SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF MECHANICAL ENGINEERING

19MEB201 – FLUID MECHANICS AND MACHINERY

II YEAR III SEM

UNIT 2 – FLOW THROUGH CIRCULAR CONDUITS

TOPIC 6 – FRICTION FACTOR

CONTENT

- DARCY-WEISBACH FORMULA
- FRICTION FACTOR
- THE DARCY FRICTION FACTOR - DERIVATION
- THE MOODY CHART-NUMERICALS
- ASSESSMENT

Source : gifer.com

Source : bsz-freiberg.de

DARCY-WEISBACH FORMULA

Flow of fluid through a pipe

- The flow of liquid through a pipe is resisted by viscous shear stresses within the liquid
- This resistance is usually known as pipe friction and is measured is feet or meters head of the fluid

DARCY-WEISBACH FORMULA

The factors affect the head loss in pipes are

- ✓ The viscosity of the fluid being handled
- ✓ The size of the pipes
- ✓ The roughness of the internal surface of the pipes
- ✓ The changes in elevations within the system
- ✓ The length of travel of the fluid

Source : bsz-freiberg.de

DARCY-WEISBACH FORMULA

- The resistance through various valves and fittings will also contribute to the overall head loss
- In a well designed system
- The resistance through valves and fittings will be of minor significance to the overall head loss

Source : de.wikipedia.org

DARCY-WEISBACH FORMULA

- Chézy formula which dealt with water flow in open channels
- Using the concept of ‘wetted perimeter’ and the internal diameter of a pipe the Chézy formula being used
- To estimate the head loss in a pipe, the constant ‘C’ has to be determined experimentally

THE DARCY-WEISBACH EQUATION

Weisbach first proposed the equation we now know as the Darcy-Weisbach formula

or

Darcy-Weisbach equation: $h_f = f\,(L/D) \times (v^2/2g)$

where: h_f = head loss (m)

f = friction factor

L = length of pipe work (m)

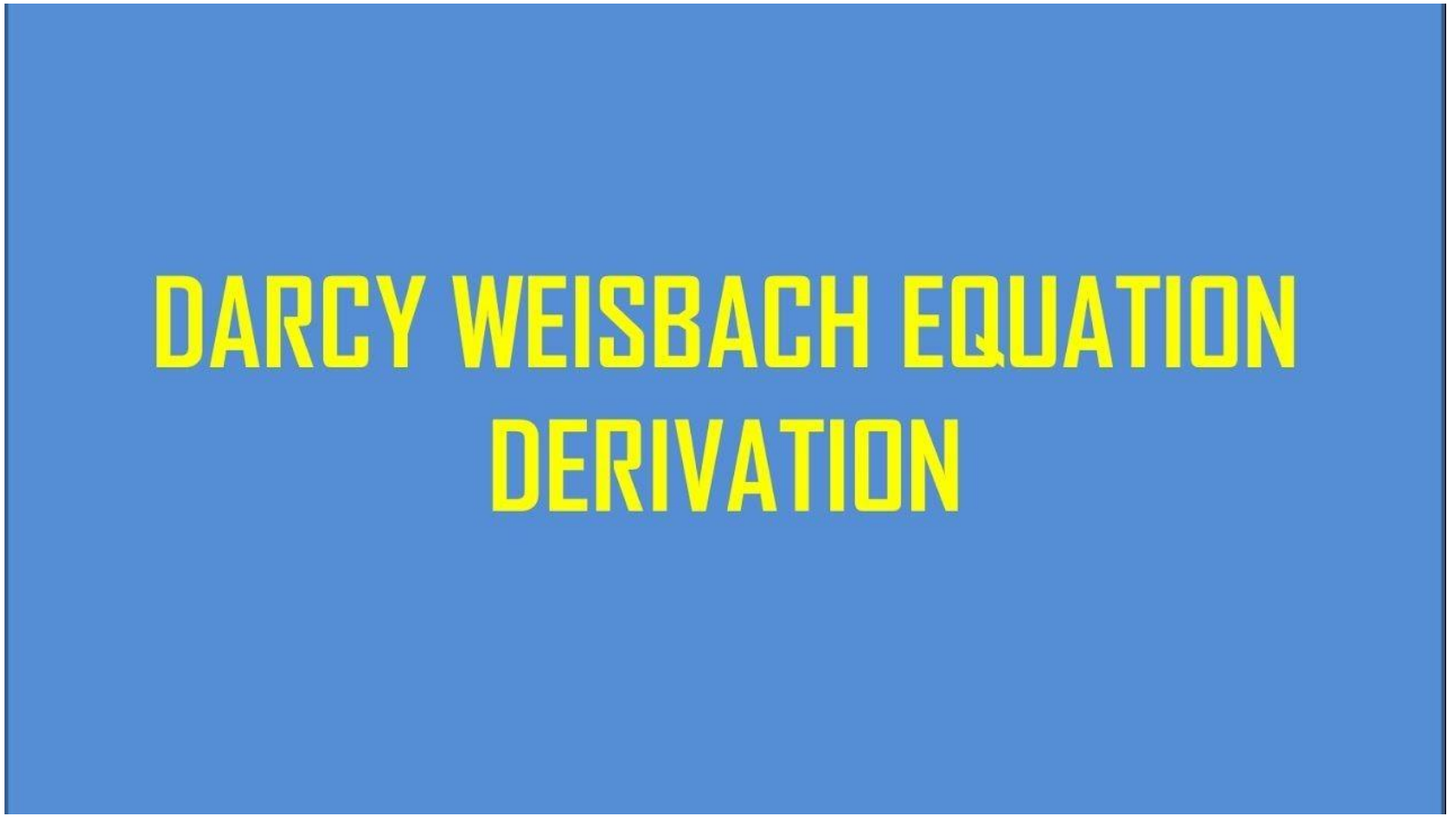
d = inner diameter of pipe work (m)

