Fan Blade Modification

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Abstract- **Ceiling fans are commonly used in tropical climate for providing comfort in domestic buildings. Although fan energy consumption is relatively low in comparison to air conditioning, it suffers from some degree of electricity loss which is mainly due to its mechanical inefficiency. This project demonstrates an approach to improve the efficiency of a ceiling fan by replacing its conventional blades with newly designed blades.**

We designed a blade having an airfoil to give better aerodynamic efficiency. And the main part of the blade includes a notch placed at its tip, which is helpful in the prevention of vortex formation at the blade tip which reduces the disturbance created around the blade tip which in turn results an uniform airflow.

The blade is designed using CATIA V5 Software and analysed using ANSYS Software. The experimental analysis was conducted for both newly designed and conventional fan blades for various speeds and plots are constructed for various values of rpm, Power and air delivery. The aim of the project is to show that the newly designed fan blade is more efficient than the conventional fan blade. If this type is produced in mass, then there will be a huge amount of power savings in future.

I. INTRODUCTION

A ceiling fan is a mechanical device, usually electrically power-driven, hanging from the ceiling of a room that uses hub-mounted rotating paddles to circulate air.

Ceiling fans typically spin more slowly than other types of circulating fans, such as electric table fans. They cool people effectively by introducing deliberate movement into the otherwise immobile, hot air of a room. Fans never actually cool air, unlike air-conditioning apparatus, but use significantly a lesser amount of power (cooling air is thermodynamically expensive). Conversely, a ceiling fan also be used to reduce the stratification of warm air in a room by forcing it downwards to affect both occupants' sensations and thermostat readings, thereby improving climate control energy efficiency.

II. OBJECTIVE

- To compare the experimental and computational results of Fan blade designed.
- To understand the flow characteristics of Fan blade.
- To make sensitive Fan blade with considerable noise reduction.

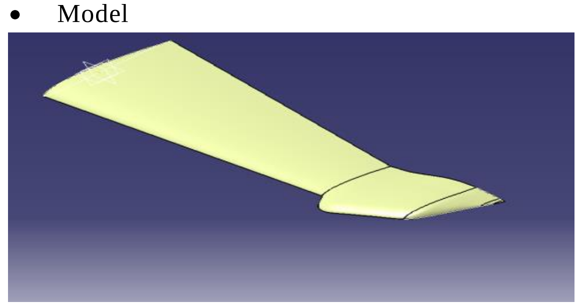
III. METHODOLOGY

- Literature survey of ceiling fan blades is done to study the characteristics of the blades.
- Selection of airfoil from the literature survey for the new blade.
- Design of the normal blade and the newly modified blade using CATIA V5.
- Meshing of the normal blade and the modified blade using ANSYS ICEM CFD.
- Analysis of the blades using FLUENT.
- Field testing of the modified fan blade.
- Comparison of the results between normal and modified blade obtained from both experimental and CFD analysis.

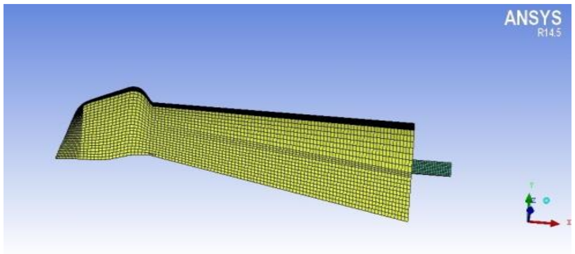
IV. DESIGN AND FABRICATION

The modified blade is designed using CATIA V5 and is meshed using ANSYS ICEM CFD.SD 7032 airfoil is used in this modified blade. Power is calculated using torque obtained from the CFD analysis.

- Model



- Meshing



- Fabrication is done using Fiber reinforced plastic and is subjected to resin moulding.

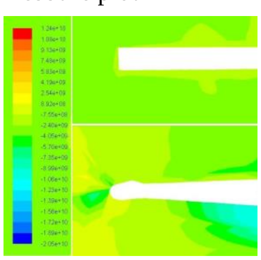
CFD analysis is conducted using FLUENT and the fabricated model is subjected to experimental analysis by mounting the blade to the ceiling fan hub.

Measuring instruments like Multimeter, Velocity meter, Tachometer and Clampmeter are used to measure voltage, airflow, rpm and current respectively.

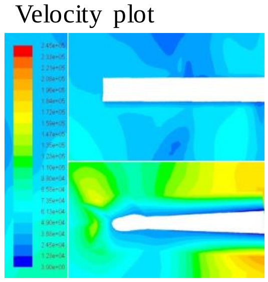
V. RESULTS

A. CFD Analysis

Pressure plot



Velocity plot



We can observe that the pressure distribution around the normal blade is uniform, whereas it varies around the tip for the modified blade. Also the velocity distribution around the conventional blade is lesser, whereas for the modified blade, the velocity is increasing to higher values and the velocity around the modified blade tip is higher compared to the velocity around the conventional blade tip.

