DEPARTMENT OF ENVIRONMENTAL, WATER RESOURCES, AND COASTAL ENGINEERING

MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY

FLUID MECHANICS SESSIONAL

EWCE 262

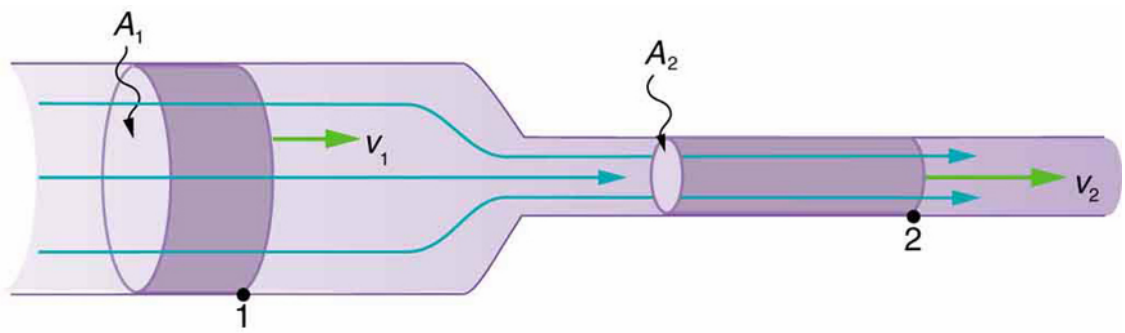
Experiment No. 8

Determination of co-efficient of resistance for change in cross section of pipe

8.1General

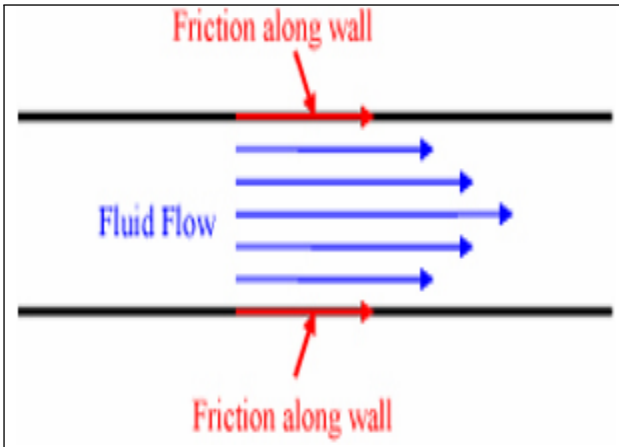
In practical setting, fluid flows through different pipe fittings such as sudden contraction, sudden enlargement, valve, elbow or bend, tee section etc. Sudden changes in the flow path result in secondary flow patterns, denoted as **separation region** and ***vena contracta*** (flow area contraction due to secondary flow). Vortices and eddies occur in these regions, consuming energy and resulting in an observable pressure drop. Large pressure drops are observed as the fluid is forced through non-streamlined passages. These losses through valves and fittings are known as **minor losses** or **fitting losses**. Due to separation of flow, the fluid energy reduces in the downstream of the component than the upstream.

Frictional losses are avoided here since the lengths of pressure measuring points (tapping points) are comparatively small.



8.2 Practical application

In any pipe network there may sudden change in pipe diameter. In any change in pipe diameter there is considerable head loss and we need to calculate the loss. From this experiment, we can determine the coefficient to calculate the losses.





Friction along wall	A modern water distribution system with PVC pipes

8.3 Theory

With the turbulent pipe flow, where the flow is considered stydy ae Reynolds number of R_e > 2320, pressure loss is proportional to the

- Length of the pipe
- Coefficient of the pipe friction
- Square of the flow speed
- Density of the flowing medium

In addition the pressure loss increases as the pipe diameter reduces. It is calculated as follows:

$Pv = \rho v^2$ .....(1)

The associated head loss h_v is calculated as follow:

$h_v = = v^2$ .....(2)

For turbulent pipe flow R_e > 2320 the pipe friction coefficient depends on the pipe roughness k and Reynolds number R_e. The pipe roughness k specifics the height of the wall elevation in mm. The relationship between R_e and K is shown in the Colebrook and Nikuradse diagram. Here the wall roughness k is related to pipe diameter d.

Reynolds number, Re is calculated from pipe diameter, velocity of flow and from the viscosity of following fluid,

Re = ...(3)
The flow speed, v is calculated from the volumetric flow Q and the pipe cross section.

V = Q/A .....(4)
For laminar flow the pipe friction coefficient is determined by using the Blasius formula,

= .....(5)

For turbulent flow, the co-efficient of pipe friction is calculated according to Colebrook

= 2 log { + }$^{-2}$ .....(6)

It is an implicit formula that has to be iteratively resolved. First of all estimate, place it in the formula and calculated an initial approximation is re-used in the equation to calculate a second approximation.