v = velocity of fluid (m/s)

What is head? g = acceleration due to gravity (m/s^2)

Source : /de.wikipedia.org

DARCY WEISBACH EQUATION DERIVATION



FRICTION FACTOR

- Establishment of the friction factors, still an unresolved issue
- Fanning, did much experimentation to provide data for friction factors
- Head loss calculation using the Fanning Friction factors has to be applied using the hydraulic radius equation (not the pipe diameter)

FRICTION FACTOR

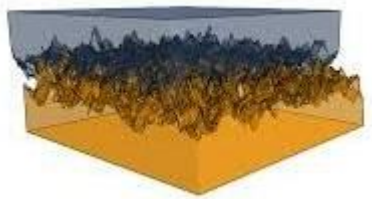
- The hydraulic radius calculation involves, dividing the cross sectional area of flow by the wetted perimeter
- For a round pipe with full flow the hydraulic radius is equal to ¼ of the pipe diameter

so the head loss equation becomes: $h_f = f\, f(L/Rh) \times (v^2/2g)$

where

Rh = hydraulic radius

f f = Fanning friction factor



Source:en.wikipedia.org

FRICTION FACTOR

- Darcy, introduced the concept of relative roughness
- In a relatively smoother pipe the turbulence along the pipe walls has less overall effect, hence a lower friction factor is applied
- The work of many others including Poiseuille, Hagen, Reynolds, Prandtl, Colebrook and White have contributed to the development of formulae for calculation of friction factors and head loss due to friction

THE DARCY FRICTION FACTOR

- The Darcy friction factor used with Weisbach equation
- Standard head loss equation for calculating head loss in pipes where the flow is turbulent
- Initially the Darcy-Weisbach equation was difficult apply, calculations carried out by manual method

THE MOODY CHART

- ✓ In 1944 LF Moody plotted the data from the Colebrook equation and Friction Factor Chart
- ✓ Used to plot the Reynolds number and the Relative Roughness of the pipe and friction factor for turbulent flow conditions
- ✓ The Moody Chart encouraged the use of the Darcy-Weisbach friction factor

