IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719,
|| Special Issue || June-2019, || PP 13-17 ||

CFD Simulation of Modified Ceiling Fan

S.N.Tapase[1], G.N.Tale[2], A.S.Patki[3], A.D.Tambi[4], N.R.Warade [5]
[1]*(Asst. Prof. Mechanical Engineering Department , JSPM Narhe Technical Campus, Pune , India)*
[2,3,4,5]*(U G Scholar, Mechanical Engineering Departmen, JSPM Narhe Technical Campus Pune,, India)*

Abstract: *A parametric study of ceiling fans is carried out with the objective to improve flow field variables and fan efficiency. Ceiling fans provide cooling to indoor occupants as well as improve their thermal comfort in warm environments at the low energy consumption. Understanding indoor air distribution related with ceiling fans helps designs during ceiling fans are used. The performance indicators such as velocity profile, mass flow rate, torque, rated air delivery and service value are calculated. Different cases of rake angles are considered and compared to the baseline geometry. If several ceiling fans are installed symmetrically in the classroom, there might be an increase in airflow velocity at the center of the classroom and the supply air from air-conditioner will be not spread horizontally but turns downward. CFD predictions were validated by experimental results. In general, numerical results we observe that for an unoccupied space, the fan blade geometry, ceiling-to-fan depth, and ceiling height only influence air speed profiles within a cylindrical zone directly under a ceiling fan whose diameter is identical to that of the ceiling fan. However, the average speeds within the cylindrical zone at each height are very similar for the different blade shapes studied, indicating a minor influence of blade geometries on occupants' perception of the thermal environment.*

Keywords: *CFD analysis, Ceiling fan, Air circulation, Velocity and Pressure, Blade angle, Motor, Air flow, Flow distribution.*

I. Introduction

Ceiling fans have been used since decades as a means to improve indoor thermal comfort in buildings in tropical and subtropical climatic zones. The fans there offer a technically simple, inexpensive, individually operable and, above all, effective method to increase air movement and thus thermal comfort in a room. It comprises of a get together of an electric motor with 3-4 blades suspended from the roof of a room. In spite of its straightforwardness and boundless use, the stream instigated by a roof fan in a shut room has not been explored, and problematic plans are in wide utilize. There is tremendous potential for energy saving and enhanced comfort by creating improved fan plans. This work builds up a principal comprehension of the stream qualities of a roof working inside a closed room . In Indian residences, ceiling fans are as common as electric light bulbs, being present in almost every habitable space. They are part of most of Indian residences, and they are widely used in both old and more recent buildings. In case of developing economy and rising level of populace which can bear the cost of procurement and operation of air-conditioning system for higher need of Thermal comfort, India has encountered ascend in sales of ventilation systems.

The power demand for space cooling involves up to 60% of summer crest load in huge urban communities, for example, Delhi. Roof fans are likewise utilized as a part of workplaces, living arrangements as a contrasting option to broaden the late spring comfort envelope. These fans are of reasonable cost, basic in development, simple to introduce, and needn't bother with consistent or refined support. The flow pattern features instigated by roof fans are extremely useful for individuals of enthusiasm working in the field of HVAC. This flow is probable to be rotational, three-dimensional and turbulent. Along these lines, knowing the stream qualities, because of roof fan turn would enable enhancing the fan to outline notwithstanding choosing its ideal situation to spare energy. Unless the utilization of energy demanding air-conditioners are restricted just to times of greatly sweltering climate, at that point general Indian vitality utilization and related CO_2 emanations will fundamentally expand, prompting extreme ramifications for the worldwide atmosphere and furthermore difficult the dependability of the Indian power network.

The coefficient of performance (COP) of a ceiling fan which describes the fan efficiency will be expected to in-crease by changing the blade angle and enhancing the pro-file of the blades. Thus, this research aims to conduct a comparative Analysis on the ceiling fan. By changing the blade angle, the input power needed for operating the ceiling fan will be reduced and they will be produce high velocity of airflow. For Analysis purpose we are changing the angle of blade. To achieve graphical representation of result we used ANSYS Software. It saves time and optimizes the design.

