An Experimental Investigation of the Performance of a Centrifugal Fan with Radial Inclined Vane Impellers.

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ABSTRACT

An experimental investigation of the performance of a centrifugal fan with radial inclined vane impellers has been reported. It is found that the inclined vane impeller is better than the conventional straight vane as regards pressure rise across the fan and efficiency.

INTRODUCTION

The vanes of a centrifugal fan on pump impeller are usually set at right angles to the two parallel shrouds. This type of vane arrangement will be called straight vane (angle of inclination 90°). When the vanes are set to an inclined manner between the two parallel shrouds, it will be called inclined vane. No work on inclined vane is available. So, an attempt is made to find the effect of inclination of vanes on the performance of a contrifugal fan fitted with such an impeller.

The vanes of a centrifugal fan or pump can be arranged in three ways··· forward curved, radial and backward curved. The majority of impellers have vanes that are curved backward. High speed superchargers and centrifugal air compressors for aircraft gas turbines have radial vanes to withstand the centrifugal force due to high rotational speed. Radial vane fans are also used for supply of air in boiler furnace. Large numbers of radial vane pumps are used as cellar drainers, cooling water pumps for internal combustion engines and other applications where low initial cost is more important than higher efficiency. Centrifugal fans with forward curved blading are used as induced for forced draft fans in boilers where pressure variation is not very much desirable with the variation of flow rate.

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In this work, an experimental investigation on the performance of radial inclined vane impellers is undertaken. Four radial vane impellers with vane inclinations of 90°, 75°, 60° and 45° are used. The impeller with 90° vane inclination is called the straight vane impeller or the conventional impeller.

Experimental Set Up and Procedure

The test facility consists of a volute type centrifugal fan (made by Plint and Partners of U. K.) which is belt-driven by a three phase 1.5 h. p. motor. The suction end of the fan is fitted with a long horizontal 3-inch dia smooth brass pipe which in turn is fitted with a parabolic nozzle. Air enters the fan through this nozzle and it is calibrated to measure the flow rate. The delivery end of the fan is fitted with a short vertical smooth pipe connected with a flexible baffle valve to control the flow rate. A schematic diagram of the experimental set-up is shown in figure-1.

Two pressure tappings, one at the fan suction end and one at the delivery end are made at convenient locations and these are connected to a water manometer to measure the pressure rise across the fan. A draft gage was used to measure the pressure difference across the parabolic nozzle to calculate the flow rate. The input power to the motor was measured by two wattmeter method and the combined efficiency of the fan system (motor and fan) was calculated.

Four radial vane impellers with inclinations of 45°, 60°, 75° and 90° are used. The first three impellers are fabricated at Bangladesh University of Engineering & Technology and the last one is supplied by the manufacturer of the fan, Plint and partners. All the impellers are made similar except the inclination. For each impellers measurements on head, discharge and efficiency are taken varying the flow rate with the help of the baffle valve. All measurements are taken at a constant speed of 3750 rpm.

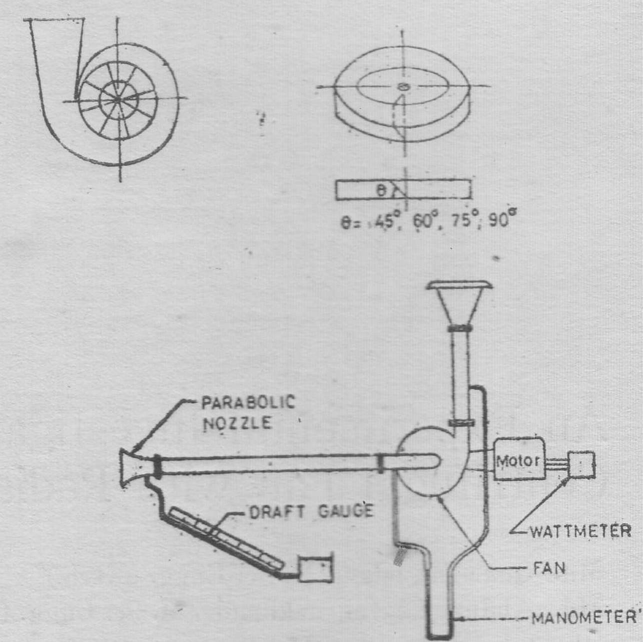

FIGURE 1 SCHEMATIC DIAGRAM OF EXPERIMENTAL SET-UP

Results and Discussions

The variations of total head and efficiency with flow for different vane inclinations are shown in figures 2 and 3. The results can be compared with those of straight vane impeller. It is found that pressure rise as well as the efficency tend to increase with the increase of angle of vane inclination. Higher the angle of inclination, closer it is to the straight vane type. An inclination of more than 75° will approach towards straight vane. Lower angle of inclination [fig. 1] actually means more oblique setting of vanes between shrouds and this would reduce the area of flow to a certain extent. It would result in higher velocity and losses. This has become apparent from figures 2 and 3.

