# Properties of Fluids

## Specific Weight

## Specific Gravity

## Shear Stress

: Shear strain rate

: Dynamic Viscosity

## Rotational Surfaces(ref tut Qn)

## Angled surfaces

Gravity contributes to shear force experienced by the liquid.

Newtonian Fluids – satisfies condition.

|  |  |
| --- | --- |
|  |  |

|  |  |
| --- | --- |
| Temperature | Liquid Viscosity |
| Gas Viscosity |

## Kinematic Viscosity

## Surface Tension

## Pressure Difference

|  |  |
| --- | --- |
| Droplets |  |
| Bubbles |  |

## Contact Angle

|  |  |
| --- | --- |
|  | Rise, |
|  | Depr, |

## Liquid Columns

By forces on liquid column or interface.

# Fluid Statics

|  |  |
| --- | --- |
|  |  |

## Pascal’s Law

## Plane Submerged Surface

\* and are from liquid level.

## Curved Submerged Surface

A is the horizontal projection of curve.

is the weight of the liquid above and acts at (centroid area) of the liquid.

A diagram of mathematical equations

Description automatically generated

For a radial surface, the resultant force passes through centre radius.

## Stability

A diagram of a circle with text

Description automatically generated with medium confidence

|  | Stable |
| --- | --- |
|  | Unstable |
|  | Neutral |

|  |  |
| --- | --- |
|  |  |

# Fluid Motion

Incompressible Fluid:

### Conservation of mass

## Bernoulli - Along Streamlines

For **Inviscid** Flow

A diagram of a measuring device

Description automatically generated with medium confidence

## Bernoulli - Across Streamlines

Equate z and n with r as they are in the same direction. E.g

Pressure Gradient is towards O, away from O. Direction affects polarity.

# Rigid Body Motion

## Rectilinear Acceleration

### Constant Acceleration

|  |  |
| --- | --- |
|  | In this case, |

## Cylindrical Rotation

# Momentum Equation

when in positive x-direction.

NOTE: Add if

*^Use if is the same for all branches*

## Relative Motion

|  |  |
| --- | --- |
| U, V same dir. |  |
| U, V diff dir. |  |

## Angular Momentum

Add to fluid as absolute is used.

# Dimensional Analysis

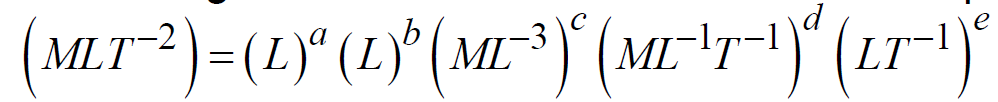
| Force |  |
| --- | --- |
| Density |  |
| Velocity |  |
| Viscosity |  |
| OR RPM |  |
| Torque |  |

## Rayleigh’s Method

Deal with all variables together

A black letter on a white background

Description automatically generated



A close up of a letter

Description automatically generated

A black and white math equation

Description automatically generated

## Buckingham Pi

Given var and repeating variables: ( groups

|  |  |
| --- | --- |
| A group of black letters and numbers  Description automatically generated | Solve for unknown variables |

Note: All groups for model (scaled) and prototype (actual size) are equal.

### Repeating Variables

1. Geometry (Length, Dia)

2. Fluid Property (Density, Viscosity)

3. Fluid Motion (Velocity, Flow, Pressure)

## Similarity

Geometric, Kinematic, Dynamic

### Dynamic Similarity

### Reynold’s Number

### Froude’s Number

For open channel/free surface flow.

# Pipe Flow

|  |  |
| --- | --- |
| **Laminar** | **Turbulent** |
|  |  |
|  |  |

## Common equations

### Bernoulli – Energy Form

## Laminar Flow

Not affected by roughness of pipes

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Description automatically generated

### Non-circular pipes

If ,

Hence,

## Turbulent Flow(Smooth Pipe)

^Use for finding and

## Turbulent Flow(Rough Pipe)

|  |  |
| --- | --- |
|  |  |

| Smooth |  |
| --- | --- |
| Rough |  |
| Transitional |  |

## Velocity Profile

### Smooth

### Rough

### Transitional

Like rough, but 8.5 is replaced with a value found from expt data.

## Finding Friction Factor

Moody Diagram: Calculate and use the highlighted line (right of diagram). Then, find given .

### Completely Rough

### Else: Haalander

# Minor Losses

|  |  |
| --- | --- |
|  |  |

## Sudden Enlargements

Since

For exit into large tanks,

## Sudden Contraction

is unknown, is found via expt.

Entrance Loss: Square Edges

## Multiple Pipes

### Series

|  |  |
| --- | --- |
|  |  |

### Parallel

|  |  |
| --- | --- |
|  |  |

## Branched Pipes

At junction:

### Head Loss due to pipe

### Head at Tank

Assumption that tanks are large ( and Equal Pressure ()