II. Working of Normal Ceiling Fan

II.1 CREO Model of Ceiling Fan:

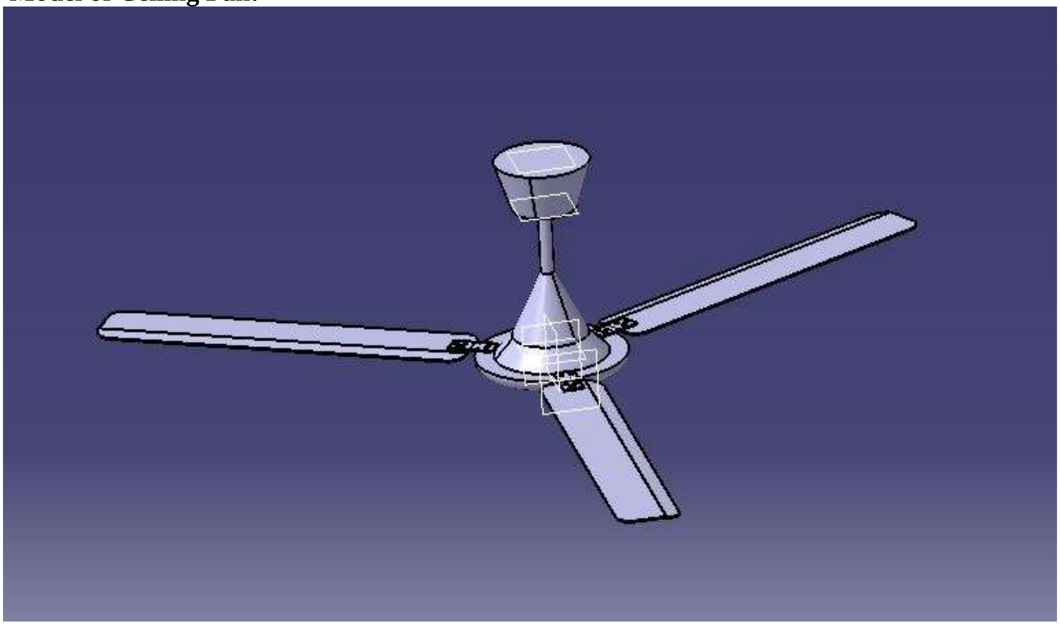


Fig 1: Ceiling Fan.

The electric motor is the electric machine within the ceiling fan that converts electrical energy into mechanical energy. The ceiling fan capacitor increase the torques of electric motor and allowing it to start. An electrical current reaches the motor and then enters coils of wire that are wounded around a metal core. For conversion of electrical energy to mechanical energy, electric current passes through the wire, then magnetic field is caused that expends force in a clockwise motion and conversion of energy happened. This action causes the motor coils to spin. As the coils are spinning, the fan captures this spinning motion, transferring it to the fan blades.

