راهنمای نرم افزار اندازه گیری ونتوری متر، اوریفیس متر، پیتومتر و اندازه گیری افت اتصالات (پیتو متر)

Pitot tube

This is the instruction window. It may be scrolled either forwards or backwards,by moving the cursor to the arrows at either side of the window, but you may only scroll forwards upto the end of the current instruction. You may not scroll past the current instruction until it has been satisfied.

However you may scroll backwards to examine past pages whenever you like. There is a means of accessing any page at random, but you have to enter LECTURER MODE, which requires a password.

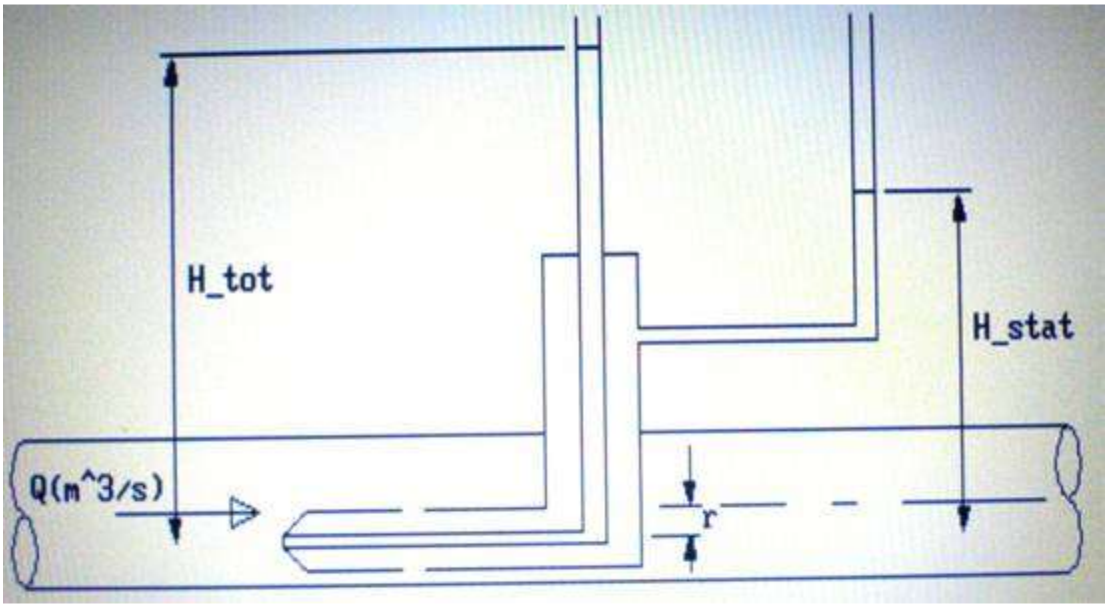
In LECTURER MODE all the data may be entered in any order and any page may be accessed in any order. It is essential that any user, whether it be a student or lecturer first run through the program in STUDENT MODE, so that a familiarity of the program is gained.

The object of this experiment is to demonstrate how a pitot tube can be used to measure fluid velocity. A velocity profile is obtained and used to determine the mean velocity of flow. This is then compared with the actual mean velocity calculated from the measured flow rate.

This page shows a diagrammatic representation of the main equipment needed to undertake the investigation. You will require the following items

- Fluid Friction Equipment
- Stop Watch

It will be useful if you obtain a printout of this diagram, by accessing the above PRINT rectangle. After you have studied this diagram you may scroll this window to move onto the Theory Page.



T H E O R Y

Nomenclature: (also see diagram)

g   = acceleration due to gravity (9.81 m/s^2)

H_tot   = Total relative head (relative stagnation pressure)

H_stat = Static relative head

H = Velocity head (H_tot - H_stat)

P_tot   = Total pressure (dynamic pressure + static pressure)

P_stat = Static pressure (at nose of pitot tube)

i   = inner suffix

o   = outer suffix

P   = fluid pressure

p   = density

A   = cross sectional area of pipe

Qa = actual flow rate

V   = mean velocity of flow (Qa/A)

Vr = fluid velocity at radius r

USE OF PITOT STATIC TUBE TO MEASURE VELOCITY

Applying Bernoullis principle at radius r between a point well

upstream and the nose of the pitot static tube:

$$\frac{P\_stst}{pg} + \frac{Vr^2}{2g} = \frac{P\_tot}{pg} + 0$$ since V = 0 at a stagnation point

rearranging:

$$\frac{Vr^2}{2g} = \frac{P\_tot - P\_stat}{pg} \quad \text{.................................. 1}$$

Since P=pgh then

$$\frac{P\_tot - P\_stat}{pg} = H\_tot - H\_stat = H$$

substituting in 1 :

$$H = \frac{Vr^2}{2g}$$ Vr = SQRT(2.g.H)

This is often expressed as V = Cm.SQRT(2.g.H) where Cm is a coefficient to allow for meter error.