THE MOODY CHART

- Many forms of head loss calculator were developed to assist with the calculations, amongst these

✓ A round slide rule offered calculations for flow in pipes

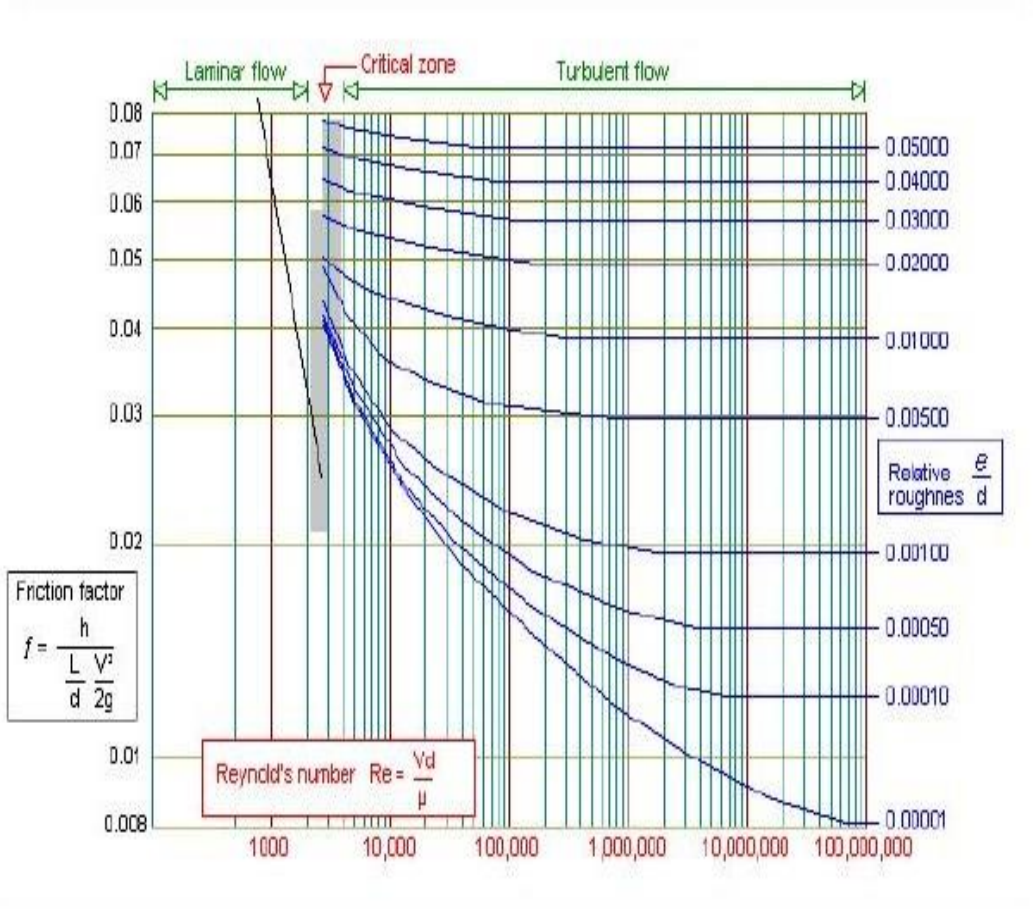
✓ Flow in open channels on the reverse side.

✓ Personnel computer from the 1980's onwards reduced the time needed to perform the friction factor and head loss calculations

Lewis Ferry Moody	
Born	5 January 1880 Philadelphia, Pennsylvania
Died	February 21, 1953 (aged 73) Princeton, New Jersey
Nationality	United States
Occupation	Mechanical engineer
Employer	Princeton University
Known for	Moody chart
Awards	Elliott Cresson Medal (1945)

Source : en.wikipedia.org

THE MOODY CHART



Soure : Pipeflow.com

- The friction factor can be determined by its *Reynolds number (Re)*
- *Relative roughness (e/D)* of the Pipe

where: e = absolute roughness

D = diameter of pipe

REFERENCE