II.2 Major Parts of Ceiling Fan

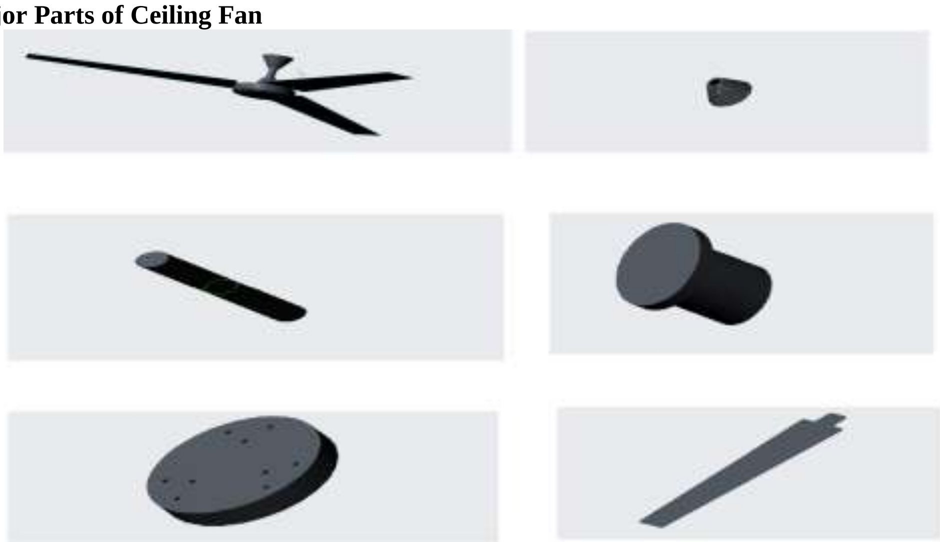


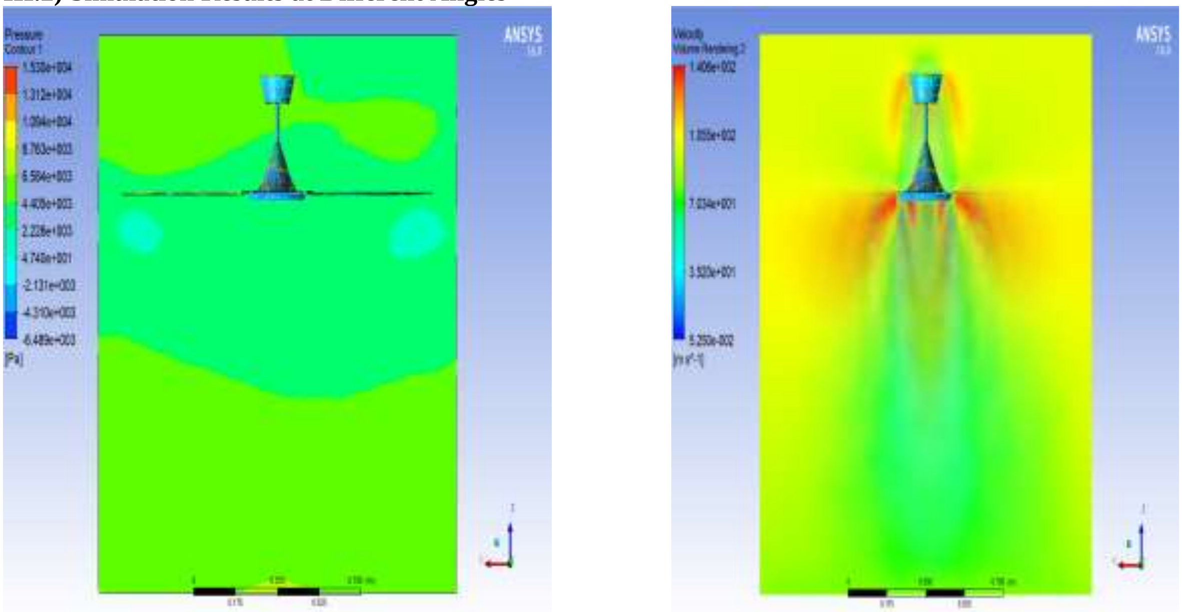
Fig.2 Components of Ceiling Fan.

