is in perfect horizontal plane to avoid shift in cg and dynamic imbalance. Torque Wrench was used to ensure uniform tightening torque

VI) VIBRATION MEASUREMENT PROCESS –



Vibration level measurement at Drive and Non Drive end in X,Y& Z Axis.



Vibro-meter used to measure the vibrations at X,Y& Z axis at drive and non-drive end.

VII) RESULTS -

A)VIBRATIONS LEVEL BEFORE MODIFICATIONS-

SR NO	PARAMETER	VELOCITY Full Closed (mm/sec)		VELOCITY Full Open (mm/sec)	
		DE	NDE	DE	NDE
1	Vertical Axis (Z)	2.60	1.80	1.40	1.17
2	Horizontal Axis(Y)	2.40	1.70	2.10	1.70
3	Axial Axis (X)	1.90	2.20	2.60	2.20

B)VIBRATIONS LEVEL AFTER MODIFICATIONS-

SR NO	PARAMETER	VELOCITY Full Closed (mm/sec)		VELOCITY Full Open (mm/sec)	
		DE	NDE	DE	NDE
1	Vertical Axis (Z)	1.69	1.17	0.91	0.80
2	Horizontal Axis(Y)	1.68	1.19	1.47	1.22
3	Axial Axis (X)	1.33	1.54	1.76	1.36

VIII) VALIDATION OF VIBRATIONS -

A)Modal Analysis of the impeller :-

Modal analysis is performed on the impeller of the blower 2 mm thick for five mode shapes to find out the natural frequency for each mode shape.

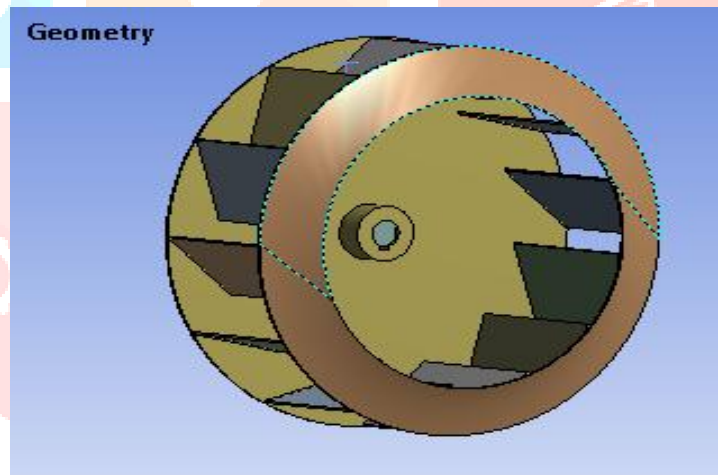


Fig.No.2 Solid Geometry
Solid Modeling is done by using CATIA V5.

