**9. FLOW THROUGH PIPE**

**LOSSES IN FLOW:**

The energy sacrificed (Given Away) by a fluid in order to overcome resistance against the flow is known as loss.

|  |  |
| --- | --- |
| **TYPES OF LOSSES** | |
| **MAJOR LOSS** | **MINOR LOSS** |
| It’s caused by friction or by the virtue of wall shear stress. | Due to geometric change in the stream lines. |

**MAJOR LOSS:**

|  |  |
| --- | --- |
| 1. It’s caused due to Fluid friction/ Wall shear Stress. 2. Darcy-Weisbach Equation is used for calculating loss. |  |
| 1. For Different flow,  |  |  | | --- | --- | |  |  | |  |
| 1. Major head loss linearly increases with the length of pipe. |  |
| 1. Influence of .  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | For laminar Flow |  |  |  | | Depends on the Constant Condition () | | For Turbulent Flow |  | 1. For Relatively Smooth pipe 2. is relatively law. E.g. Blasius Equation. | | |  | |  | 1. Rough pipe 2. High | |  |  | |  | | | |

**FLOW THROUGH DUCT:** A conduit having non circular cross section is known as duct. E.g. AC duct, Etc…

|  |  |  |
| --- | --- | --- |
|  | Characteristic Length of Flow/ Hydraulic Diameter: | **NOTE:** The working fluid through a pipe is mostly a liquid whereas the working fluid through a duct is mostly gaseous. |

**MINOR LOSSES:** Losses in flow due to abrupt change in the geometry of flow are known as minor losses. It’s generally in the range of 5%-10% of major losses. E.g. Sudden Expansion/ Contraction, Bends, Fittings, Etc…

**PHYSICS BEHIND MINOR LOSSES:**

Real flow takes place from higher total head to lower total head. For boundary Stream lines, the total head is almost in the form of pressure head and flow should take place from higher pressure head to lower pressure head. For adverse pressure gradient minor losses takes place.

**SUDDEN EXPANSION LOSSES:**

|  |  |  |  |
| --- | --- | --- | --- |
| From continuity equation,  From momentum equation,   |  |  | | --- | --- | |  |  |   From Bernoulli’s equation, | MINOR HEAD LOSSES IN PIPE FLOW - Mechanical engineering concepts and  principles |

If Coefficient of loss is given directly use the formula.

|  |  |  |  |
| --- | --- | --- | --- |
|  | |  | |
| **SUDDEN CONTRACTION LOSS:** |  | **ENTRY LOSS:** | 8 pipe note 3 |
| **LOSSES IN BENDS & FITTINGS:** |  | Simulation of secondary flow in lubrication pipe with end bends of an Aero  engine | |

|  |  |
| --- | --- |
| **CONNECTIONS IN PIPE SYSTEM** | |
| **SERIES CONNECTION** | **PARALLEL CONNECTION** |

**ASSUMPTIONS:**

1. Minor Losses are neglected unless the problem specifies them to be considered.
2. Flow is assumed to be turbulent.

**EQUIVALENT PIPE:**

A single pipe which can replace a system of pipes such that it creates the same discharge and head loss.

