Design Optimization of Backward Inclined Radial Blade Impeller Using Ansys

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***Abstract*-In general the backward inclined radial blade fans are used for ventilation, dust collecting purpose. Because of the adequate need of the impellers. Most of the manufacturing sectors spends more than of their money for making the materials. This emphasizes the need for adequate material management because even a small saving of material can reduce the production cost to a fair extent and thus add to the profits. The purpose of optimization is to minimize the weight of the radial blade fan without exceeding the allowable stresses and keeping in considering the operating restrictions and design parameters.**

Keywords: Backward inclined radial blade, Impeller, fans.

I. INTRODUCTION

Fans are one of the types of turbo machinery which are used to move air continuously with in slight increase in static pressure. Fans are widely used in industrial and commercial applications from shop ventilation to material handling, boiler applications to some of the vehicle cooling systems. The performance of the fan system may range from free air to several cfm (cubic feet per min.). Selection of fan system depends on various conditions such as airflow rates, temperature of air, pressures, airstream properties, etc. Although, the fan is usually selected for nontechnical reasons like price, delivery, availability of space, packaging etc. The fan is always analysed by its performance curves which are defined as the plot of developed pressure and power required over a range of fan generated air flow. Also these fan characteristic curves can be used to data like fan bhp for selection of the motor being used.

II. CENTRIFUGAL FANS

The centrifugal fans with impellers having blades of Airfoil section are considered as the high efficiency impellers among the six types Airfoil blades, Backward Inclined single thickness blades, Backward curved blades, forward curved blades, radial tip blades and radial blades.

A centrifugal fan is a mechanical device for moving air or other gases. These fans increase the speed of air stream with the rotating impellers. Centrifugal fan use a rotating impeller to move air first radially outward towards by centrifugal action, and then tangentially away from the blade tips. As the air moves from the impeller hub to the blade tips, it gains kinetic energy. This kinetic energy is then converted to a static pressure and increase the pressure of the air or gas stream which in turn moves them against the resistance caused by ducts, dampers and other components. Industrial application of fans are to supply ventilation or combustion air, to circulated air or other gases through equipment and the exhaust air or other vapours from equipment. N. Vibhakar and Masutage [1] experimented on a “backward curved radial tipped blade centrifugal fan”. Performance curves are obtained under different variable inlet parameters like volume flow rate, rotational speed and number of impeller blades. It is observed that number of blades increases, circulatory flow reduces in blade passage and more energised flow develops.Prajesh M. Patel and Keyur k Patel [2] Study about the “performance analysis and optimization of centrifugal fan“the parameters of inlet blade angle, outlet blade angle, number of blade have been changed for analysis. And optimized by Tauguchi method.M.MohammedMohaideen [3] discussed about the Optimization of Backward Curved Aerofoil Radial Fan Impeller using Finite Element Modelling. In this work the analysis was carried using various reduced thicknesses of the impeller and the optimum thickness of the impeller parts found for the safe stress and strain limits.Sharad Chaudhary, and Santosh Kansal [4] Performance Analysis of Backward CurvedCentrifugal Fan in Heating Ventilation and Air Conditioning” In this analysis blade angles is varied, and its effect on static pressure and total pressure of the fan is investigated. Also, theoretical analysis on the same lines has been developed.

III. METHODOLOGY

Increasing cost of consumable materials has put an enormous pressure on the pricing as well as the profitability of an organization. Therefore without any compromise on quality, the variable cost has to be reduced. This demands novel thinking and creativity for constant improvement in design, resulting in good profits. To ensure the desired performance the designer not only has to arrive an optimum design but also need to make a design analysis for prediction of behaviour in a given physical operating situation which need not necessarily be the design condition.

In this project work, an attempt has been made to optimize the design of backward inclined radial blade impeller using ANSYS work bench.

For the optimization of backward inclined radial blade impeller, the thickness of the blade was reduced then the stress and deformation of the model and the optimized model is to be studied. And also the analysis for decreasing the number of blades (i.e.) reducing the blade from 12 blades to 10 blades and then the stress and deformation of the model and the optimized model is to be carried out.

The model of centrifugal fan is drawn in Pro Engineering version 5. Then the centrifugal radial fan was analysed in ANSYS 14. And the static structural analysis to be carried out in ANSYS WORKBENCH.

In order to model the centrifugal blower it is necessary to model the parts of the blower which are

- Modelling of back plate
- Modelling of hub
- Modelling of inclined blades
- Modelling of shaft
- Modelling of housing
- Modelling of inlet cone
- Modelling of top plate

Then it was assembled to get the assembled view of the centrifugal fan blower.