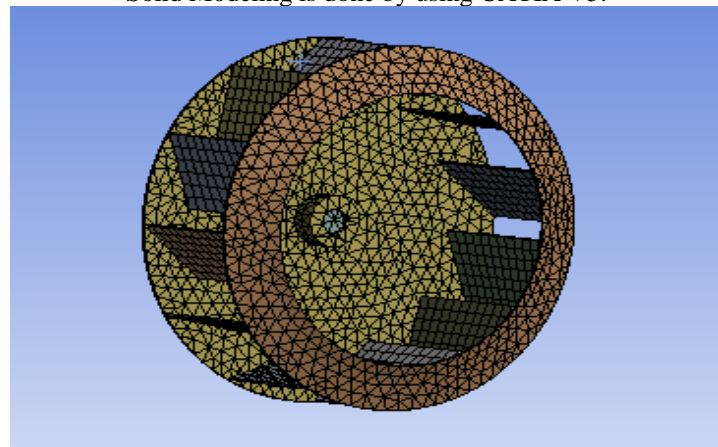


Fig.No.3 Meshing
Meshing Details: Nodes=23341 Elements=8195

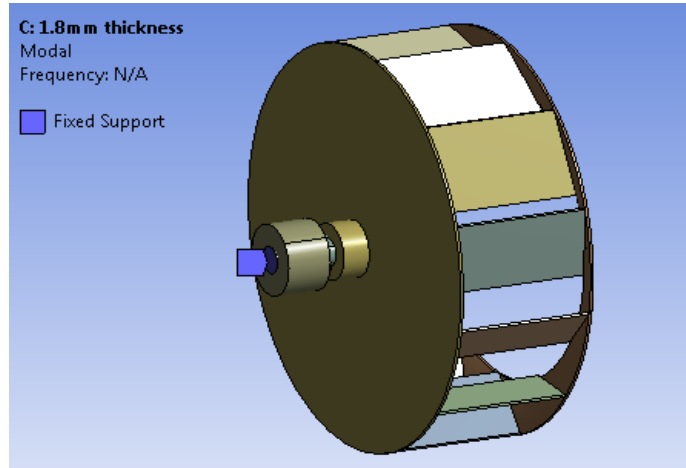


Fig.No.4 Boundary Conditions
Boundary Conditions applied to impeller.

MODE SHAPES:

This mode is obtained for the thickness of blade:

- 1. For 2.0mm thickness:

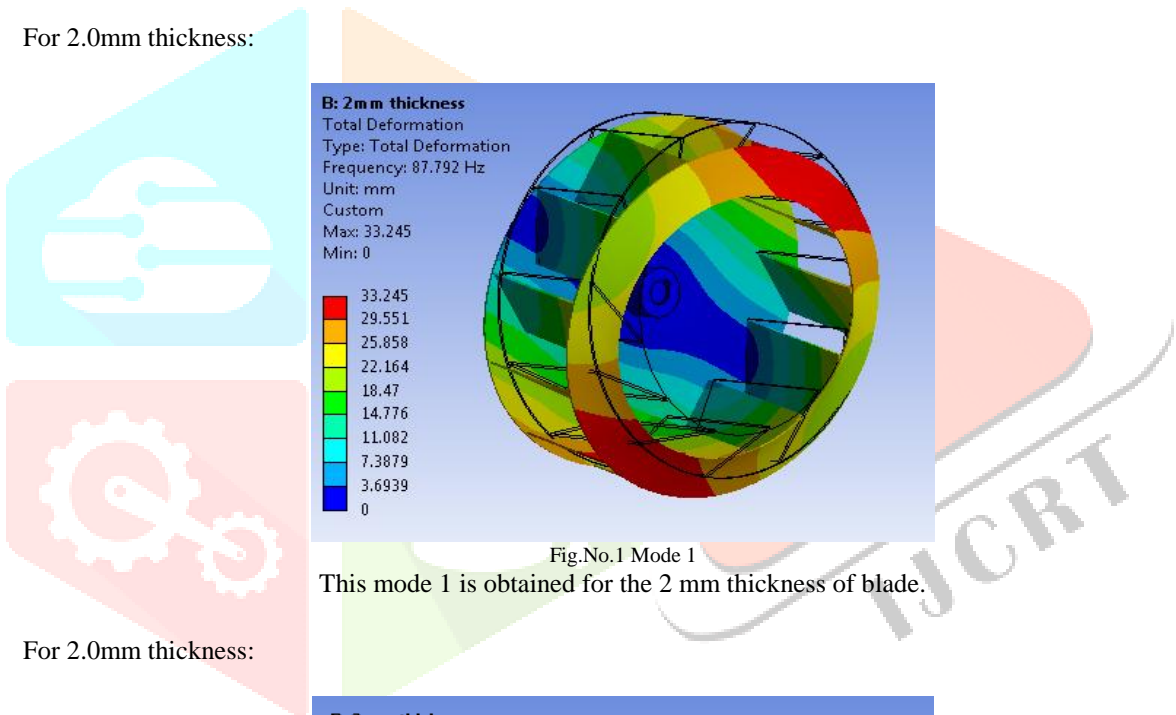


Fig.No.1 Mode 1

This mode 1 is obtained for the 2 mm thickness of blade.

