

Comparative Analysis between Backward Inclined and Backward Curved Blades of Centrifugal Fan

Soham Choudhary¹, Rohan Ramesh Patil², Priya Sachin Jadhav³

B.Tech Student, Department of Mechanical, Symbiosis Institute of Technology, Lavale village, Mulshi Taluka, Pune, Maharashtra, India¹

M.Tech Thermal Power Engineering (Application Engineer), Pune, Maharashtra, India²

Assistant Professor, Department of Mechanical, Symbiosis Institute of Technology, Lavale village, Mulshi Taluka, Pune, Maharashtra, India³

ABSTRACT: Centrifugal fan is the increasing need of today's HVAC industries and recommending the right type of blade depending on the application it is needed for is one of the most important job for an engineer. Also, a literature review of the reference paper has been provided. A comparative analysis between two blade types namely backward inclined and backward curved has been done. Results for the two vary and are most suited in their line of work. Results show that backward inclined blades utilize more power as more RPM is needed to drive the impeller and therefore display less efficiency as compared to backward curved blades. Moreover, how much average percent more or less power, RPM and efficiency has also been denoted.

KEYWORDS: Centrifugal fan, curve mapping, blade parameters

Symbols	Meanings	Symbols	Meanings
Q	Capacity	A	Area
P _s	Static Pressure	V	Velocity
T	Temperature	P _t	Total Pressure
D	Diameter	N	RPM

I. INTRODUCTION

The main objective of a centrifugal fan is to drive or deliver air through a duct setup and distribute it to a required area. Centrifugal fans are by far the most prevalent type of fan used in the HVAC industry today. The horsepower curves do not overload for centrifugal fans. These fans can handle large air volumes and static pressures that are moderately high. The differences in operation of a centrifugal fan with Backward curved and backward inclined vanes have been demonstrated. Our observation consists of the difference between backward curved and backward inclined blades of a centrifugal fan. The backward inclined blades must be operated at a much higher RPM than the Backward curved blades. The rotating impellers. Analysis of backward curved and backward inclined blades have been developed. In this analysis capacity and pressure have been varied. Observations have been made on how these variations vary velocity, RPM, power consumption and efficiency of centrifugal fan (Backward Curved and Backward Inclined Vanes). We can divide centrifugal fans into 4 categories namely: Backward incline/ Forward Curved, Backward Curved, Radial blade and Air foil. These four types of blades were developed to fit their own specific and exclusive applications. However, we are studying the comparative analysis between backward inclined and backward curved blades.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

1.1 Classification:

The various types of blades being employed in centrifugal fans are:

- Backward inclined/ Forward Curved
- Backward curved
- Airfoil blade
- Radial blade

1.1.1 Backward inclined/ Forward Curved: They are employed to deliver medium to high airflow. A deep stall range is not demonstrated by these fans. These are cheaper than the backward curved blades in production. These are most suitable in medicinal industries, as the chemicals do not get deposited on the blades. They have a higher RPM, but a lower efficiency than those of the backward curved blades for the same capacity, static pressure and velocity. They have a weaker structural strength i.e.; they tend to vibrate more than the backward curved blades.



Fig. 1.1.1: Backward Inclined Blades

1.1.2 Backward curved: they are often heavier than those of backward inclined blades for the same capacity, static pressure and velocity. They are highly energy efficient and are an appropriate alternative to backward inclined blades. In this paper comparison between two types of impellers are done namely the backward curved blades and the backward inclined blades. Both of these impellers are subjected to the same airflow volume, static pressure, inlet and outlet diameters of centrifugal fans and henceforth the same velocities.



Fig. 1.1.2: Backward Curved blades

1.1.3 Airfoil blade: Bernoulli's principle stating that high speed flow is correlated with low pressure and low speed flow with high pressure, Airfoil works on the above stated basis. The airflow speed above the surface of a wing is increased with the help of airfoil, causing a decrease in air pressure.

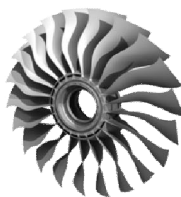


Fig. 1.1.3: Airfoil blades

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

- 1.1.4 Radial blade:** They acquire the strongest physical design among all other types of fans and are mostly used to process materials. Hence, they can achieve topmost pressure of practically any industrial fan arrangement. The radial blade centrifugal fan also has the power to self-cleanse itself.



Fig. 1.1.4: Radial blades

II. LITERATURE REVIEW

Sharad Chaudhary^[3] and Santosh Kansal^[3] have mentioned how the fan is to be modelled with respect to its specifications. Then doing a performance analysis of the fan using CFD TOOL Autodesk CFD 2013 and later a theoretical analysis on very same stream was done as well. These requirements were fulfilled to get a better understanding of the performance characteristics under different traits to enhance the design of the fan.

