Experiment No 3

Objective: - Performance analysis of centrifugal blowers with flat vane and airfoil vane impellers.

- To verify the laws of centrifugal blowers.
- To plot characteristic curves for centrifugal blowers.

 **Prerequisites: -**

1. Basics of fan Vs blowers.
2. Concept of centrifugal blowers.
3. Self-Reading before Coming to The Laboratory:

    - What are Fan Laws?
    - How to organize experiments to verify Fan Laws?
    - Prepare Brief Planning and show it to the instructor before starting the experiments.

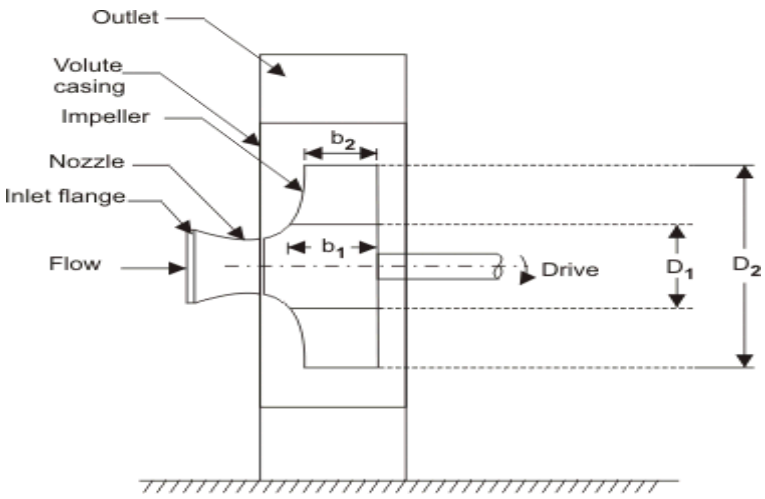
 **Minute details about the practical Setup :-(or the theoretical brief background)**

Blowers are turbo machines which deliver air at a desired high velocity (and accordingly at a high mass flow rate) but at a relatively low static pressure.

The rise in static pressure across a blower is relatively higher and is more than 1000 mm of water gauge that is required to overcome the pressure losses of the gas during its flow through various passages. A blower may be constructed in multi stages for still higher discharge pressure.

Many blowers for relatively high-pressure applications are of centrifugal type. The main components of a centrifugal blower are shown in Fig. A blower consists of an impeller which has blades fixed between the inner and outer diameters. The impeller can be mounted either directly on the shaft extension of the prime mover or separately on a shaft supported between two additional bearings. Air or gas enters the impeller axially through the inlet nozzle which provides slight acceleration to the air before its entry to the impeller. The action of the impeller swings the gas from a smaller to a larger radius and delivers the gas at a high pressure and velocity to the casing. The flow from the impeller blades is collected by a spiral-shaped casing known as volute casing or spiral casing. The casing can further increase the static pressure of the air, and it finally delivers the air to the exit of the blower.

The blower arrangement of straight blades has the diameter of the orifice as 24.5 mm, the diameter of the pipe is 34.5 mm. The test rig with airfoil blade has the diameter of the orifice as 24.5 mm, the diameter of the pipe is 34.5 mm.



Main components of a centrifugal blower

Orifice Flow Meter Equations:

$$q_v = CA_2\sqrt{\frac{2(P_1 - P_2)}{\rho}}\ \frac{m^3}{s}$$

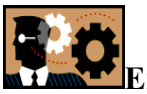
$$C = \frac{c_d}{\sqrt{1-\beta^4}}$$

$$\beta = \frac{d}{C}$$

$$P_{Kinetic} = \frac{\rho {q_v}^3}{2{A_1}^2}$$

Nomenclature for symbols used in this page:-

qv = volume flow of air, m^3/sec
n = rotational speed of fan
d = diameter of fan
p = pressure developed by the fan
p = density of air, kg/m^3
PR = power absorbed by the fan, kW
$A_1 = Area\ corresponding\ to\ Pipe$
$D = diameter\ of\ pipe$
$A_2 = Area\ corresponding\ to\ orifice$
$d = diameter\ of\ orifice$

 **Experimental Procedure/what you should aim at: -**

- Draw a neat sketch with all the major dimensions of the test rig and details of all the instruments available on the test rig.
- Measurement of speed and power consumed by the blower.
- Measurement of static pressure at inlet and exit of the blower for various flow rates.
- Carry out all the measurements to verify blower laws as in table 1.
- Draw graphs corresponding to
    1. Pressure difference vs Flow rate at each RPMs speed.
    2. Hydraulic power vs Flow rate at each RPMs speed.
    3. Efficiency vs Flow rate at each RPMs speed.

S. No.	Valve opening	Motor speed	Pressure	Flow rate	Temperature
1	Full open				
2	$1/4^{th}$ opening				
3	½ opening				
4	$3/4^{th}$ opening				
5	Full closed				

 **What next (Things you can ponder over):-**

1. Why did I do this whole experiment?
2. What are the different manufacturing companies involved in making Blowers?
3. How does a blower score over fans and where do fans have upper hand?
4. Can I find the historical lineage of how blowers of the day came into being?
5. What are the different large and small blower applications?

Submission of Report:

- A single report per group.
- All are equally responsible for the preparation of the report.
- Should answer the question on your report.
- Each Report will be evaluated for 10 points.

References:-

1. Turbines, compressors and Fans by S. M. Yahya.