- 2. For 2.0mm thickness:

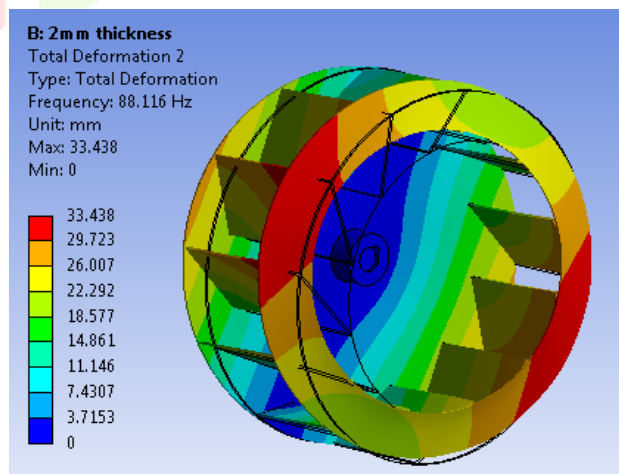


Fig.No. 2 Mode 2

This mode 2 is obtained for the 2 mm thickness of blade.

3 For 2.0mm thickness:

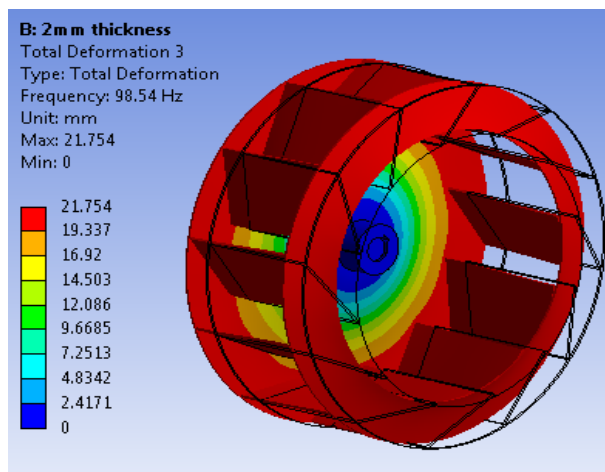


Fig.No.3 Mode 3

This mode 3 is obtained for the 2.0 mm thickness of blade.