P. NavinKumar^[2] and S. SahayaRubinson^[2] mentioned the endeavour that has been created to optimise the thickness of the blade. Also, detailed study has been shown how 10 blades of 8mm thickness replaces 12 blades of 9 mm thickness. It has also been demonstrated that how to minimize the weight of radial blade fan keeping in mind the allowable stress, the operating limitations and design parameters.

III. TEST PROCEDURE

- 3.1 The air is assumed a density of 1.2kg/m^3 .
- 3.2 Volume flow rate: the quantity of fluid flowing the duct of given cross sectional area per unit time.
- 3.3 Static pressure: Fluid which is at rest exerts certain pressure, known as fluid static pressure. Here, fluid is air.
- 3.4 Operational temperature: this is the temperature at which the fan is meant to work at. Here it is 20°C .
- 3.5 We are supplied with three parameters namely: the capacity required, static pressure and the operating temperature. We have some standard inlet diameters which best serves the requirement in concepts of highest efficiency. The area, velocity and total pressure are calculated by simple analytical calculations.
- 3.6 With the help of performance graphs produced based on experiments the RPM of the impeller is chosen, which further helps in achieving the power consumption of the fan.
- 3.7 The system impedance curve is overlaid with the performance data of air of the particular fan. The main objective of a cooling fan is to transfer the undesirable heat to the surrounding with moving appropriate amount of air. The inlet angle of backward curved blades is 34.4° and for backward inclined blades is 5° .
- 3.8 The fan has to abide to certain laws while working like speed, power and pressure. A change in pressure rise and necessary power to operate the fan is observed when there is a change of speed (rpm). During the selection of fans, ample safety margin is considered as well. The fan and impeller types are chosen once the system flow and pressure needs are established.

IV. EXPERIMENTAL RESULTS

- 4.1 Backward Inclined blades: Calculations demonstrates that centrifugal fans, employing these types of blades require higher RPM and higher power to be driven. And as a result, produce less efficiency.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

TABLE 4.1: BACKWARD INCLINED BLADES CALCULATIONS

Q	P _s	T	D	A	V	P _t	N	Power	Efficiency
3 m ³ /s	200 mmwg	20° C	0.05m	0.1963 m ²	15.28 m/s	215 mmwg	1400 RPM	8 KW	75%
3 m ³ /s	300 mmwg	20°C	0.05m	0.1963 m ²	15.28 m/s	315 mmwg	1625 RPM	11 KW	81.81%
3 m ³ /s	400 mmwg	20°C	0.05m	0.1963 m ²	15.28 m/s	415 mmwg	1850 RPM	16 KW	75%
5 m ³ /s	200 mmwg	20°C	0.05m	0.1963 m ²	25.47 m/s	241 mmwg	1630 RPM	17 KW	58.82%
5 m ³ /s	300 mmwg	20°C	0.05m	0.1963 m ²	25.47 m/s	341 mmwg	1850 RPM	22.5 KW	66.67%
5 m ³ /s	400 mmwg	20°C	0.05m	0.1963 m ²	25.47 m/s	441 mmwg	2050 RPM	27.5 KW	68.96%
7 m ³ /s	200 mmwg	20°C	0.05m	0.1963 m ²	35.66 m/s	280 mmwg	1900 RPM	29 KW	51%
7 m ³ /s	300 mmwg	20°C	0.05m	0.1963 m ²	35.66 m/s	380 mmwg	2120 RPM	37.5 KW	56%
7 m ³ /s	400 mmwg	20°C	0.05m	0.1963 m ²	35.66 m/s	480 mmwg	2290 RPM	46.8 KW	59.82%

4.2 Backward Curved blades: Calculations demonstrates that centrifugal fans, employing these types of blades require lower RPM and lower power to be driven. And as a result, produce more efficiency.

