UNIVERSITY OF NAIROBI
DEPARTMENT OF MECHANICAL ENGINEERING

FLUID MECHANICS/AERODYNAMICS DIVISION

Pressure distribution around a circular cylinder

Object

To measure the distribution of normal pressure around a circular cylinder.

Apparatus

Wind tunnel, circular cylinder with pressure tapping, manometer.

Procedure

Mount the cylinder with its axis normal to the flow direction and with the pressure orifice facing upstream. Connect the pressure lead to the manometer and note the zero reading. Run the tunnel at a selected speed and measure the surface pressure at the following angular positions $-20^{\circ}(5^{\circ})20^{\circ}$, $20^{\circ}(10^{\circ})100^{\circ}$, $100^{\circ}(15^{\circ})190^{\circ}$, where the angle is measured relative to the position corresponding with the orifice facing upstream. If a multi-tube manometer is used the angle of the manometer should be noted.

Treatment of results

The measured pressures should be converted to coefficients based on tunnel dynamic pressure, but they must be corrected for the effects of model and wake blockages. The measured tunnel static and dynamic pressures P_∞ and $\frac{1}{2}\rho V_e^2$ correspond to an empty tunnel, but owing to the presence of the cylinder and wake the effective stream speed is V_f with a corresponding static pressure $P_{\infty f}$. If the blockage cor ection is ε then $V_f = V_e(1+\varepsilon)$, where V_e is the speed obtained from the calibration data or undisturbed flow. ε is the sum of two terms, ε_s due to solid blockage and ε_w due to wake blockage, where

$$\varepsilon_s = 0.82\left(\frac{t}{h}\right)^2$$

and $\varepsilon_w = \frac{1}{4}\frac{t}{h} C_{DT}$

where h is the tunnel height, t the diameter of the cylinder and C_{DT} the measured drag coefficient, which may be assumed to be unity.

The student should then show that the required pressure coefficient expressed in terms of the measured data is given by

$$C_p = \frac{P-P_{\infty f}}{\frac{1}{2}\rho V_f^2} = \frac{P-P_\infty}{\frac{1}{2}\rho V_e^2}(1-2\varepsilon) + 2\varepsilon$$

The corrected pressure coefficients should then be plotted against angular position. Due to possible misalignment of the tun: flow direction the true angular positions θ may be a little different from the measured ones. This can be determined by plotting the values near the "nose" to see if the pressure distribution is symmetrical about $\theta = 0^o$. Any difference found should be applied to all the measured values of θ .

The form drag coefficient based on the projected area is given by

$$C_D = \int_o^\pi C_p \cos\theta d\theta$$

where θ has been corrected as discussed above.
Determine C_D graphically.
Determine also the Reynolds number based on the cylinder diameter.

Run the tunnel at other speeds and obtain other sets of values.

<u>Conculsions</u>

The pressure distributions and drag coefficients obtained at the different Reynolds numbers should be compared with one another and with other published results at similar Reynolds numbers.

References:

1. Aerodynamics for Engineering students by E.L. Houghton and A.E. Brock, Edward Arnold. Chapter 10.

2. Mechanics of Fluids by Irving H. Shames McGraw-Hill International editions. Chapter 13.

BHO/July, 1993.