4 For 2.0mm thickness

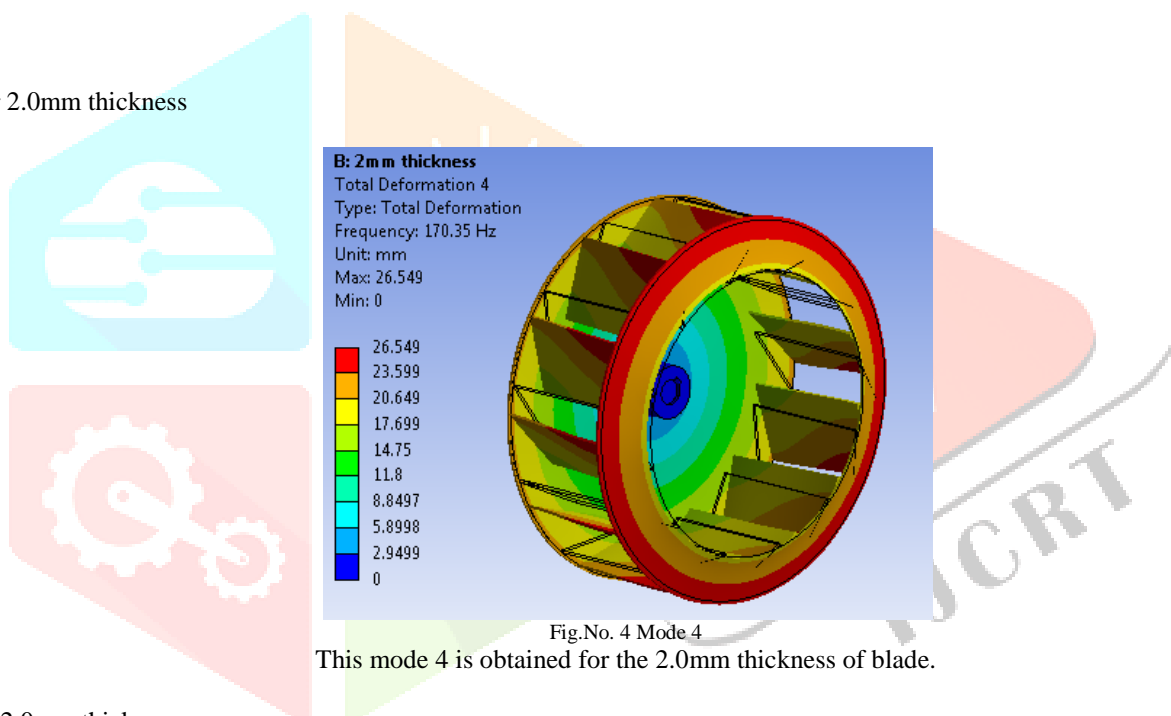


Fig.No. 4 Mode 4

This mode 4 is obtained for the 2.0mm thickness of blade.

5 For 2.0mm thickness

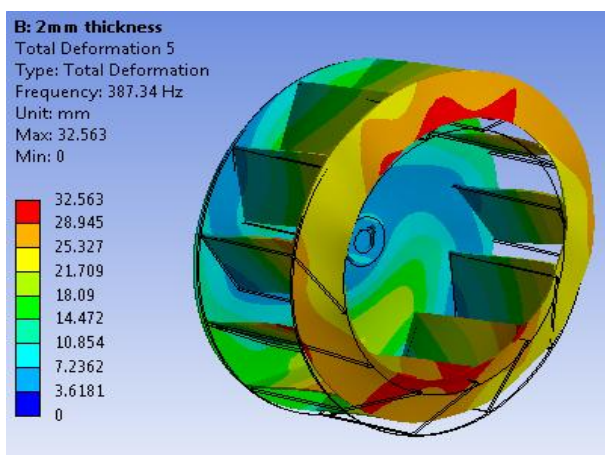


Fig.No.5 Mode 5

This mode 5 is obtained for the 2.0 mm thickness of blade.

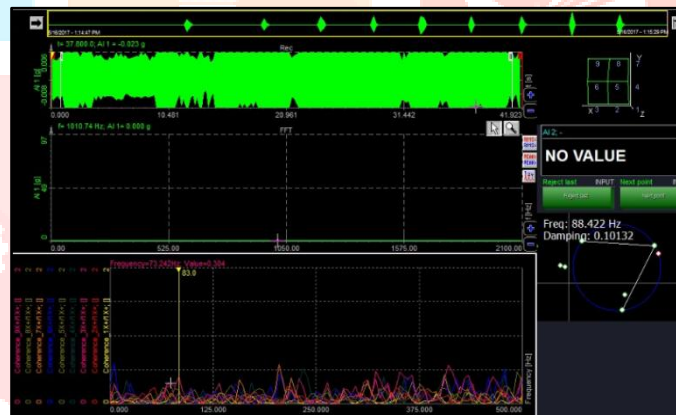
IX.RESULT

Sr No	Material Thickness (mm)	Mode Number	Frequency (Hz)	Deformation (mm)
1	2	1	87.792	33.245
2	2	2	88.116	33.438
3	2	3	98.54	21.754
4	2	4	170.35	26.549
5	2	5	387.34	32.563

X .EXPERIMENTAL SET-UP



Experimental Set-up of FFT Analyzer& Soft ware



Result Displayed on the screen

XI. RESULTS

MODE NO	Frequency in Hz (Measured by Modal Analysis)	Frequency in Hz (Measured by Experimental set-up)
1	87.79	88.42
2	88.16	102.18
3	98.54	118.82
4	170.35	163.61
5	387.34	360.63

XII) CONCLUSION :-**A)VIBRATION REDUCTION :-**

After modification in the casing design and improvisation in clamping technique along with dynamic balancing of the impeller has reducing the vibration level around 35% in the vertical axis and around 30% in the axial and horizontal direction.

B) VALIDATION OF VIBRATIONS :-

- i)The results obtained by experimental set-up when compared with Ansyssoftware the variation is within the range of 10-15% .
- ii)The readings are comparable for lower natural frequencies which are within the range of 5%, hence the results are validated.

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