TABLE 4.2: BACKWARD CURVED BLADES CALCULATIONS

Q	P _s	T	D	A	V	P _t	N	Power	Efficiency
3 m ³ /s	200 mmwg	20° C	0.05m	0.1963 m ²	15.28 m/s	215 mmwg	1070 RPM	5.2 KW	82.19%
3 m ³ /s	300 mmwg	20°C	0.05m	0.1963 m ²	15.28 m/s	315 mmwg	1300 RPM	10.8 KW	83.3%
3 m ³ /s	400 mmwg	20°C	0.05m	0.1963 m ²	15.28 m/s	415 mmwg	1480 RPM	15 KW	80%
5 m ³ /s	200 mmwg	20°C	0.05m	0.1963 m ²	25.47 m/s	241 mmwg	1300 RPM	13.3 KW	75.18%
5 m ³ /s	300 mmwg	20°C	0.05m	0.1963 m ²	25.47 m/s	341 mmwg	1480 RPM	20 KW	75%
5 m ³ /s	400 mmwg	20°C	0.05m	0.1963 m ²	25.47 m/s	441 mmwg	1640 RPM	26 KW	76.9%
7 m ³ /s	200 mmwg	20°C	0.05m	0.1963 m ²	35.66 m/s	280 mmwg	1580 RPM	23.5 KW	59.57%
7 m ³ /s	300 mmwg	20°C	0.05m	0.1963 m ²	35.66 m/s	380 mmwg	1710 RPM	32 KW	65.63%
7 m ³ /s	400 mmwg	20°C	0.05m	0.1963 m ²	35.66 m/s	480 mmwg	1850 RPM	40 KW	70%

We have implemented an automatic text detection technique from an image for Inpainting. Our algorithm successfully detects the text region from the image which consists of mixed text-picture-graphic regions. We have applied our algorithm on many images and found that it successfully detects the text region.

International Journal of Innovative Research in Science, Engineering and Technology

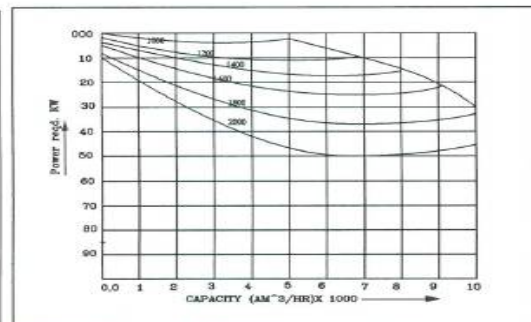
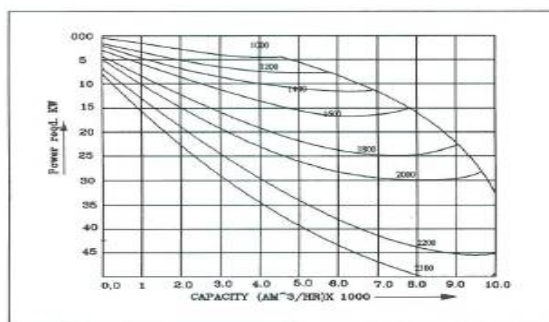
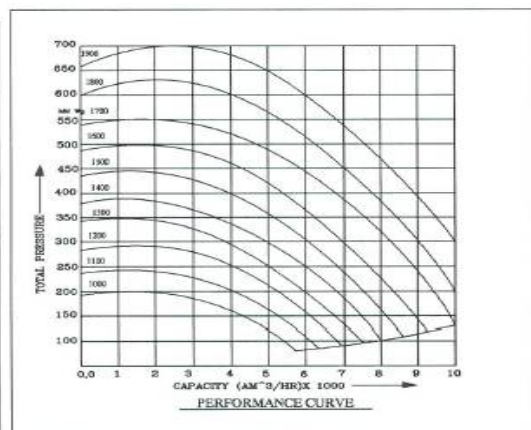
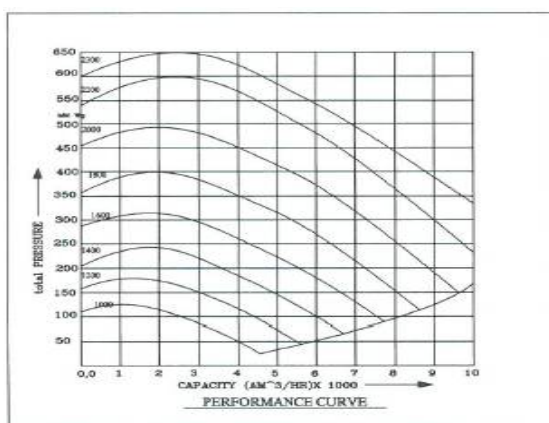
(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

V. CONCLUSION

- 5.1 It can be safely concluded that backward curved blades operate at a lower RPM and Power. Henceforth producing an efficiency that is higher than that of backward inclined blades (without varying other parameters).
- 5.2 Backward curved blades have a smoother working as compared to backward inclined blades because backward inclined blades mostly deal with corrosive or dusty airstreams whereas, backward curved blades are employed in Air handling units, back filter applications and conveying units.
- 5.3 Backward Curved Blades Centrifugal fan have 13.43% higher efficiency on an average as compared to backward inclined blades Centrifugal fan.
- 5.4 Backward inclined blades Centrifugal fan utilise on an average 18.36% more power as compared to Backward Curved Blades Centrifugal fan.
- 5.5 Backward inclined blades Centrifugal fan operate on an average 24.91% more RPM as compared to Backward Curved Blades Centrifugal fan.



