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Design Modification and Finite Element Analysis of Centrifugal Fan

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ABSTRACT

In this dissertation, the fluid flow and structural characteristics of centrifugal fan by changing the number of blades from 16 to 20 at different speeds and using different materials for blades are investigated. CFD investigation is performed on the fan to decide outlet velocities, pressures, mass flow rates & Reynolds number at different speeds 2800rpm, 3000rpm and 3200rpm. Static investigation is done by applying pressures obtained from results of CFD analysis as boundary condition. Distinctive materials Aluminum., E Glass Epoxy, Aramid Fiber are considered for the examination where displacements & stresses are established. 3D models of the centrifugal fan are done in Creo 2.0 and CFD & Static analysis are performed in Ansys 14.5.

I.INTRODUCTION

A centrifugal fan is a mechanical apparatus to move air or gases. The expressions “squirrel cage fan” & "blower" (since it would seem like a hamster wheel), are much of the time utilized as equivalent words. With the rotating impellers, these fans increment the volume & speed of an air stream. It is a drum shape made out of no. fan blades assembled around a hub. As appeared in the enlivened figure 1.1, hub rotates on a driveshaft ascended on bearings in the fan housing. From the fan wheel side the gas enters, turns 90^0 and quickens because of centrifugal force as it streams over the blades of the fan and retreat from fan housing.

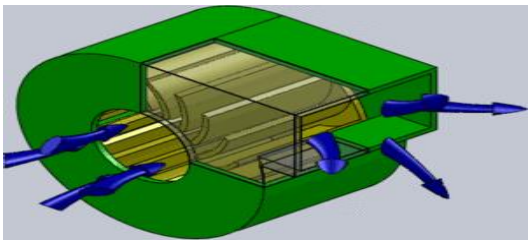

Fig 1 - A typical backward-curved centrifugal fan, where the blades curve away from the direction they rotate

II.LITERATURE SURVEY

Uppada Umamaheswara Rao [1], The execution of centrifugal fans having Airfoil area, forward blades is researched and thought about. Hypothetical counts are done to plan the impeller blades at various rates 2800rpm, 3000rpm, 3200rpm and furthermore the efficiencies at 2800rpm are calculated.CFD examination is performed on the fan to decide outlet velocities, pressures and mass stream rates by changing limit condition bay speed. Static investigation is done on the fan by accepting pressures from CFD examination as limit condition. Distinctive materials Steel, Aluminum combination, E – Glass Epoxy and Aramid Fiber are considered for the investigation where displacements & stresses are determined.3D model of the centrifugal fan is done in Creo 2.0 and CFD examination is performed in Ansys. **Mane Pranav Rajanand [3],** investigation on MS and SS pump impeller is done so as to enhance quality of radiating pump. This paper gives the static and Modal investigation of MS and SS Pump Impeller to check quality of Pump and vibrations created by pump.

3D MODELS OF CENTRIFUGAL FAN

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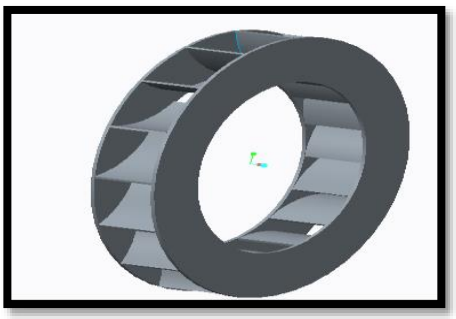

