EXPERIMENTAL ANALYSIS OF CENTRIFUGAL BLOWER WITH BACKWARD, FORWARD AND RADIAL CURVED VANE

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ABSTRACT

Blower play an important role in Air-conditioning, Furnace, Low pressure cooling and dust or fame extraction system because they can achieve high pressure compare to fans. Blower is widely used in industrial and commercial application to sum of the vehicle cooling system. The centrifugal blower has been widely investigated because of their extensive application in ventilation and processing at industries. The performance of the centrifugal blower mainly depends upon the different parameter of the impeller blade used. The performance analysis of centrifugal blower Taste stand should consist of blower driven by electric motor, closed lopped piping, Flow control valve, Pitot tube, Energy meter, Tachometer, U Tube differential manometer with mercury and water fluid and so on. Aim of project is to check the experimental performance is to varying the mass flow in Forward, Backward and Radial curved vane and analyzed the efficiency.

Keyword *Centrifugal Blower, Electric Motor, Static pitot tube, Tachometer, Energy meter etc.*

1. INTRODUCTION

Blower is an important class of fluid machine, which has characteristics of transfer of energy between continuous stream of fluid & an element rotating about a fixed axis. Blower is a head generating machine which employs the dynamic action of a rotating element "the rotor" the action of rotor changes the energy level of the continuously flowing fluid. Blowers & Compressors are pressure-increasing machines. In all these, the fluid enters axially and is discharged by the rotor into a static collector system casing and then into a discharge pipe. Main components of Blower are impeller which is having rotary motion, where energy is transfer and followed by stationary part casing, in which energy transformation takes place. Casing decides the size and pressure rise in the system.

1.1 Scope of Blower

This design should be implemented on the higher speed and capacity of machine.

1. The flow within the volute casing is three dimensional; I feel that the flow due to presence of overhung portion forms a vortex. The flow may have the axial component within the volute casing; may be surveyed by using PIV.
2. The flow condition within the volute casing may be surveyed at off design condition.
3. The flow may be surveyed within the casing of different shape and behavior may be determined within the volute at different rotational speed.
4. The detailed analysis may be performed for the tongue region and for the different shape of tongue.
5. Flow visualization may be carried out using appropriate flow visualization technique.

6. The flow within the volute casing may be surveyed with different values of blade angle at exit covering whole range of angle i.e. backward to forward type of impeller.

2. EXPERIMENTAL SETUP AND PROCEDURE

2.1 Layout of test rig of centrifugal blower

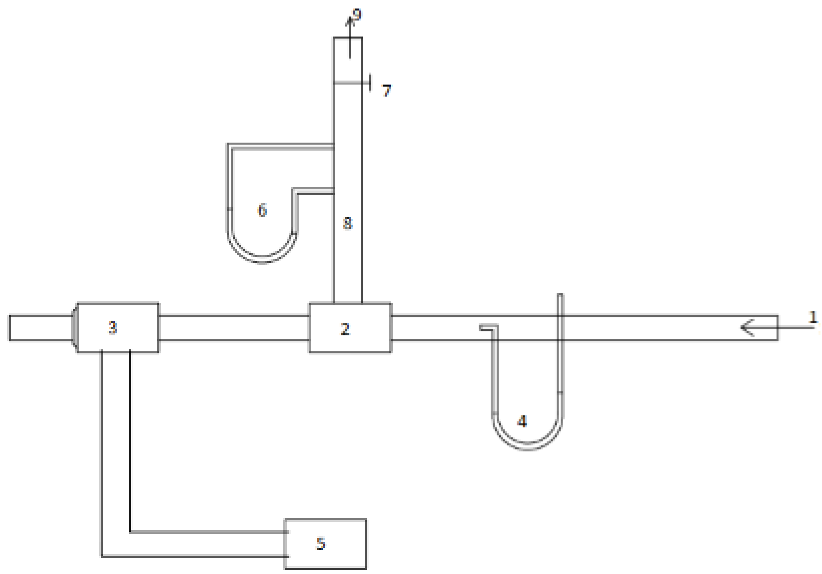


Figure1: Layout of set up of centrifugal blower

(1) Inlet (2) Centrifugal blower (3) Electric motor (4) U Tube manometer with mercury fluid (5) Energy meter (6) U Tube manometer with water fluid (7) Flow regulating valve (8) Duct (9) Outlet

2.2 General description of set up

Blower consists of a motor, impeller and its body. Three impellers i.e. forward curved, backward curved and radial curved vane is provided with the set-up. These are interchangeable and any one of them can be fixed on the motor shaft. To find out the outlet velocity, the Pitot tube is provided. Differential manometer is fixed to find out the difference of pressure of Pitot tube at Blower outlet. Energy meter is provided to find out the input power to blower. For changing the discharge and head, valve is provided at outlet of the air.