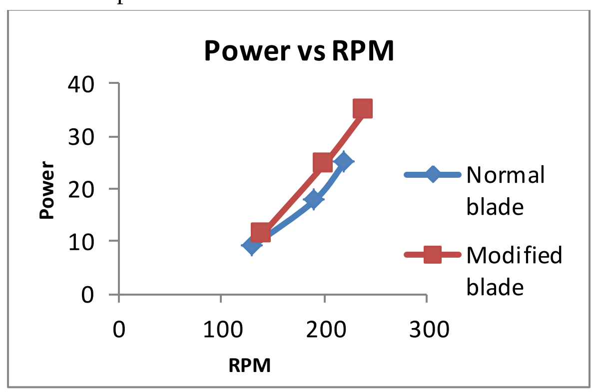
For normal blade

RPM	Torque in N/m	Power in watts
130	0.659	8.971
190	0.887	17.64
220	1.086	25.01

For modified blade

RPM	Torque in N/m	Power in watts
140	0.774	11.34
200	1.176	24.63
240	1.385	34.80

We can see that the power consumption increases as the rpm increases and is more for the modified blade when compared to the normal blade.



B. Experimental analysis

For normal blade

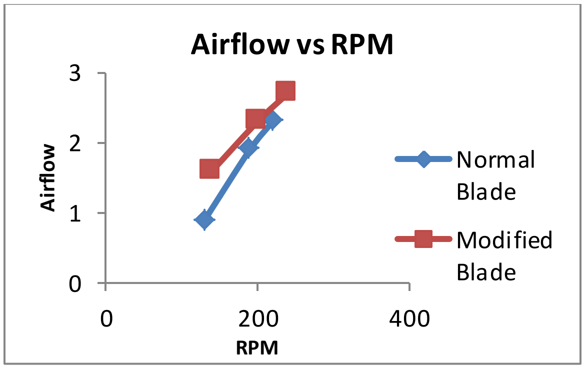
Sl No.	RPM	Current in amps	Voltage in volts	Power in watts	Airflow in m/s
1	130	0.100	81	8.1	0.9
2	190	0.150	112	16.80	1.9
3	220	0.180	131	23.58	2.3

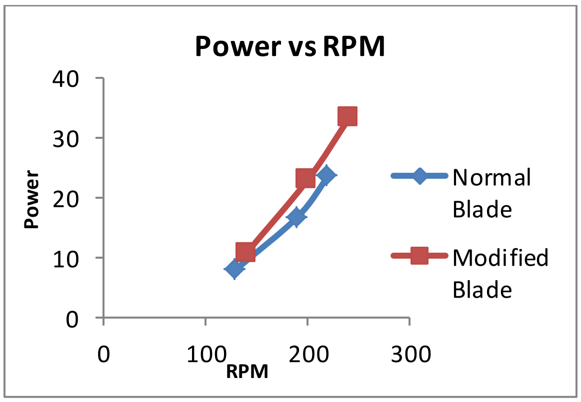
For modified blade

Sl No.	RPM	Current in amps	Voltage in volts	Power in watts	Airflow in m/s
1	140	0.130	83	10.79	1.6
2	200	0.190	121	22.99	2.3
3	240	0.230	144	33.12	2.7

The experimental analysis conducted shows that power consumption is more for the modified fan blade when compared to the normal fan blade.

Airflow increases as the speed of the fan increases but when compared to normal fan blade, the modified fan blade produces more air with increase in speed.





VI. CONCLUSION

By analyzing the results, we can conclude that the normal fan blades gives less air even at higher rpm, when compared to our newly designed fan blade having an airfoil which gives more air even at reduced rpm. Also its airflow is uniformly distributed and less noisy over the normal blade. The power consumed by the modified blade is more when compared to that of the normal blade because of the weight of the blade, since the modified blade weight is twice as that of normal blades.

Since the weight of the modified blade is more, it is consuming more power than the normal blade. So it is preferred if the weight of the modified blade is reduced to a lesser weight, then it will be so efficient that it will consume lesser power and gives more airflow than the normal flat blade. Also if the thickness or chord of the airfoil is reduced and also if the twist angle or the airfoil is changed and also if a lighter material is used, then there is a possibility of reduction in weight. If this blade is developed into a lower weight blade and subjected to mass production, then there may be a huge amount of power savings in the future.

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REFERENCES

[1] Scharff, Robert and Casablanca Fan Co “The Fan Book” Reston Publishing.(1973).
[2] Dane Roger, Patricia "Eye on Design" The Washington Post (1975).
[3] Gromicko and Nick “Ceiling Fan Inspection” International Association of Certified Home Inspectors (1979).
[4] A Technical Research Multi Axes Ceiling Fan by ISSU Inc(1982).
[5] Dhananjay B and Sadaphale Analysis to analyse the different blade angle by Computational Fluid Dynamics (CFD) in ANSYS software to finding the maximum air delivery (1995).
[6] Improvement of the Ceiling Fan by Using Aerodynamic Blade Profile by, M.N.M. Zubir,T.Olofsson (1980).
[7] High efficiency ceiling fans by Danny S Park and Guan su (2015).
[8] S Sali “Evaluation of blade angle performance” (1984).
[9] Charles A Mcknight “ Filtering means for ceiling fan blades” (1986).
[10] Fransco Rispoli and A.G Tropical “ceiling fans for low indoor comfort” (1992).