Fig:2 - View of centrifugal impeller for 16 blades

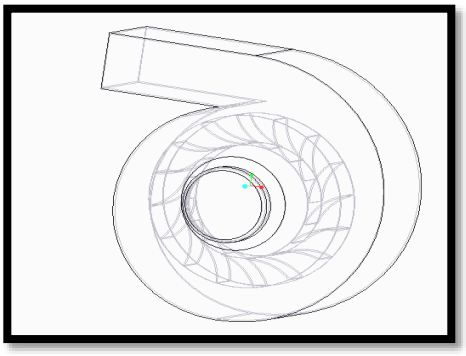

Fig:3 - Wireframe view of assembly – centrifugal fan for 16 blades

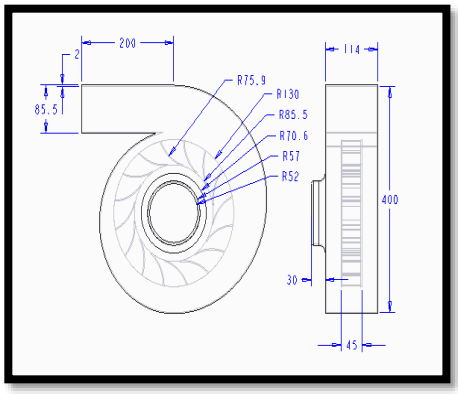

Fig:4 - Drafting of assembly – centrifugal fan for 16 blades

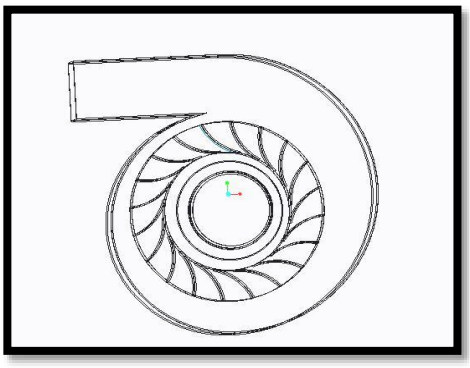

Fig:5 - Wireframe view of assembly – centrifugal fan for 20 blades

III.ANALYSIS OF CENTRIFUGAL FANS

Boundary conditions for ANSYS

Note: - input parameters (velocities) are taken from above calculations

Material Properties

	Density (g/cc)	Young's modulus (MPa)	Poisson's ratio
Aluminium alloy	2.8	71000	0.33
E-glass epoxy	2.6	72400	0.2
Aramid fiber	1.39	11000	0.35

CFD ANALYSIS ON CENTRIFUGAL FAN FOR 20 BLADES USING FLUID AIR

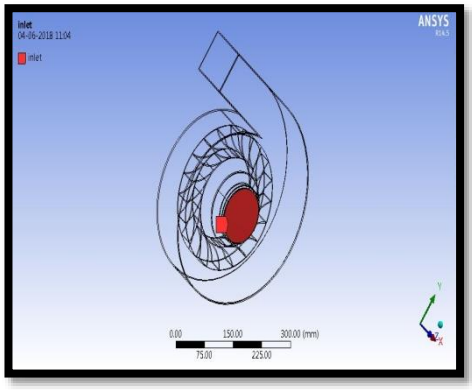

Fig:6 - Inlet of centrifugal fan for 20 blades

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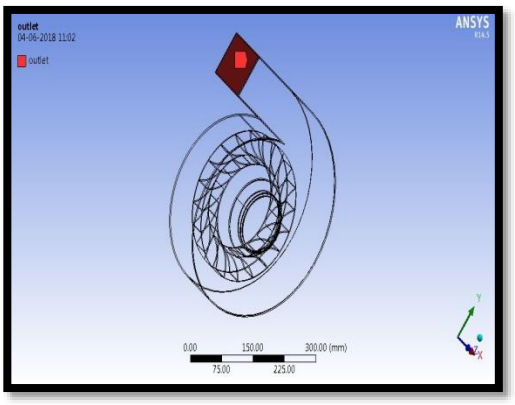