III. Simulation

III.1) Simulation Parameters

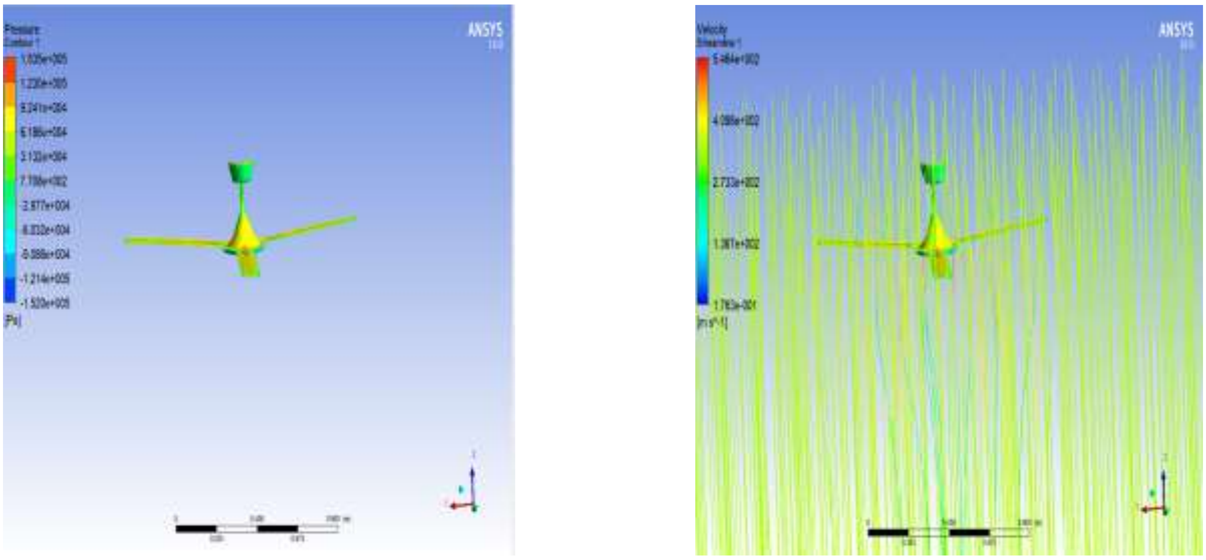
Blade Angle	Pressure Contour (pa)	Velocity Contour (ms^{-1})
8^{θ}	$1.53e^{+004}$	$7.034e^{+001}$
10^{θ}	$1.535e^{+005}$	$2.73e^{+002}$
12^{θ}	$9.22e^{+003}$	$7.779e^{+001}$

III.2) Simulation Results at Different Angles



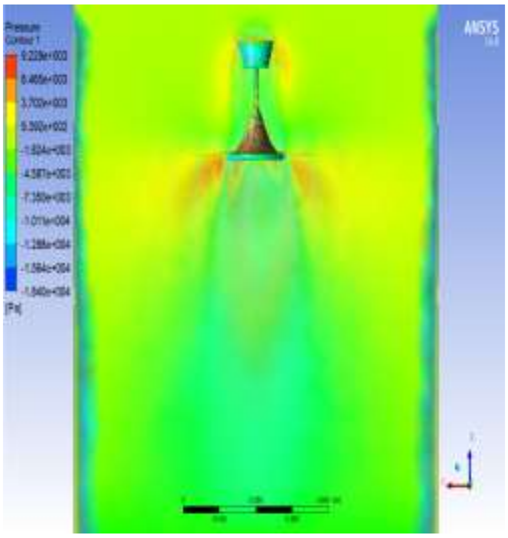
Pressure Counter **Velocity Counter**

Fig.3 CFD analysis at an angle of 8-Degree.

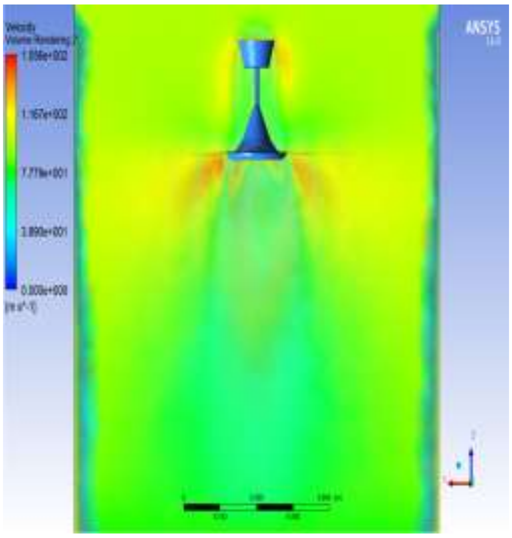


Pressure Counter **Velocity Counter**

Fig.4 CFD analysis at an angle of 10-Degree.



