STUDY OF AERODYNAMICS OF A CRICKET BALL

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ABSTRACT

This research is concerned with the nature and aerodynamic behavior on cricket balls in flight. It is written to determine the aerodynamic characteristics of a cricket ball with a mass of 156 gm and approximate diameter of 70 mm, where a sample cricket ball was fixed with a shaft in a wind tunnel. The aerodynamic characteristics have been analyzed by varying the rotational rpm of the cricket ball, where the axis of rotation for seam and shaft is same and the pressure difference between the upper and the lower surface of the cricket ball determine by the help of static manometer. Some experimental works have also been carried out and compared with those of the results obtained numerically. The upward pressure, which creates lift, has increased almost linearly with the increase of ball position angle to approximately 15° to 30° and it also decrease with increase of ball rotational speed. Finally some conclusions have been drawn on the basis of the experimental result.

Keywords: Lift, Drag

1. INTRODUCTION

A cricket ball has six rows of prominent stitching, which are known as primary seam. There are typically 60-80 stitches in each row. The seam is along the "equator" of the two-hemisphere ball. Better quality balls are made of 4 pieces of leather so that each hemisphere has a line of internal stitching forming the "secondary seam". The secondary seams of the two hemispheres are at right angles to each other.For such construction different types of swings are generated and for different speed of rotation direction lift and Magnus effect occurs.The key to making a cricket ball swing is to cause a pressure difference between the two sides of the ball. The air pressure depends on the flow of the air over each side of the ball. Swing is generated when blowers, by accident or design, disrupt the flow of air over one side of the ball.The lift generated by a cricket ball depends on factors such as the speed of the airflow, the density of the air, the total area of the ball, rotational speed of ball.Researches in Bangladesh were carried out to visualize the flow over the cricket ball in steady and rotational (manual rotation) condition without airflow. But here in this study, considerable effort is given to visualize the air flow pattern over the cricket ball across the seam in steady and various rotational conditions with airflow. Effort is also given to determine the pressure difference between the upper and lower surface of the sample cricket ball during lift and Magnus effect.

2. EXPERIMENTAL SET UP

Figure 1-2 shows the design and photograph of the complete experimental set up. The wind tunnel made by 8 mm think transparent "Acrylic plastic sheet". This wind tunnel has four parts as air inlet section, test section, diffuser section and blower section.

A 1 hp, 3 phases, 220 V, AC blower used at the end of diffuser section whose maximum rpm is 1400. For rotating the sample cricket ball in test section one AC motor is used, whose maximum rpm is 9500. A regulator used to control the motor rpm.
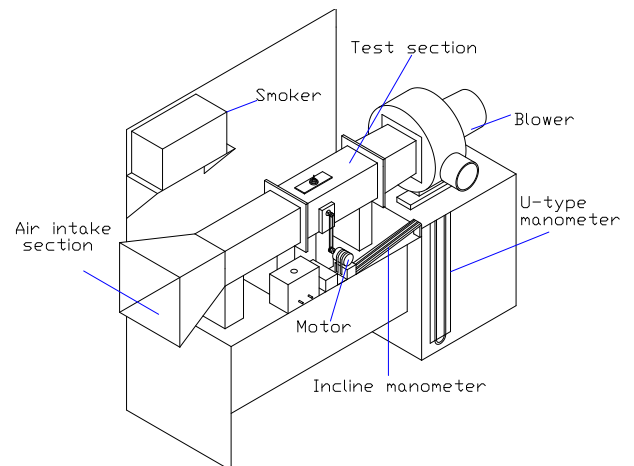