For change in cross section and associated change in speed the proportion of the total head loss is made up of Bernoulli,s head loss needs to be taken in account. Bernoulli,s equation will loss element is

$V_1^2/(2g) + h_1 + Z_1 = V_2^2/(2g) + h_2 + Z_2 + h_f$ .....(7)

If $Z_1 = Z_2$

Then,

$V_1^2/(2g) + h_1 = V_2^2/(2g) + h_2 + h_f$ .....(8)
Introducing the coefficient of resistance , the total head loss,

$h_v = (V_2^2 - V_1^2) + V_1^2 + V_2^2 + \zeta V_2^2/(2g)$ .....(9)

where, $h_1 - h_2 = h_v$

The pipe friction coefficient must be determined separately for the section before and after the change of cross section. By contrast the coefficient of resistance is only related to the space v_2 after the change of cross section.

Flow for equation (9) we get coefficient of resistance

$\zeta = 2ghv/(V_2^2) - [1- ()^4] - [\lambda_1)^4] + \lambda_2$ .....(10)

With no change in cross section = 1,

Therefore equation 10 becomes,

$\zeta = 2ghv/(V_2^2) - \lambda$ .....(11)

8.4Objectives

1. To determine head loss due to sudden expansion and contraction.
2. To plot H_{LC}Vs. V_2 in log log paper and determine the exponent n and coefficient K_1.
3. To plot H_{LE}Vs. (V_2-V_3) in log log paper and determine the exponent n and coefficient K_2.

8.5 Procedure

8.6. Apparatus

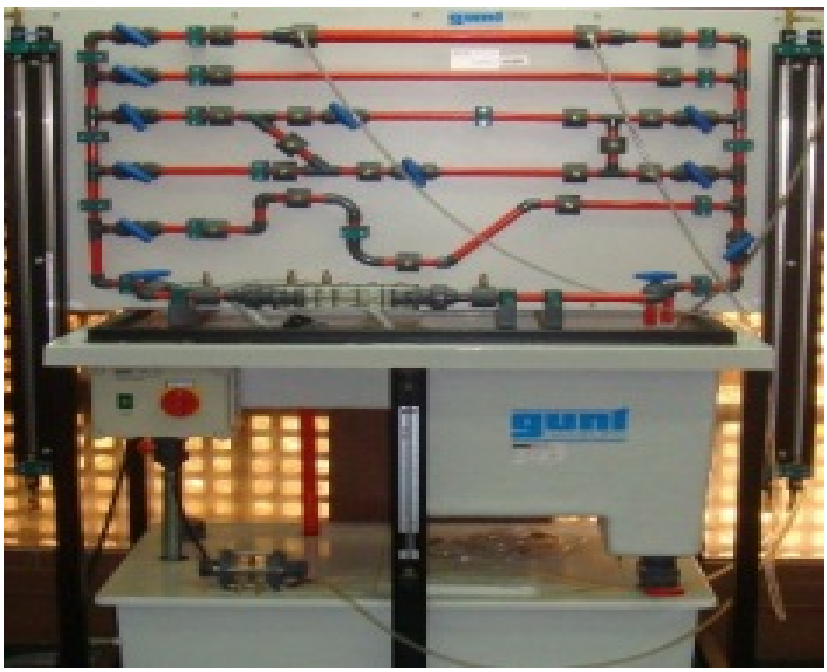
Fluid friction apparatus, hydraulic bench and stop watch.



Fluid friction apparatus



Stop Watch



Fluid friction apparatus with hydraulic bench

8.7 Experiment No. 8

Determination of co-efficient of resistance for change in cross section of pipe

Experimental Data Sheet

Temp = _____^{0}C υ =

Expansion to contraction

l1 = m, l2 = m, d1 = 0.0282 m, d2 = 0.0172 m

Group No	h_1 (m)	h_2 (m)	$h_v = h_1 - h_2$ (m)	Q_a (m^3/sec)	V_1	V_2	R_{e1}	R_{e2}	λ_1	λ_2	ζ
1											
2											
3											
4											
5											
6											

Contraction to expansion

l1 = m, l2 = m, d1 =0.0172 m, d2 = 0.0282 m

Group No	h_1 (m)	h_2 (m)	$h_v = h_1 - h_2$ (m)	Q_a (m^3/sec)	V_1	V_2	R_{e1}	R_{e2}	λ_1	λ_2	ζ
1											
2											
3											
4											
5											
6											

Level / Term : **Dept. :**
Reg No. : **Section:**
Group No. : **Date :**

Signature of the Teacher

8.8 Calculation from graph

8.9 Discussion

Comments on results:

Comments on graphs:

Sources of errors:

8.10 Practice Questions

1. ”For the same diameter ratios and the same velocities the loss due to sudden expansion is greater than the loss due to a corresponding contraction” Explain why?