Figure 2: Experimental set-up of centrifugal blower

2.3 Procedure

1) Clean the apparatus and make it free from Dust.

2) Fill manometer fluid in manometer Tube i.e. water.
3) Fix the Impeller on the blower desired one (Radial, Backward or Forward Curve Vane).
4) Ensure that all On/Off Switches given on the Panel are at OFF position. Now switch ON the Main Power Supply. Switch ON the Blower.
5) Fix the RPM of motor with the help of DC Drive and read the RPM of motor with the help of RPM Indicator provided on the Panel.
6) Control the flow of air with the help of control valve provided in the discharge pipe.
7) Measure the pressure difference, static head & dynamic head with the help of manometer.
8) Record the power consumption by means of energy meter, provided in panel using Stop Watch.
9) Repeat the same experiment for constant RPM but change the flow of air with the help of control valve and then for different RPM.
10) When experiment on first particular Impeller is over, fix other desired Impeller on Blower and start experiment.

2.4 Observation Table

We have performed experiment on different vane of blower is Backward vane, Forward vane and Radial vane by varying the mass flow rate like ¼ open, ½ open, ¾ open, and fully open valve are showed in following table. Observation table for backward curved vane is shown below.

Table 1: observation table of backward curved vane

Opening	Static pressure mean (cm)	Velocity Measure mean (cm)	Differential pressure mean (cm)	Time taken 5 Rev. (sec)	R.P.M
¼ open	14.6	15.75	1.24	29	2590
½ open	9.6	15.1	3.04	25	2590
¾ open	8.0	13.64	6.22	24	2590
Full open	3.5	11.74	8.32	23	2590

Observation table for forward curved vane is shown below with different position of valve opening.

Table 2: Observation table for forward curved vane

Opening	static pressure mean (cm)	Velocity pressure mean (cm)	Differential pressure mean (cm)	Time taken 5 Rev. (sec)	R.P.M
¼ Open	17.3	17.46	0.46	26	2810
½ Open	14.4	16.52	1.98	24	2810
¾ Open	8.1	14.58	5.7	19	2810
Full open	2.7	12.0	8.7	19	2810

Observation table for radial curved vane is shown below with different position of valve opening.

Table 3: observation table for radial curved vane

Opening	Static pressure mean (cm)	Velocity pressure mean (cm)	Differential pressure mean (cm)	Time taken 5 Rev. (sec)	R.P.M
¼ open	16.1	17.1	0.62	27	2570
½ open	12.7	16.2	3.06	24	2570
¾ open	8.4	14.86	5.68	22	2570
Full open	3.7	13.06	9.5	19	2570

2.5 Relation for calculate efficiency

Efficiency (η %) = $\frac{Output}{Input} * 100$

(1) Input H.P.shaft = $\frac{r}{t} * \frac{3600}{E.M.C} * \frac{1000}{736} * 0.8$

Where,

r = revolution of meter

t = time taken for rev.

E.M.C = energy meter constant = 1600 pulses / kW hr.

Motor efficiency = 0.8

(2) Output H.P. = $\frac{\rho QH}{75}$

Where,

ρ = density of air = 1.19 Kg / m3

Q = Discharge, m3/ sec.

H = Head, m

(a) $H = (static\ head + Dynamic\ head) * (\frac{\rho_m}{\rho_a} - 1)$

(b) Q = v * area of pipe

Where,

(I) Area of pipe = $\frac{\pi}{4} * (Outer\ dia.)^2$

(ii) $v = C_p \sqrt{2gR\,(\frac{\rho_m}{\rho_a} - 1)}$

Where,

ρ_m = Density of manometer fluid

ρ_a = Density of air = 1.19 Kg / m3

R = Manometric reading

3. RESULT AND DISCUSSION

From, observation table, we can calculate Input, Output, Discharge and Efficiency for different position of valve. There are different result table for backward, forward and radial curved vane are following below.