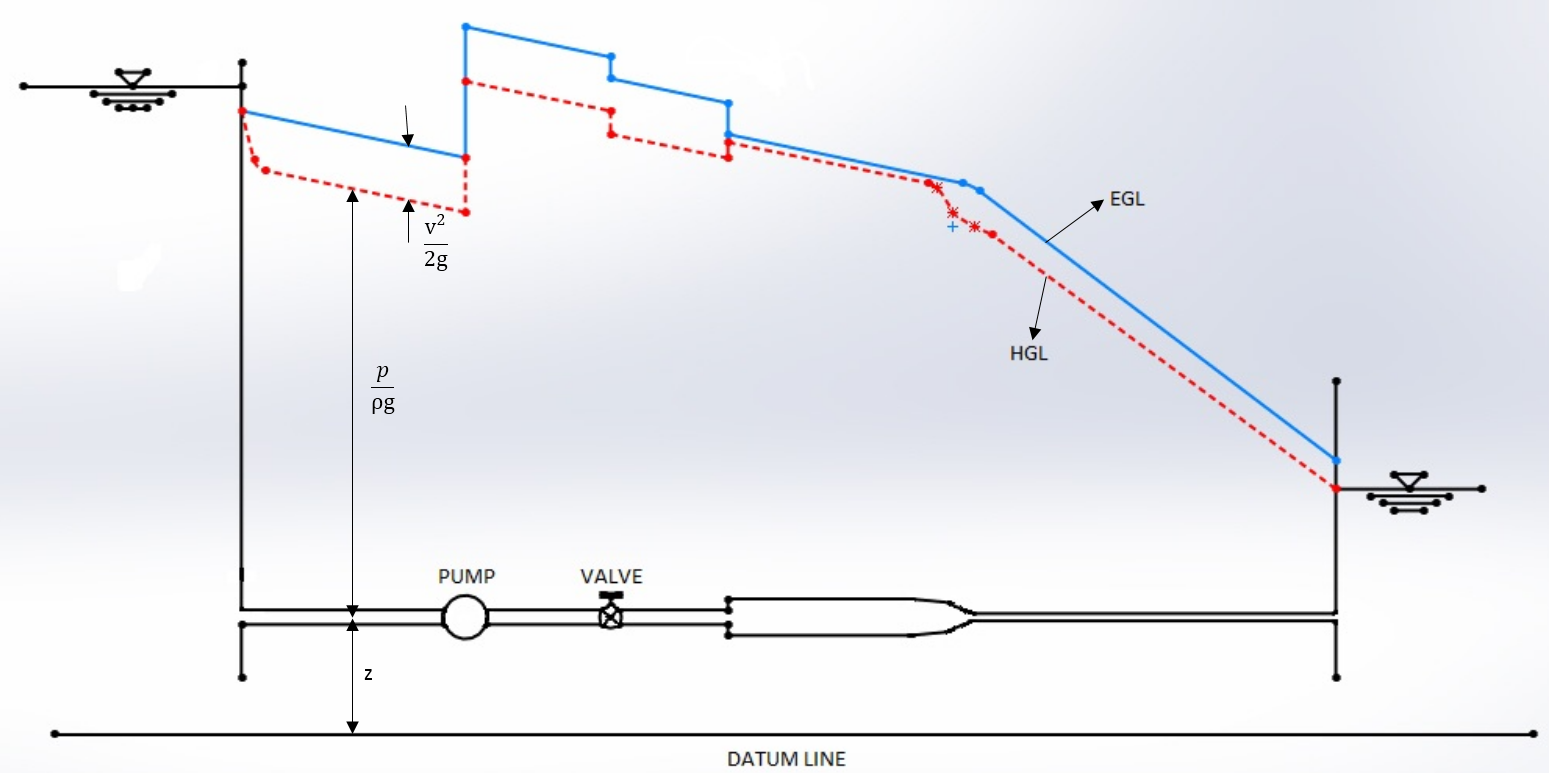
**ANALYSIS OF PIPES IN SERIES:** Discharges remains same.

|  |  |
| --- | --- |
| Each Pipe have  From continuity equation,  From Energy Balance,  By converting into head, | FLOW THROUGH PIPES IN SERIES AND PARALLEL - Mechanical engineering concepts  and principles |

**ANALYSIS OF PARALLEL CONNECTION:** Head Loss remains same.

|  |  |
| --- | --- |
| Each Pipe have  From continuity equation,  From Energy Balance,  By converting into head, | **C:\Users\Shiv\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.MSO\A2247384.tmp** |

|  |  |
| --- | --- |
| **GRADE LINES** | |
| **ENERGY GRADE/ TOTAL ENERGY LINE** | **HYDRAULIC GRADE LINE** |
| The locus of total head throughout a flow. | The locus of piezometric head throughout a flow. |



