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MATERIALS AND METHODS: LABORATORY TEST SET-UP

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ABSTRACT

The results obtained during the laboratory testing of the blowers are discussed in this paper. The blowers were tested in the laboratory at speeds between 1700 r/min and 4500 r/min. The results of the tests of the blowers are discussed individually first, then they are compared with each other. Observations were taken for the determination of dynamic head, static head, atmospheric temperature, input voltage and current. The power factor and the efficiency of the motor were assumed. From these observations, the values of air velocity, discharge, dynamic and total pressure at the blower exit, input power to blower, and dimensionless coefficients as flow, pressure and power coefficients were calculated.

Keywords: *Laboratory Testing, Blowers, Power Factor, Air Velocity, Input Power.*

Introduction

The following equipment were required during the performance evaluation of the centrifugal blowers in the laboratory.

- Blower assembly,
- Frame to support blower assembly,
- Prime mover,
- Power transmission assembly,
- Wind tunnel assembly,
- Pressure measuring instruments,
- Power measuring instruments,
- Speed measuring instrument, and
- Temperature measuring instrument.

These equipment's are discussed briefly below.

Blower Assembly

This consist of impeller, casing and the bearing block. The different blower assemblies of tractor mounted air carrier centrifugal sprayers which were tested in the laboratory are,

- Solo-mini,
- ASPEE-small,
- ASPEE-big, and
- Newly designed blower assembly.

The specifications of the above blower assemblies.

Frame to Support Blower Assembly

The whole frame was constructed of angle iron joints.

Two pieces of L-shaped angle irons were bolted to a heavy base of cast iron so that the whole set up remained firm in place. The iron base was mounted over two parallel, cast iron rails over which it could be moved so that the distance between the blower assembly and the stationary motor could be adjusted. This facilitated the mounting and removal of the drive belt. An iron plate welded to the angle iron frame provided the base for the bearing block.

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Prime Mover

The solo-mini blower assembly was run with the help of a solo 210 c.c. one cylinder two-stroke, 12.5 hp petrol engine.

The other blower assemblies were run with the help of electric motor. Two, 3-phase, a.c. induction motors were used for this purpose. Their specifications are as follows:

- **Motor A**

Type	:	3-phase squirrel cage induction motor
Voltage	:	415 V
Frequency	:	50 cps
Power	:	10 hp
Full load current	:	14.5 A
r/min	:	1440

- **Motor B**

Type	:	3-phase, squirrel cage induction motor
Power	:	15 hp
Full load current	:	20 A
r/min	:	1440

Power Transmission Assembly

Power was transmitted from the motor shaft to the impeller shaft of the blower by means of belt and pulley arrangement.

Wind Tunnel Assembly

AS, the three of four blowers had the same outlet diameter, only two wind tunnels were fabricated. The wind tunnels were made of brass. Brass sheet was also used for making the flow straighteners. The entrance of the wind tunnel was slightly enlarged so that it could tightly fit over the blower outlet. A hole was drilled at the required distance from the entrance, to insert the pitot tube. The pitot tube was tightened in place with the help of a nut and bolt arrangement.

Pressure Measuring Instruments

The velocity pressure, static pressure and the total pressure of the air issued by the blower were determined by using standard pitot static tube in conjunction with U-tube manometer. The two limbs of the manometer connected to static and total pressure end of the pitot static tube would give the difference in water columns which is nothing but velocity head. Static head is the difference in the levels of water in U-tube manometer when one limb of it is connected, to the static end of the pitot tube and the other limb of the manometer is kept open to the atmosphere. Total pressure head is the sum of static head and velocity head.

The pitot tube was inserted into the tunnel through a hole at a specific distance from the outlet of the blower.

Power Measuring Instruments

For measuring the power consumed by the blower, a voltmeter and an ammeter were used. Voltmeter and ammeter were connected to the line supplying power in parallel and series respectively after the starter.

Speed Measuring Instrument

A tachometer was used to measure the speed of the impeller shaft in r/min. The ranges available in r/min were: 30- 150, 100-500, 300-1500, 1000-5000, and 10,000-50,000.