Table 4: Result table for Backward curved vane

Opening	Input	Output	Discharge m3/sec	Efficiency η%
¼ open	0.42	0.052	0.013	12.38
½ open	0.48	0.13	0.04	27.08
¾ open	0.51	0.25	0.08	49.01
Full open	0.53	0.274	0.135	51.6

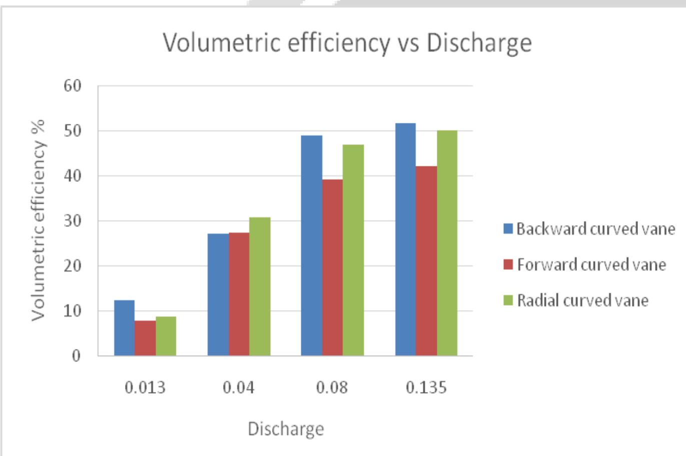
Table 5: Result table for Forward curved vane

Opening	Input	Output	Discharge m3/sec	Efficiency η%
¼ open	0.47	0.037	0.008	7.9
½ open	0.51	0.14	0.034	27.45
¾ open	0.64	0.25	0.084	39.06
Full open	0.64	0.27	0.138	42.18

Table 6: Result table for radial curved vane

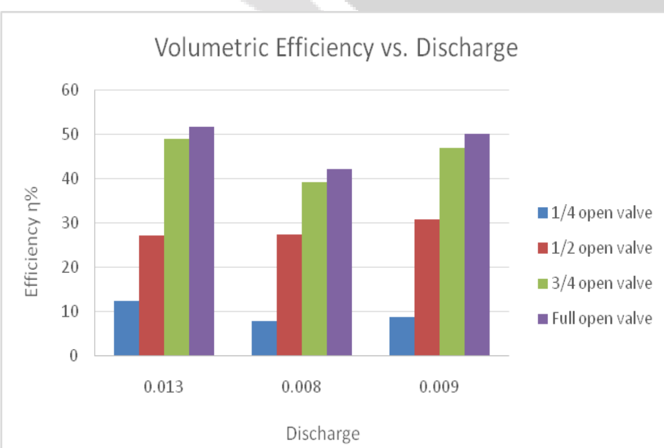
Opening	Input	Output	Discharge m3/sec	Efficiency η %
¼ open	0.45	0.04	0.009	8.88
½ open	0.51	0.157	0.041	30.9
¾ open	0.55	0.25	0.083	46.8
Full open	0.64	0.32	0.144	50.0

After performing the experiment on centrifugal blower and from experiment table we can plot the graph and compare various parameter like volumetric efficiency and discharge, Input power and discharge, Head and discharge, Pressure and velocity of blower is following below:



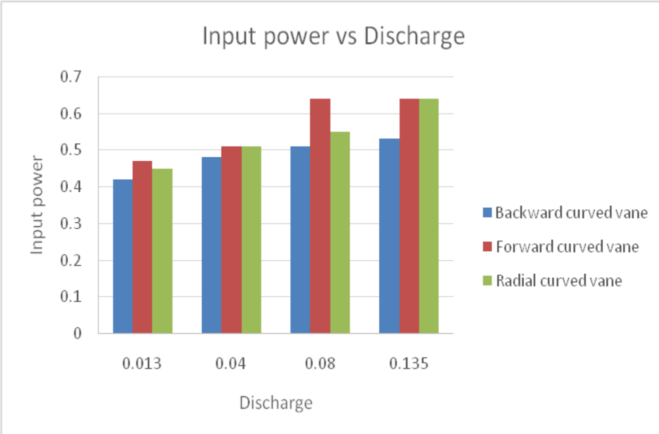
As we can see from the graph of volumetric efficiency vs. Discharge, as increase Mass flow rate the Efficiency of three different blades also increases with it. Similarly, decreasing mass flow rate also reducing the efficiency. In short Discharge (i.e. mass flow rate) directly effect on the efficiency.