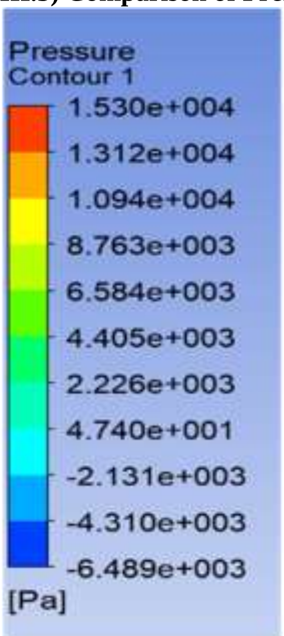
Pressure Counter



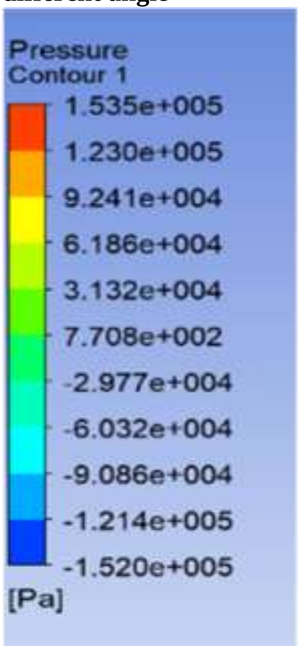
Velocity Counter

Fig.5 CFD analysis at an angle of 12-Degree.

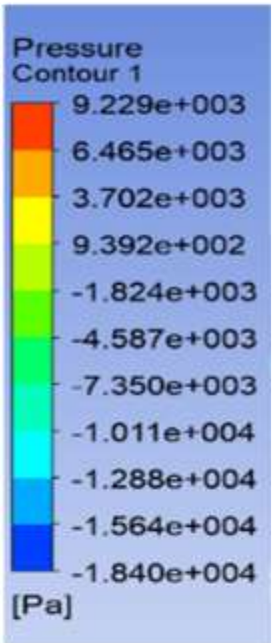
III.3) Comparison of Pressure Counter at different angle