Figure 1: Schematic diagram of Experimental Set-Up

Figure 2: Photograph of Experimental Set-Up

3. EXPERIMENTAL RESULT

The research was conducted test in the low speed subsonic wind tunnel. The free stream airflow (v) is kept constant at 2.62 m/s and the other parameters are atmospheric pressure (P_o) is 101365 Pa; density of air (ρ) is 1.1774 kg / m^3, absolute viscosity (μ) is 1.79 x 10^{-5} kg/m-s, Reynolds Number (R_e) is 35053. Here the effect of temperature is neglected. The lift has been calculated from the experimental data based on the consideration of 2-D cricket ball.
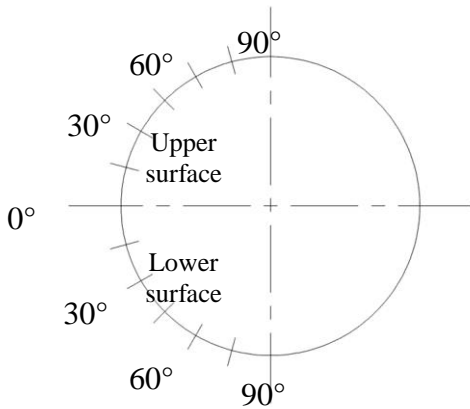
Figure 3: Angular position of the cricket ball where the manometer reading was taken.

3.1 Aerodynamic Characteristics of cricket ball with steady position.

There are no pressure differences in upper and lower surface of the sample cricket ball, when it is steady.

3.2 Aerodynamic Characteristics of cricket ball with rotation.

The variation of lift pressure with ball position for a sample cricket ball with 2624 rpm rotational speed is shown in Figure 4. At zero degree, the pressure difference is almost zero and increases linearly with the increase of ball position angle up to approximately 30°. After wards, lift pressure decreases with further increase of ball position angle. It is also observed that the maximum pressure difference (lift pressure) is approximately 94 Pa.
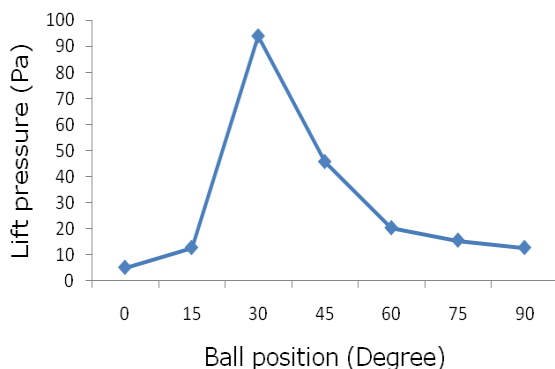
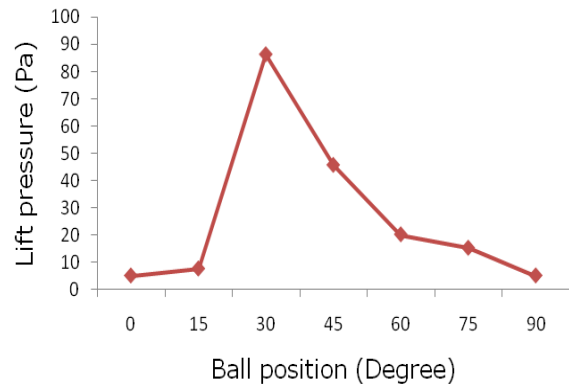Figure 4: Ball position Vs lift pressure curve at ball rotational speed (2624 rpm)

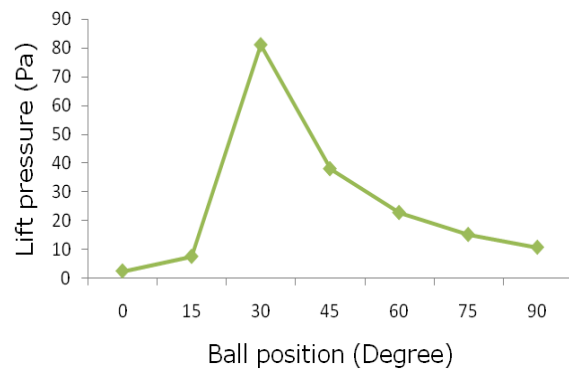Figure 5: Ball position Vs lift pressure curve at ball rotational Speed (3043 rpm)