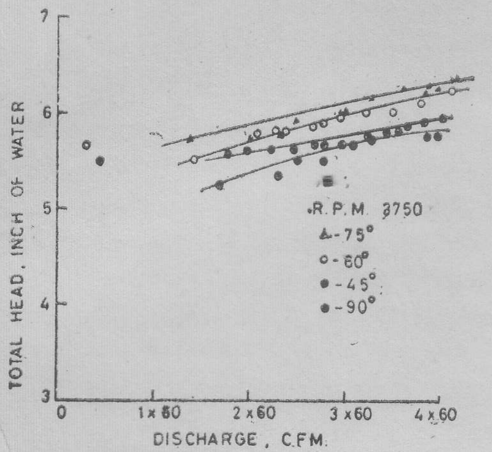

FIGURE 2 EFFECT OF VANE ANGLE ON THE TOTAL HEAD-DISCHARGE RELATIONSHIP

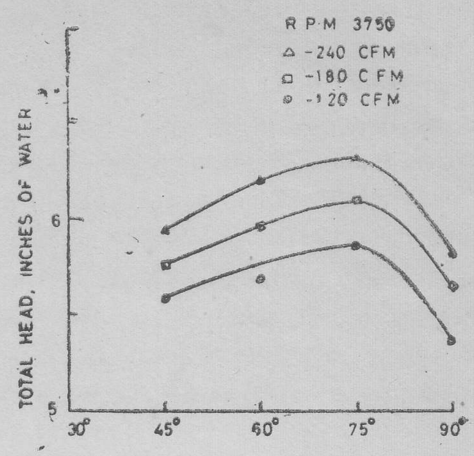

FIGURE 4 HEAD-VANE ANGLE RELATIONSHIP AT VARIOUS DISCHARGES.

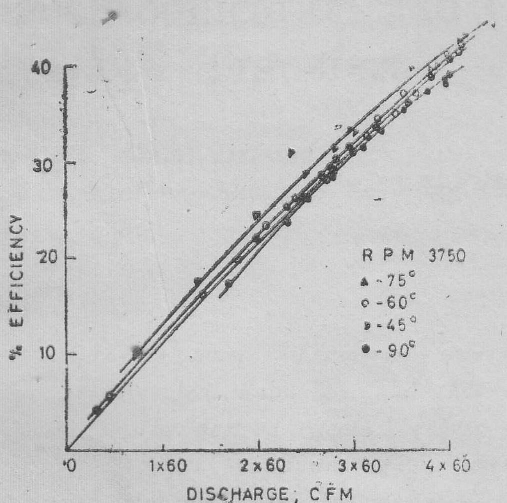

FIGURE 3 EFFECT OF VANE INCLINATION ON THE EFFICIENCY-DISCHARGE RELATIONSHIP

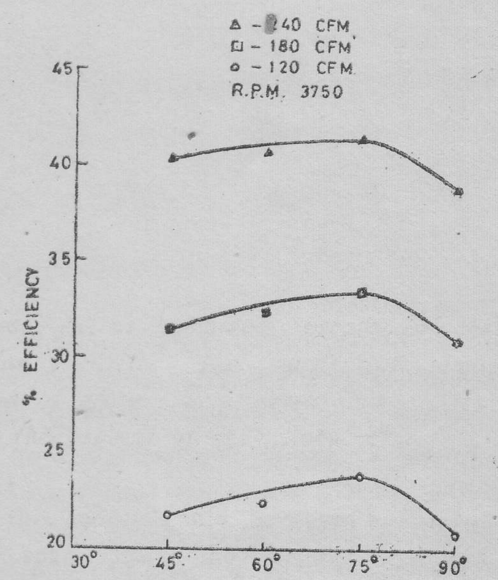

FIGURE 5 EFFICIENCY-VANE ANGLE RELATIONSHIP AT VARIOUS DISCHARGES

Figures 4 and 5 are cross piots of total head and efficiency for different inclinations at three flow rates. Both total head and efficiency increase with angle of inclination upto about 75° and then it decreases for 90° inclination. It is quite obvious from figures 2, 3, 4 and 5 that the vane inclination of 75° is the best amongst the other inclinations of 45°, 60° and 90°. So it can be concluded that a radial inclined vane impeller delivers better pressure rise and efficiency than the conventional straight radial vane.

References

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