8 Degree

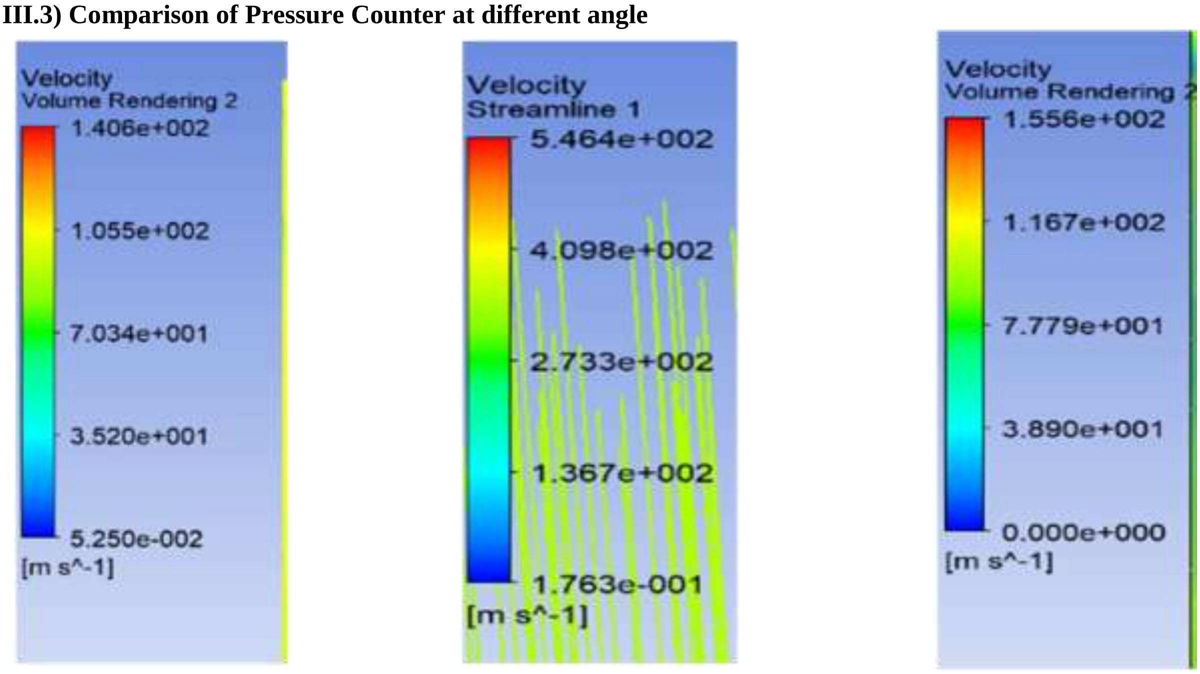


10 Degree



12 Degree

III.3) Comparison of Pressure Counter at different angle



8 Degree 10 Degree 12 Degree

IV. Results (Optimum Blade Angle)

Blade Angle	Pressure Contour (pa)	Velocity Contour (ms^{-1})
10^0	$1.535e^{+005}$	$2.73e^{+002}$

The optimum blade angle has been selected from the three simulation which having optimum pressure and optimum velocity of air circulation .

V. Conclusion

[1] From the analysis we have conducted, we can see that there is certainly an effect on air flow as the blade angle changes.

[2] The thing that struck us the most is that the velocity of air which comes through the outlet keeps on increasing upto a certain blade angle and then the velocity decreases after the optimum blade angle is reached.

[3] We have found out the most effective blade angle to be at 10 degrees.

References

[1]. S. Jain , Y. "CFD Modeling of a Radiator Axial Fan for Air Flow Distribution "World Academy of Science , Engineering and Technology International Journal of Mechanical Mechatronics Engineering, Vol:6, No:11, 2012.

[2]. Y. Momoi, K. Sagara, T. Yamanaka H. Kotani, "Modeling of Ceiling Fan Based on Velocity Measurement for CFD Simulation of Airflow in Large Room".

[3]. W. Yan, D. Barker, Y. Sun, Y. Zhang, R.S. Gates, "Performance Simulation of High Volume Low Speed Fans in a Free Stall Barn",XVII th World Congress of the International Commission of Agricultural and Biosystems Engineering (CIGR) Hosted by the Canadian Society for Bioengineering, Canada June 13-17, 2010.

[4]. Y. Anand, S.K. Verma, S. Anand, "Transient 3-D Modelling of Ceiling Fan for achieving Thermal Comfort ",Building Performance Analysis Conference and SimBuild co-organized by ASHRAE and IBPSA-USA Chicago, IL September 26-28, 2018.

[5]. Harimohansoni, Subrata Sarkar, "Design Of Axial Fan Using Computational Fluid Dynamics".

[6]. SagarSali, Dhananjay B. Sadaphale, Navneet K.Patil, "Evaluation of Ceiling Fan Blade Angle Performance using CFD",International Conference on Global Trends in Engineering, Technology and Management (ICGTETM-2016).

[7]. E. Adeeb, A. Maqsood, A. Musthaq, C. H. Sohn, Parametric Study and Optimization of Ceiling Fan Blades for Improved Aerodynamic Performance",Journal of Applied Fluid Mechanics, ISSN 1735-3572, EISSN 1735-3645, Vol. 9, No. 6, pp. 2905-2916, 2016.

[8]. Winkler J. and Moreau S., LES of the trailing-edge flow and noise of a NACA6512-63 airfoil at zero angle of attack. Center for Turbulence Research Proceedings of the Summer Program 2008. pp. 331–341.

[9]. Bleier, Frank P., Fan handbook selection, application, and design, 1998. N.Y., U.S.A. McGraw Hill ISBN 0-07-005933-0.

[10]. S.C. Sekhar, Higher space temperatures and better thermal comfort—a tropical analysis. Energy and Buildings. 1995 Oct 1;23(1):63-70.