IV. STRUCTURAL ANALYSIS OF CENTRIFUGAL BLOWER

The centrifugal blower of backward-inclined radial blade of 9mm thickness with 12 blade centrifugal fan is selected for the optimization. In the analysis the thickness of the blade is analysed by increasing the thickness of the blade and by decreasing the thickness of the blade is to be analysed. And also the inclined blades in the centrifugal blower is analysed by decreasing the number of blades (i.e.) 12 blades to 10 blades is also to be studied.

V. RESULT AND DISCUSSIONS

The data for the 9mm thickness and 12 blades design specification is as shown

Part Name	Parameters	Symbol	Dimension
Impeller	Inner Diameter	D1	445.5mm
	Outer Diameter	D2	622mm
Blades	Number of Blade	N	12
	Inlet blade angle	β1	43.3
	Outlet blade angle	β2	46.7
	Width	b_{blade}	214.5
	Thickness	t_{blade}	9mm
Volute Casing	Diameter	D1	436.5mm
		D2	500mm
		D3	536.5mm
		D4	630mm
Impeller	Rotational speed	N	606rpm

PRO E **2D**-MODELLING FOR **9MM** THICK**12 BLADES [FIG1]**

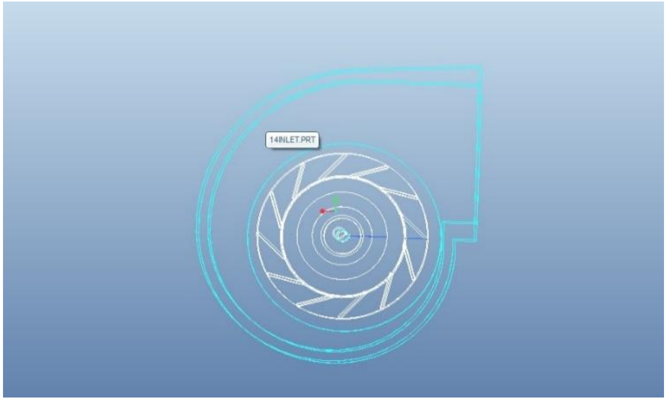


Fig 1

STRESS AND DEFORMATION RESULTS FOR **9MM** THICK **12BLADES[FIG 2&3]**

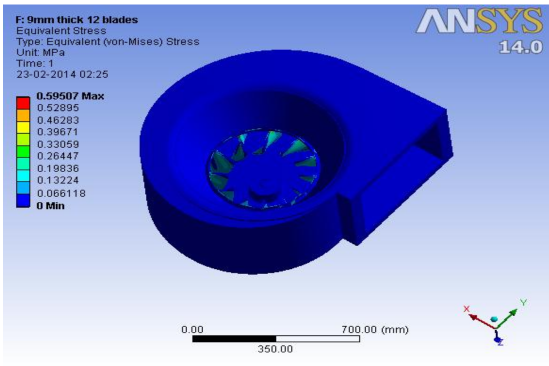


Fig 2

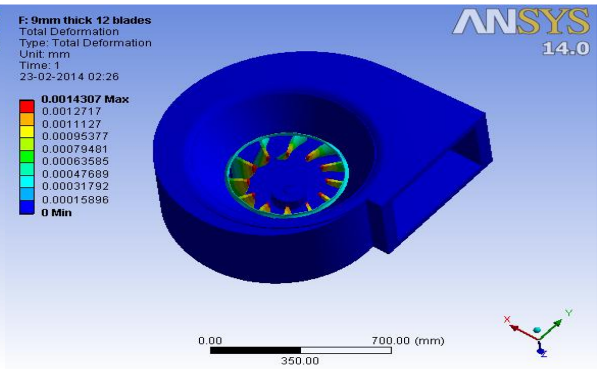
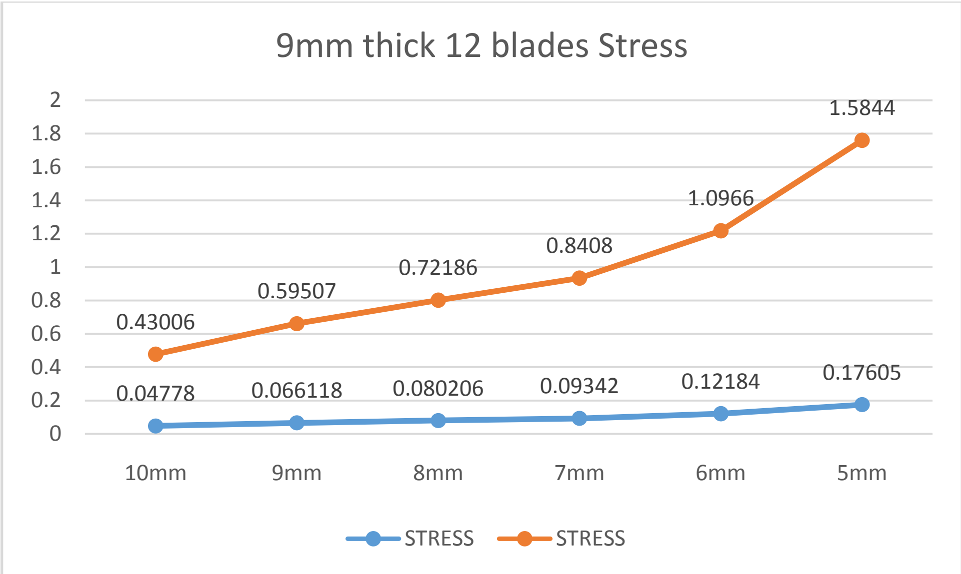
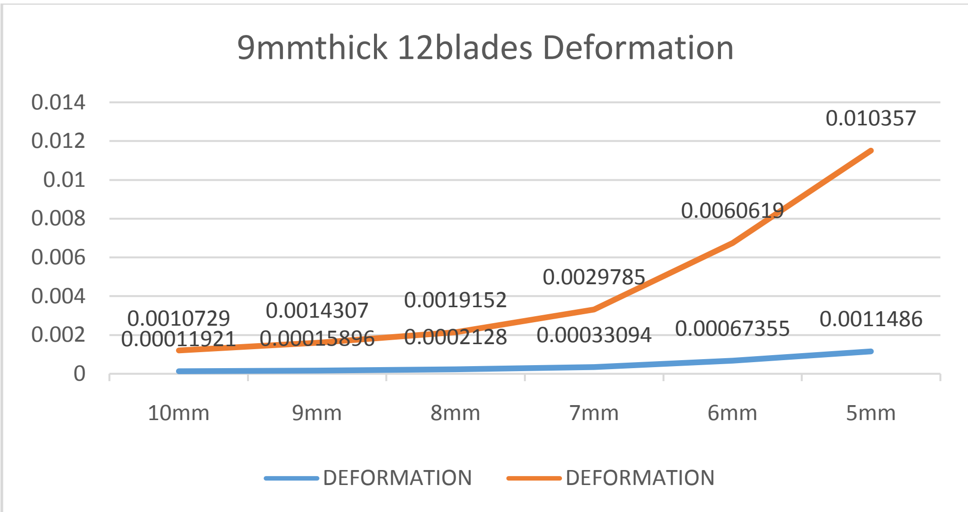


Fig 3

STRESS GRAPH FOR 9MM THICK 12 BLADES



DEFORMATION GRAPH FOR 8MM THICK 10 BLADES