By assuming Cm is unity and by taking a series of readings at different values of r we can produce a graph indicating the value of V at each radius (a velocity profile or velocity distribution

graph). The mean velocity of the fluid can be calculated by dividing the pipe into a number of annuli of inner radius ri and outer radius ro. For each annulus; its average velocity can be estimated from the velocity profile and hence its discharge (flow rate) can be calculated. (Q = V.A). The total discharge can then be obtained by summing the discharges for each annulus. The mean velocity can then be calculated by dividing the total calculated discharge by the cross sectional area of the pipe.

Method

Use the pitot static tube on the Fluid Friction Apparatus Equipment to carry out the following procedure:

Prime the pipe network with water. Open the appropriate valves to obtain flow of water through the 24mm pipe containing the pitot static tube. Measure a flow rate by using the volumetric tank in conjunction with the flow control valve V6. Move the pitot static tube to a known position and record the relative total head (stagnation) and static head, by using the water manometer. Repeat for different pitot tube positions. Note that the maximum radius at which a reading can be taken is 10mm. The computer will then be able to calculate the velocity at the pitot tube position [SQRT(2gH)] and a velocity profile is drawn. The average velocity and flow rate in each annulus is calculated enabling a mean velocity for the complete pipe to be determined. This should be compared with the actual mean velocity as determined using the volumetric tank. You should ensure that you calculate the first set of results.These results should agree with the computed results and be included in your report.

QUESTION 1

Dynamic pressure is

a) the pressure on a body in a moving fluid.

b) equivalent to the velocity head (V^2 /2g)

c) sum of the static pressure and velocity head

d) the stagnation pressure

(b) is correct. The kinetic energy can be converted into pressure energy by forcing the fluid to be stationary. The sum of static pressure and velocity head (dynamic pressure) is the stagnation or total head.

QUESTION 2

The purpose of a pitot tube (NOT pitot static tube) is to

a) measure static pressure.

b) measure dynamic pressure

c) measure stagnation (total) pressure

The correct answer is (c). The pitot tube measures the pressure when the fluid has been forced to be stationary, The kinetic energy has therefore been converted into pressure energy, so the total increased pressure energy is being measured.

QUESTION 3

A pitot static tube is used to measure

a) total (stagnation) pressure.

b) static pressure.

c) velocity head.

The correct answer is (c). The pitot static tube is used to measure the difference between the total (stagnation) pressure and the static pressure, which is the velocity head.

QUESTION 4

Which statement is WRONG ?

a) The velocity head is equivalent to the dynamic pressure.

b) The total head is the stagnation pressure.

c) The velocity head is the total pressure head of the water when it has been forced to be stationary

d) The velocity head is the difference between the stagnation and static heads.

The wrong statement is (c). The velocity head is the dynamic component of the total head.

QUESTION 5

If a pitot static tube is used to measure the velocity of water,what would be the velocity if the difference between stagnation and static pressures are 38mm of water?

a) 0.863 m/s

b) 1.35 m/s

c) 86.3 m/s

d) 8.63 m/s

e) 13.5 m/s

f) 0.851 m/s

g) 8.51 m/s

The correct answer is (a). You should have used the formula

V = SQRT(2gH)

If a pitot static tube is used to measure the velocity of AIR,what would be the velocity if the difference between stagnation and static pressures are 38mm of WATER ?

(density of water = 1000 kg/m^3, density of air = 1.28 kg/m^3)

a) 0.863 m/s

b) 1.35 m/s

c) 24.1 m/s

d) 2.41 m/s

e) 23.8 m/s

f) 238   m/s

g) 2.38 m/s

The correct answer is (c). You should have used the formula P=pgH to convert the water head into air head and then used V = SQRT(2gH). You should have noted that 38mm of water is equivalent to

(0.038 x 1000 / 1.28 =) 29.7m of air.

In the formulae used, H is always the:

a) measured head + velocity head based on the depth to the weir

crest

b) measured head + velocity head based on the depth to the

channel base

c) height of the upstream water above the weir crest

d) height of the upstream water above the channel base

The correct answer is (a). The datum for H is always the lowest point of the weir, i.e. the crest of the weir.