Fig: 7- Outlet of centrifugal fan for 20 blades

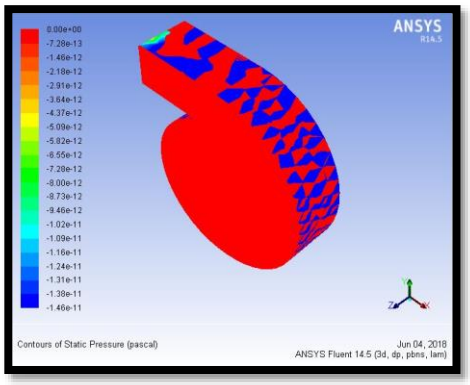

Fig:8 - Pressure in centrifugal fan for 20 blades at velocity=22.45m/s

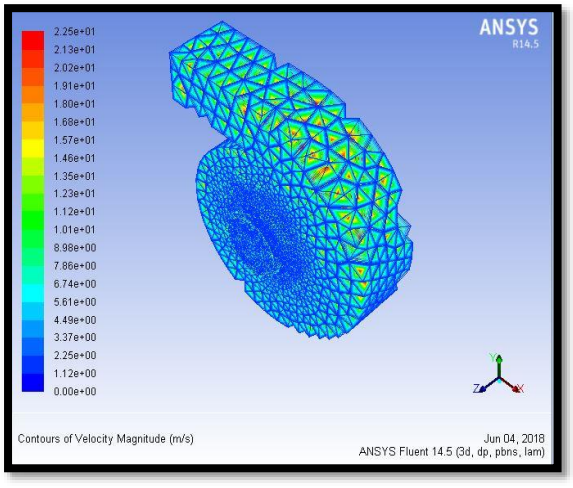

Fig:9 - Velocity in centrifugal fan for 20 blades at velocity=22.45m/s

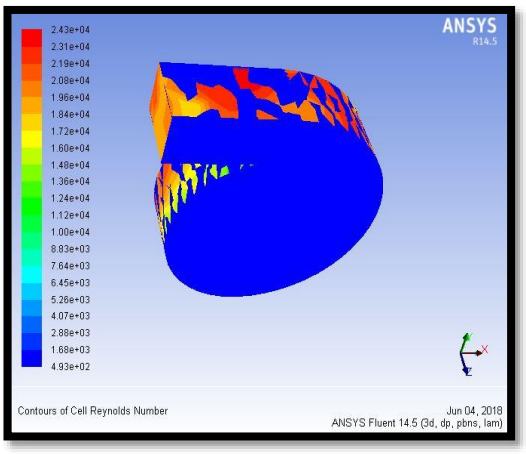

Fig:10 - Reynolds number in centrifugal fan for 20 blades at velocity=22.45m/s

Mass Flow Rate	(kg/s)
contact_region-src	0
contact_region-trg	0.21261002
inlet	0
interior-casing	0
interior-fan	0
interior-fluid	0.53065695
outlet	0
wall-11	0
wall-11-shadow	0
wall-16	0
wall-17	0
wall-casing	0
wall-fan	0
wall-fluid	0
Net	0.21261002

Fig:11- Mass Flow Rate in centrifugal fan for 20 blades at velocity=22.45m/s

STATIC STRUCTURAL ANALYSIS

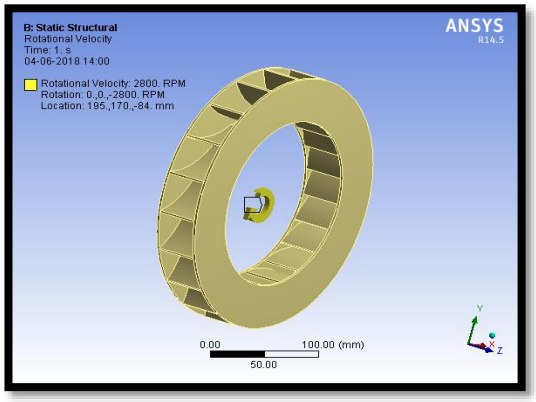

Fig:12- Rotational speed of centrifugal fan for 20 blades

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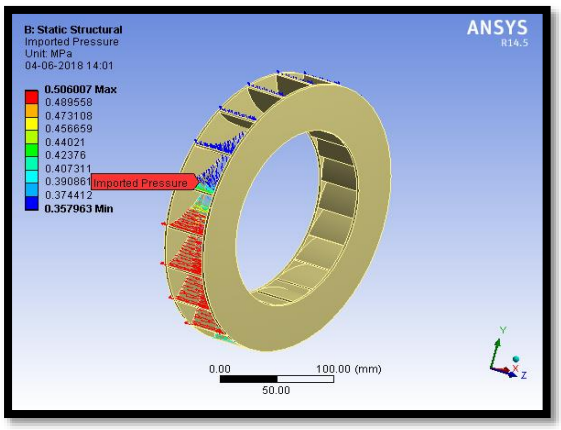

Fig:13- Imported pressure of centrifugal fan for 20 blades by using aluminium alloy

MATERIAL - ARAMID FIBER

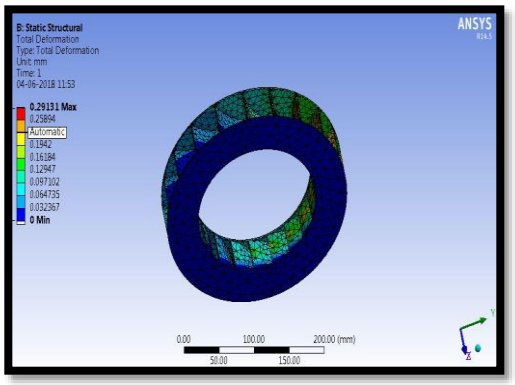

Fig:14 - Total deformation in centrifugal fan for 20 blades by using Aramid fiber at velocity=22.45m/s