Chart – 1: Volumetric efficiency vs. discharge on three different blade



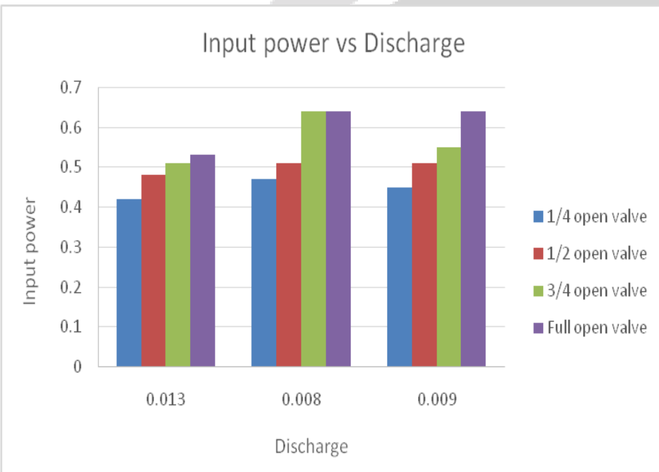
As we can see from the graph of volumetric efficiency vs. discharge when opening position of the valve is ¼ at that time, Discharge is increased or decreased the fluctuation in efficiency also noted with it. When the valve open is ½ at a time the efficiency has minimal change. Also when the valve open is ¾ and full at a time efficiency also increased or decreased with it.

Chart - 2: Volumetric efficiency vs. discharge on different valve opening position



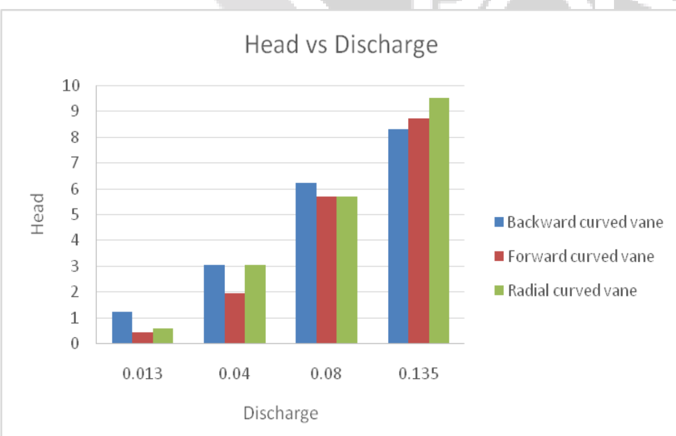
As we can see from the graph of Input power vs. Discharge, as increased in input power the discharge also increased with it. So obviously increased the efficiency because discharge directly affecting on efficiency.

Chart - 3: Input power vs. Discharge on three different blade



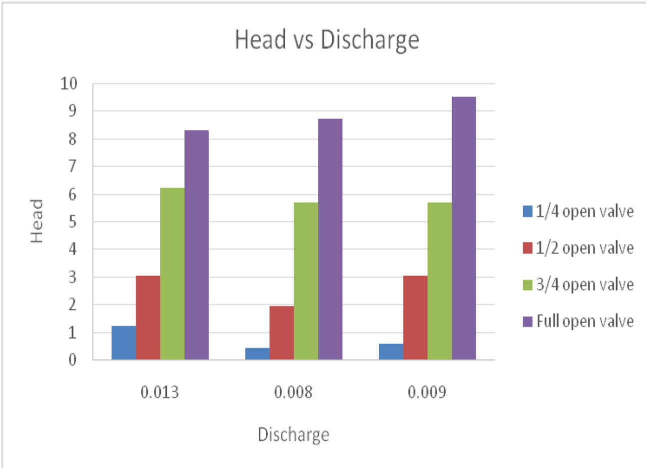
As we can see from the graph of input power vs. discharge, The increasing in input power the discharge is also increased or decreased with it when the valve is open as ¼, ½, 3/4 and full open.

Chart - 4: Input power vs. Discharge on different valve opening position



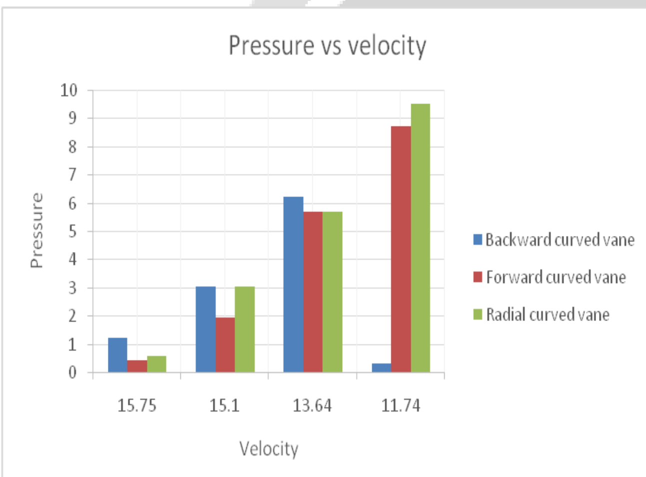
As we can see from the graph, increasing the value of head the discharge has increased also with it so for increasing the efficiency it should be necessary to increase in the head.