Graph of backward inclined blade

Graph of backward curved blade

These Graphs can henceforth be applied for designing and producing a working and highly efficient centrifugal fan, with given constraints like capacity, static pressure and temperature. For RPM range of 1000-2000 of backward curved blades and for RPM range of 1000-2300 of backward curved blades, power and efficiency can be calculated.

VI. FUTURE SCOPE

These centrifugal fans are designed to operate at air density. But further more work can be done and centrifugal fans can be designed that work with fluids that have higher density and more viscous flow. The blades can also be modified

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

to suit the altitudes of different locations. Moreover, the conditions affecting the smooth working of these centrifugal fans can be observed and with respect to that needful steps can be undertaken for smooth functioning of those.

ACKNOWLEDGEMENT

I would like to express my sincere thanks and gratitude to Mr. Rohan Ramesh Patil, Application Engineer for his constant guidance, suggestions and experience in the field.

I wish my grateful thanks to Mrs. Priya Sachin Jadhav, Assistant Professor, Mechanical Department, Symbiosis Institute of Technology, Pune, Maharashtra, India.

I would also like to express my thanks go to my father, mother and to all my friends and well-wishers whose support has been a constant source of inspiration for me.

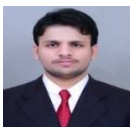
REFERENCES

- [1] C. N. Jayapragasan, Sumedh J. Suryawanshi and K. Janardhan Reddy., "Design Optimisation of Centrifugal Fan of Travelling Cleaner", ARPN, Volume 9, ISSN: 1819-6608, Page no. 1637-1644, 2014.
- [2] P. Navin Kumar, S. SahayaRubinson., "Design Optimization of Backward Inclined Radial Blade Impeller Using Ansys", IJEDR, Volume 2, Issue 1, ISSN: 2321-9939, Page no. 404 – 409, 2014.
- [3] Sharad Chaudhary, Santosh Kansal., "Performance Analysis of Backward Curved Centrifugal Fan in Heating Ventilation and Air Conditioning", IJSR, Volume 2, Issue 6, ISSN: 2319-7064, Page no.: 170 – 172, 2013.
- [4] Peter Hlbocan, Michal Varchola., "Prime Geometry Solution of a Centrifugal Impeller Within a 3D Setting", Procedia Engineering, Volume: 39, Page no.: 197 – 203, 2012.
- [5] Y Srinath, K.Monhar Reddy., " Modeling & Analysis of Centrifugal Blower using Composite Material", IOSR, Volume 9, Issue 6, ISSN: 2278-1684, Page no.: 17-25, 2013.
- [6] Usmani Fahad Ziaul Ain, Dr. Gulabchand K. Gupta., "Energy saving analysis of centrifugal blowers", IRJET, Volume: 02, Issue: 05,p-ISSN: 2395-0072, Page no.: 999-1003, 2015.
- [7] Wan-Ho Jeon., "A numerical Study on the Acoustic Characteristics of a Centrifugal Impeller with a Splitter", GESTS Int'l Trans. Computer Science and Engr, Vol.20, Issue no.1, Page no.: 17-28, 2005.
- [8] J. MENG*, L.F. Liao, D. Li, Y. Cao, L.Y. Yang, Y.Y. Chen., "Topology Optimization Method Research on Hollow Wide-Chord Fan Blade of a High-bypass Turbofan Engine", Procedia Engineering, Volume: 99, Page no.: 1228 – 1233, 2015.
- [9] Hamid Eskandari, MortezaGharouni Nik, Amir Pakzad., "Foundation analyzing of centrifugal ID fans in cement plants", Alexandria Engineering Journal, Volume: 55, Page no.: 1563-1572, 2016.
- [10] M.MohammedMohaideen., "Optimization of Backward Curved Aerofoil Radial Fan Impeller using Finite ElementModelling", Procedia Engineering, Volume: 38, Page no.: 1592 – 1598, 2012.

BIOGRAPHY



Mr. Soham Choudhary, B.Tech Student, Mechanical Department, Symbiosis Institute of Technology, Lavale village, Mulshi Taluka, Pune, Maharashtra, India-412115



Mr. Rohan Ramesh Patil, M.Tech Thermal Power Engineering (Application Engineer), Pune, Maharashtra, India



Mrs. Priya Sachin Jadhav, Assistant Professor, Mechanical Department, Symbiosis Institute of Technology, Lavale village, Mulshi Taluka, Pune, Maharashtra, India-412115