1. The difference between EGL and HGL is velocity head.
2. HGL is always below EGL except when velocity is Zero (HGL=EGL).
3. HGL can move up or down. EGL moves down due to head loss or Turbine Work. EGL moves up only if a pump or external energy source is involved.
4. In the case of a uniform diameter pipe, HGL and EGL must be parallel (Identical slopes).
5. The slopes of HGL and EGL need not be dependent on the slope of axis of flow.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **FLOW THROUGH SYPHON:**   |  |  |  | | --- | --- | --- | | FlowBelow HGL | FlowAbove HGL | Flowon HGL | |  |  |  |  * Reducing the length of uphill pipe is favourable to overcome cavitation. * If working fluid is water. * If the height between HGL & Corresponding position in flow greater than of water, cavitation takes place. | Siphon-Definition, Working Principle, Uses or Application, PDF |

**BRANCHING OF PIPES:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| WORKING RULES:   1. Flow takes place from higher to lower . 2. Minor losses are neglected.  |  | | --- | |  | |  | | |  |  | | --- | --- | | If Towards | If Towards | |   **Now, Apply Bernoulli’s Equation between J and Other Point.** | An iterative algorithm for initializing the flow in a pipe system with more  reservoirs | Semantic Scholar |

**PIPE NETWORK:**

**Rule-I:** Find For All nodes

**Rule-II:** Net Head loss in a loop is equal to zero. Give Any Clockwise and anticlockwise sign convention.

**HYDRAULIC POWER:** Power of the fluid available at the inlet of the turbine is called Hydraulic Power.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  | | --- | --- | |  |  | |  | | |  | |   Here,   |  |  | | --- | --- | |  |  | |  | |   **CONDITION FOR MAXIMUM POWER:**   |  |  | | --- | --- | |  | From the Darcy Equation, |   By differentiating w. r. t. , is maximum at | GROSS HEAD NET HEAD AND EFFICIENCY OF TURBINE - Mechanical engineering  concepts and principles |
| **DIAMETER AT THE EXIT OF NOZZLE FOR MAXIMUM :**   |  |  | | --- | --- | | By the Bernoulli’s Equation & Condition for Maximum Power & Darcy Equation, |  | | By using Continuity Equation, |  | | Where, Diameter & Velocity of Jet | Diameter & Velocity in the Pan Stoke | | |

|  |  |
| --- | --- |
| **PUMPING POWER:**  From the Bernoulli’s Eq.,  CASE-I: Ideal Pumping Power ()  CASE-II: Actual Pumping Power | CENTRIFUGAL PUMP PREPARED BY:- DEV MAKATI( ) KEVAL MAKWANA( ) - ppt download |

**MISCELLANEOUS PROBLEMS**

|  |  |  |  |
| --- | --- | --- | --- |
| |  |  | | --- | --- | |  |  |   By integrating above equation from ,  **If the Flow takes in reverse direction, Above Formula can be used.** |  |
| |  |  | | --- | --- | |  |  |   By integrating above equation from , |  |

**WATER HAMMERING:** When a valve is closed, then the sudden drop in KE creates compressible pressure wave propagating in the direction against the flow. The striking on the wall by this pressure is known as water hammer. It’s Examples of compressible fluid experience compressible flow. By using **Surge Tank,** we can avoid water hammering.

Here, Rise in Pressure

|  |  |
| --- | --- |
| **CRITICAL TIME OF CLOSURE :**  The time taken by the pressure wave to propagate back & forth the length of penstock. |  |
| **ACTUAL TIME OF CLOSURE :** Actually,Time taken for closing time. | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **TYPE OF CLOSURE** | | | | | |
| **GRADUAL CLOSURE** | | **SUDDEN CLOSURE** | | | |
|  | |  | | | |
|  | | 1. Penstock is rigid (E is not given) | | 1. Elastic Penstock (E is given) | |
|  | |  | | | |
|  | |  | |  | |
| Where | Dia. of Penstock | | Young’s Modulus of Penstock | | Thickness of Penstock |