From the above table it is concluded that 12 blades with 9mm blade thickness of backward-inclined radial blade centrifugal fan deformation min value is 0.0015896 and max value is 0.0014307 and stress min value is 0.066118 and max value is 0.59501Mpa. Similarly, the analysis of the backward inclined radial blade impeller is analysed by the various parameters. The analysis is carried out for reduce the thickness of the blade and to minimize the number of blades on the impeller.

The table shows that the result of centrifugal blower at altered thickness and decrease of the blades is as shown

THICKNESS	CENTRIFUGAL FANS WITH 10 BLADES				CENTRIFUGAL FANS WITH 12 BLADES			
	DEFORMATION		STRESS		STRESS		DEFORMATION	
	MIN mm	MAX mm	MIN Mpa	MAX Mpa	MIN Mpa	MAX Mpa	MIN mm	MAX mm
10mm	0.0001204	0.0010813	0.04636	0.41724	0.04778	0.43006	0.0001192	0.0010729
9mm	0.0001689	0.0015201	0.053658	0.48293	**0.066118**	**0.59507**	**0.0001589**	**0.0014307**
8mm	**0.0002323**	**0.0020914**	**0.069163**	**0.62247**	0.080206	0.72186	0.0002128	0.0019152
7mm	0.0003370	0.0030335	0.092232	0.83009	0.09342	0.8408	0.0003309	0.0029785
6mm	0.0006816	0.006135	0.12229	1.1006	0.12184	1.0966	0.0006735	0.0060619
5mm	0.0060127	0.05414	0.35963	3.2367	0.17605	1.5844	0.0011486	0.010357

From the above table it is shown that the 9mm thick with 12 blades of centrifugal fan blower the stress and deformation value isequated to the other parameters. By comparing the stress and deformation of outcomes the 8mm thick with 10 blades is more or less similar. So that 9mm thickness of 12 blade centrifugal impeller is interchanged by 8mm thick with 10 blades.