Figure 6: Ball position Vs lift pressure curve at ball rotational Speed (3365 rpm)
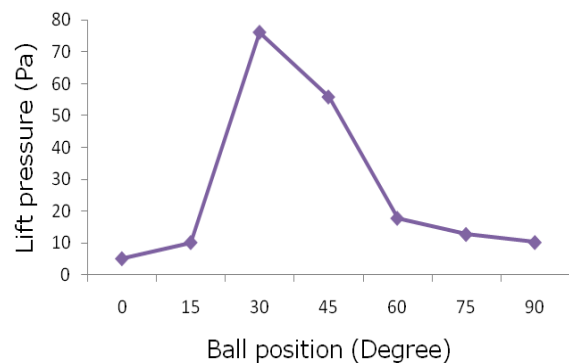
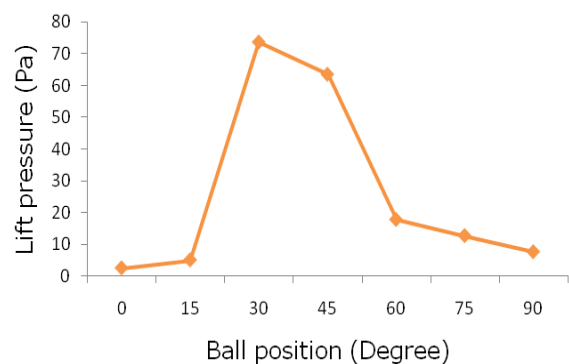Figure 7: Ball position Vs lift pressure curve at ball rotational Speed (5879 rpm)

Figure 8: Ball position Vs lift pressure curve at ball rotational Speed (6178 rpm)

Figure 5-8 shows the variation of lift pressure with ball position for a sample cricket ball for rotational speeds of 3043, 3365, 507 and 6178 rpm respectively. The results are similar with only difference is maximum pressure difference and these were 86 Pa, 81 Pa, 76 Pa and 73 Pa respectively at 30° ball position.

4. RESULTS AND DISCUSSION

The variation of upward pressure (pressure difference i.e lift) with ball position for a sample cricket ball with different rotational speed is shown in Figure 9. At zero degree, the pressure difference is almost near to zero and it increases slowly at surface area's 0 to 15 degree from the horizontal axis of the ball.

Pressure difference increases linearly with the increase of ball position angle up to approximately 30°. After wards, upward pressure decreases with the further increase of ball position angle. Also lift pressure decrease with increasing ball rotation.

It is also observed that the maximum lift pressure 94 Pa was found for minimum ball rotation 2624 rpm at 30° ball position.
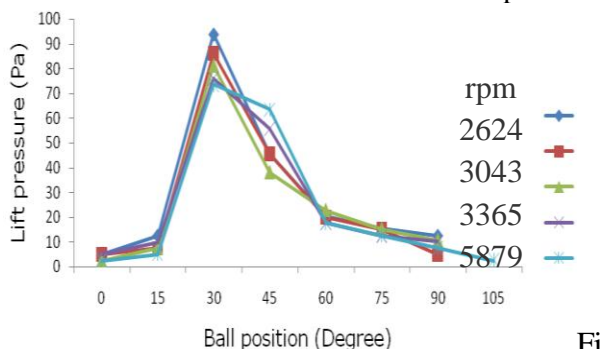

Figure 9: Ball position Vs lift pressure curve in different rpm

5. CONCLUSIONS

The experimental observation includes study of aerodynamic behavior of both stationary and rotating cricket ball placed in a wind tunnel. No pressure difference was found in between upper and lower surface of the sample cricket ball, when it is steady. In this research, various lift pressures was measured from experimental numerical data. Number of graphs are plotted to study the characteristics of lift pressure with rotational speed. The magnitude of the experimental lift pressure varies with cricket ball's rotational speed and position. Pressure difference increases linearly with the increase of ball position angle up to approximately 30° Maximum lift pressure was found in 30° ball position angle at lower rotational speed.

6. REFERENCES

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7. NOMENCLATURE

Symbol	Meaning	Unit
θ	Ball position (in angle)	Degree
P_L	Upward presser	Pa
R_e	Reynolds number	None
ρ_o	Density of air	kg/m^3
P_o	Atmospheric pressure	Pa
μ	Absolute viscosity	kg/m-s
v	air velocity	m/s