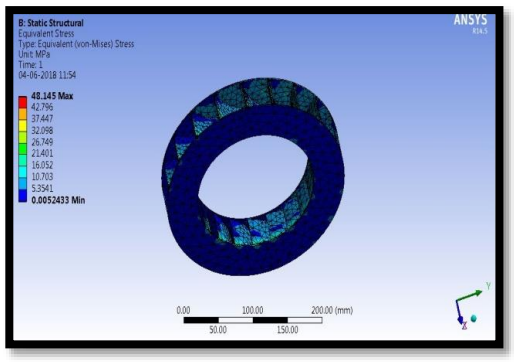

Fig:15 - Stress in centrifugal fan for 20 blades by using Aramid fiber at velocity=22.45m/s

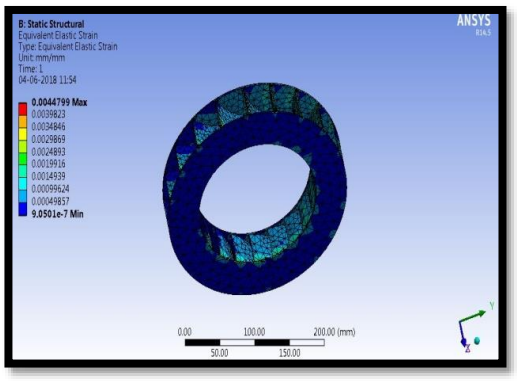

Fig:16- Strain in centrifugal fan for 20 blades by using Aramid fiber at velocity=22.45m/s

IV.RESULTS TABLES

CFD ANALYSIS

16 blades

Velocity (m/s)	Pressure (Pa)	Velocity (m/sec)	Mass flow rate (kg/sec)	Reynolds number
22.45	5.06e+005	3.72e+01	0.0004800	2.17e+04
24.05	5.063e+005	4.72e+01	0.0005688	2.44e+04
25.649	5.063e+05	4.73e+04	0.000649	2.49e+04

20 blades

Velocity (m/s)	Pressure (Pa)	Velocity (m/sec)	Mass flow rate (kg/sec)	Reynolds number
22.45	7.28e-13	2.25e+01	0.21261002	2.43e+04
24.05	7.28e-13	2.40e+01	0.2271944	2.60e+04
25.649	7.28e-13	2.56e+01	0.24221443	2.77e+04

STRUCTURAL ANALYSIS

16 BLADES

	Speed	Deformation	Strain	Stress

	(RPM)	(mm)		(MPa)
Aluminium alloy	2800	0.034198	0.00056927	40.412
	3000	0.034687	0.00057749	40.996
	3200	0.035211	0.00058629	41.62
E-glass epoxy	2800	0.033392	0.00056691	41.041
	3000	0.033847	0.0005746	41.597
	3200	0.034334	0.00058283	42.193
Aramid fiber	2800	0.20436	0.00034512	38.3227
	3000	0.21095	0.00035025	38.521
	3200	0.21266	0.00035312	38.837

20 blades

	Speed (RPM)	Deformation (mm)	Strain	Stress (MPa)
Aluminium alloy	2800	0.049192	0.0007757	53.716
	3000	0.050377	0.00080379	55.273
	3200	0.051645	0.0008347	56.937
E-glass epoxy	2800	0.04771	0.00083924	54.923
	3000	0.048807	0.00086813	56.808
	3200	0.04998	0.00089903	58.824
Aramid fiber	2800	0.29131	0.0044799	48.145
	3000	0.29487	0.0045525	48.92
	3200	0.29874	0.00463	49.749

V.CONCLUSION

CFD investigation is performed on the fan to decide outlet velocities, pressures, mass flow rates & Reynolds number at different speeds 2800rpm, 3000rpm and 3200rpm. By observing the results, the pressure is less, mass flow rate is more, Reynolds Number is more when 20 blades are used when compared with that of 16 blades. Static investigation is done by applying pressures obtained from results of CFD analysis as boundary condition. Distinctive materials Aluminum., E Glass Epoxy, Aramid Fiber are considered for the examination where displacements & stresses are established. By observing the results, the deformations and strains are more when Aramid Fiber is used but the stresses are less when that material is used when compared with that of E Glass Epoxy and Aluminum alloy. The stresses are slightly more when 20 blades are used. It can be concluded that using 16 blades centrifugal fan with Aramid Fiber is better.

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