Optimized 8mm thick with 10 blade of backward-inclined radial blade centrifugal fan specification is as shown.

PRO E **2D**-MODELLING FOR **8MM** THICK**10 BLADES [FIG4]**

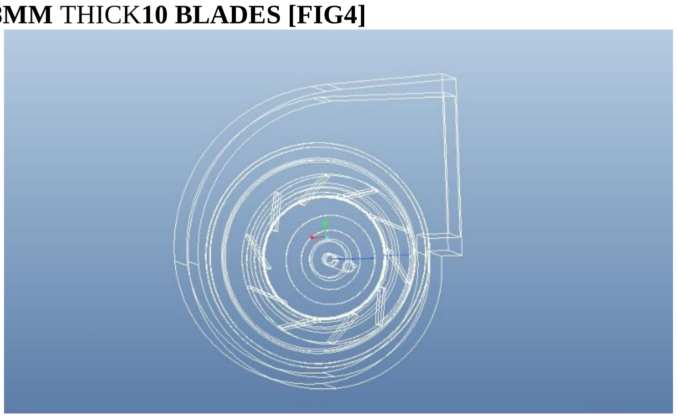


Fig 4

The data for the 8mm thickness and 10 blade design specification is as

Part Name	*Parameters*	*Symbols*	*Dimensions*
Impeller	Inner Diameter	D1	445.5mm
	Outer diameter	D2	622mm
Blades	Number of Blade	N	10
	Inlet blade angle	β1	43.3
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		D4	630mm
Impeller	Rotational speed	N	606rpm