Temperature and Humidity Measuring Instruments

Temperature was measured with the help of a dry bulb thermometer. A sling psychrometer was used to measure humidity.

Laboratory Testing of Blowers

Effort was made to test the blowers at five different speeds between 1500 r/min and 5000 r/min with three replications. A schematic view of laboratory test set up. The following measurements were taken at each speed of the blower:

- Dry bulb temp (°C),
- Wet bulb temp (°C),
- Relative humidity (%),
- Speed of blower (r/min),
- Velocity head (cm of water column),
- Static head (cm of water column),
- Input current to motor (A),
- Input voltage to motor (V)

Using the formula mentioned in section 3.3, the following variables were calculated at each speed of impeller,

- Saturated vapour pressure (N/m2),
- Dry air density (kg/m3),
- Humid air density (kg/m3),
- Mean air velocity at test section and blower exit (m/s),
- Air discharge (m3/s),
- Dynamic, static and total pressure at test section and blower exit (N/m2),
- Input power to motor (Kw),
- Output power of motor (Kw),
- Input power to blower (Kw),
- Output power of blower (kw),
- Performance coefficients i.e., flow coefficient, pressure coefficient, power coefficient and efficiency of the blower.

The test results of laboratory experiment with four different equipment's are given in the next chapter, where they have been analysed and discussed.

Efficiency

The efficiency of blowers at different speeds is shown 2500. The efficiency of the newly designed blower at r/min was 44.36% while the efficiency of Aspee-Small and Aspee- Big at the same speed were 21.29% and 33.18% respectively. The efficiency of Solo-Mini could not be determined as the input power to the blower was unknown. The efficiency is approximately the same for a given flow per revolution, Q/n, as the velocity diagrams for both the inlet and outlet will be homologous.

Some of the relationships obtained under test conditions did not hold true, due to large variations in speed.

Dimensionless Coefficients

Here, the performance of blowers has been discussed on the basis of flow coefficient, pressure coefficient and power coefficient.

- **Flow Coefficient**

Flow coefficient is a dimensionless coefficient, which when multiplied by a factor 4/2 yields the ratio of the actual flow rate to the reference flow rate that corresponds to the product of peripheral velocity at the tip and the circular area based on the tip diameter. Hence, this coefficient eliminates the effect of impeller size. The flow coefficient for all the blowers at different operating speeds were determined and the variation of flow coefficient with increase in impeller speed. Due to various losses occurring in blade the flow coefficient is not constant at different operating speeds. For all the blowers, except for Solo-Mini, there is a slight increase in the values of flow coefficient with the increase in impeller speed. There is a slight decrease in the values of flow coefficient of Solo-Mini with increase in speed. The maximum value of flow coefficient obtained at a speed of 2500 r/min was by the newly designed blower which was 0.1646.

- **Pressure Coefficient**

Pressure coefficient is a dimensionless coefficient and when multiplied by a factor 2/m2 yields the ratio of actual fan pressure to the reference pressure corresponding to the peripheral velocity at the tip.

The pressure coefficient for all the blowers at different operating speeds were determined and their variation with increase in impeller speed.

For all the blowers the pressure coefficient increased with increase in speed except for Solo-Mini. Solo-Mini showed a slight decrease in the values of pressure coefficient with the increase in speed.

The maximum value of pressure coefficient at 2500 r/min, was obtained by the newly designed blower which was 7.477.

The performance of newly designed blower was compared with those of Solo-Mini, Aspee-Small and Aspee-Big. The different parameters compared were total pressure, air velocity, discharge, input power to blower, efficiency and the dimensionless coefficients. From the laboratory tests the following conclusions were drawn:

- Total discharge developed by the newly designed blower at 2500 r/min was 383.33 per cent, 90.23 per cent and 15 percent more than that developed by Solo-Mini, Aspee-Small and Aspee-Big respectively.
- As the input power to the newly designed blower is only 3.84 horse power at 2500 r/min, it can be mounted on even lesser (< 15 hp) horse power tractor.

Based on the conclusions drawn, it can be pointed out that the performance of the newly designed tractor mounted blower was better than the existing three blowers by showing higher air velocity, more discharge, lesser power consumption and greater efficiency at the designed operating speed of 2500 r/min.

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