Chart - 5: Head vs. Discharge on three different blade



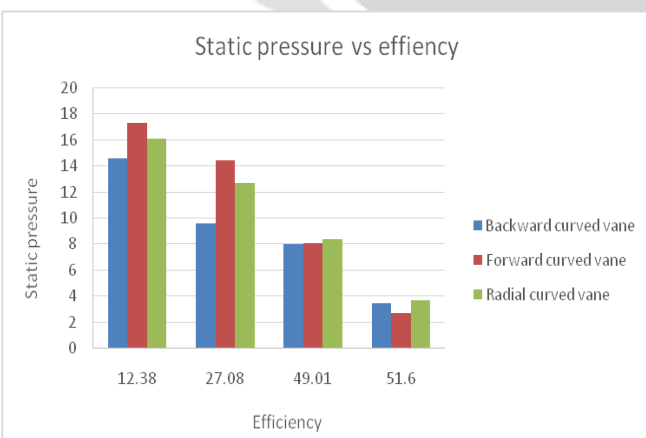
As we can see from the graph of head vs Discharge when the valve opening position are ¼, 1/2, and ¾ at that time as increased or decreased in head the discharged fluctuate with it but when the valve has fully open at that time discharge is increased or decreased the head continuously increased.

Chart - 6: Head vs. Discharge on different valve opening position



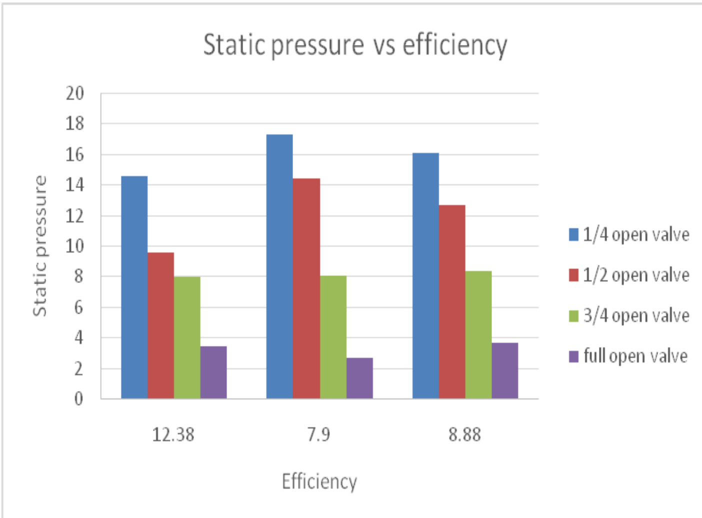
As we can see from the graph of Pressure vs. velocity reducing in the velocity of fluid the pressure increased when the valve opening is ¼, ½ and ¾ meanwhile for fully open valve as reducing in the velocity the pressure has not continuously rising as we seen in initially three different valve opening position but here pressure drops with reducing the velocity.

Chart - 7: Pressure vs. velocity on three different blade



As we can see from the graph of Static pressure vs. efficiency, In order to increase the efficiency it must be necessary to reduce the static pressure for three different blade.

Chart - 8: Static pressure vs. efficiency on three different blade



As we can see form the graph of static pressure vs. efficiency when opening position of valve is ¾ at a time static pressure remain same nearly but efficiency continuously fluctuate so there is no perfection while comparing the above parameter for different opening position of the valve.

Chart - 9: Static pressure vs. Efficiency on different valve opening position

4. CONCLUSIONS

By performing experiment on the centrifugal blower on three different vane of Backward, Forward and radial curved vane and from the graph and result table we conclude something is as follows:

1) The performance of centrifugal blower mainly depends upon the design parameters of the impeller blades. From the result table the efficiency of backward blade was found to be greater than that of the other blades. At medium mass flow rate, the backward blade is most efficient impeller to be used because of its ease to manufacture and higher efficiency.

2) From the graph, In order to increase the efficiency the static pressure must be lower and medium or higher discharge raised the efficiency of blower.

Future Scope

1) For different speed find out experimental performance of blower.

2) For different load find out experimental performance of blower.

3) Flow behavior and analyzed the different parameter which are affect the performance of blower by using CFD.

5. ACKNOWLEDGEMENT

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