STRESS AND **DEFORMATION** RESULTS FOR **8MM** THICK **10 BLADES [FIG 5 &6]**

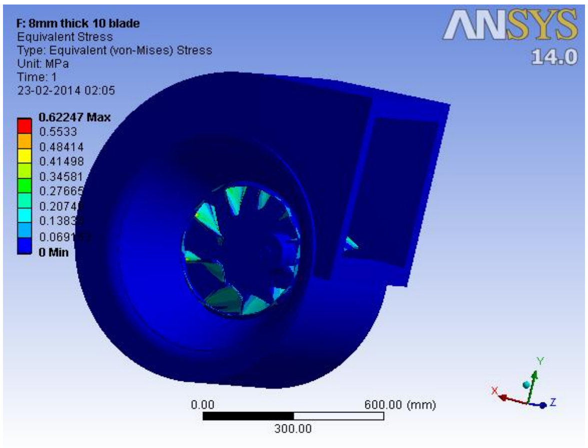


FIG 5

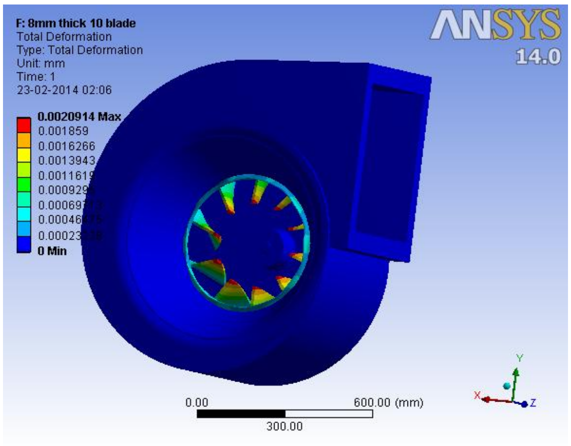
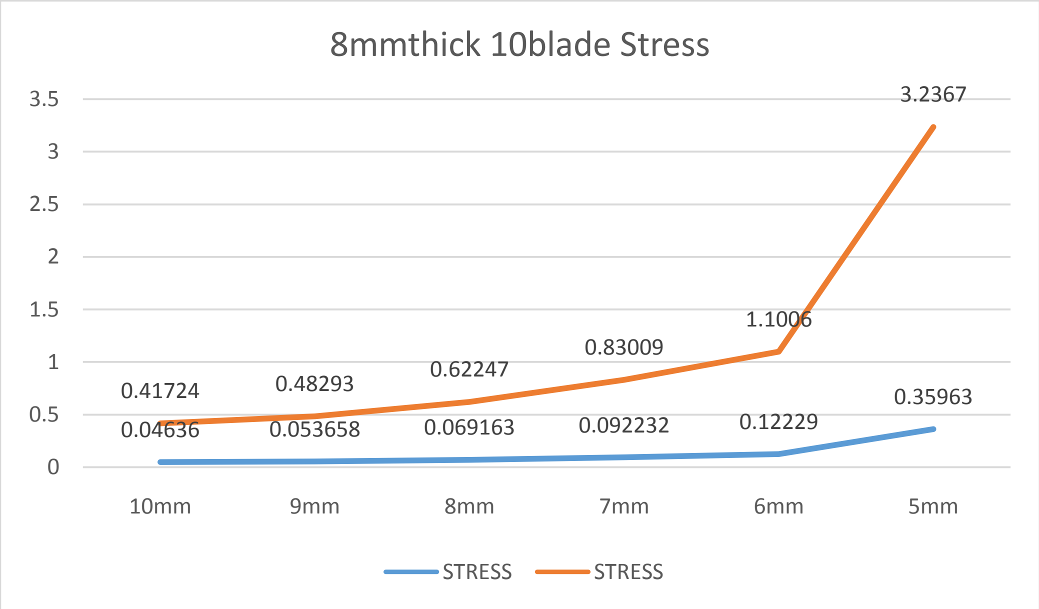
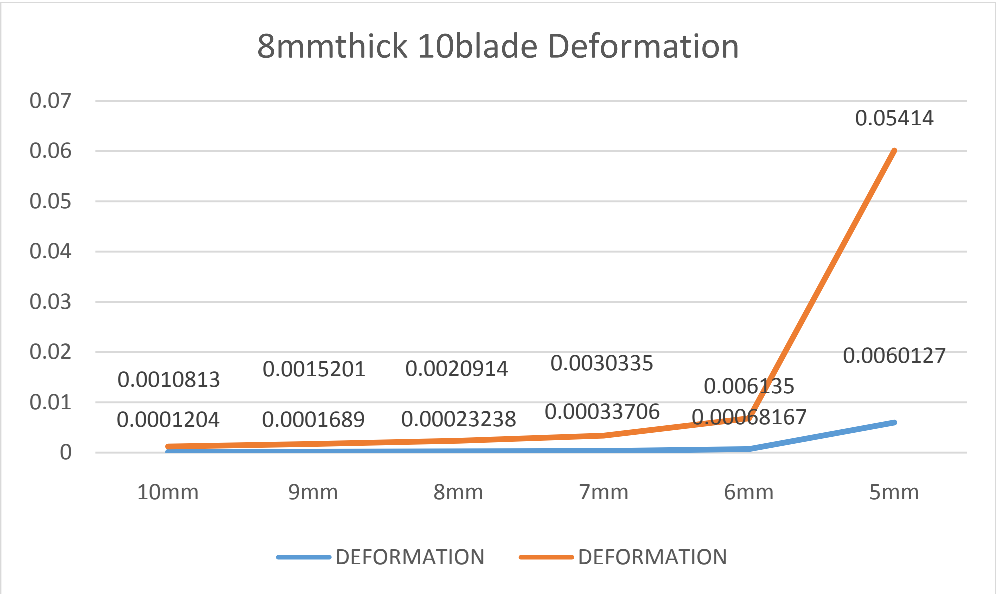


FIG 6

STRESS GRAPH FOR **8MM** THICK **10 BLADES**



DEFORMATION RESULTS FOR 8MM THICK 10 BLADES



From the above table it is exposed that 10 blades with 8mm blade thickness of backward-inclined radial blade centrifugal fan deformation min value is 0.00023238mm and max value is 0.0020914mm and stress min value is 0.069163Mpa and max value is 0.62247Mpa.

VI. CONCLUSION

In this work, an attempt has been made to optimizing the thickness of the blade and the decrease of the blade in the fan impeller, and analysing the stress distributions in them.

Looking out these results, the stress and deformation of the 8mm thick with 10 blades is more or less similar to 9mm thickness of 12 blades. So that 9mm thickness of 12 blade centrifugal impeller is interchanged by 8mm thick with 10blades.

Thus it is concluded that these optimized thicknesses of the fan impeller will lead to advantages like

1. Reduction in cost due to reduction of material.
2. Reduction in weight of the impeller.

VII. ACKNOWLEDGMENTS

We are sincerely thankful to our institutes and management for permitting us to use Infrastructure, library and computational resources.

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