SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution
Coimbatore-35

Department of Civil Engineering

23CEB203- MECHANICS OF FLUIDS AND MACHINERY

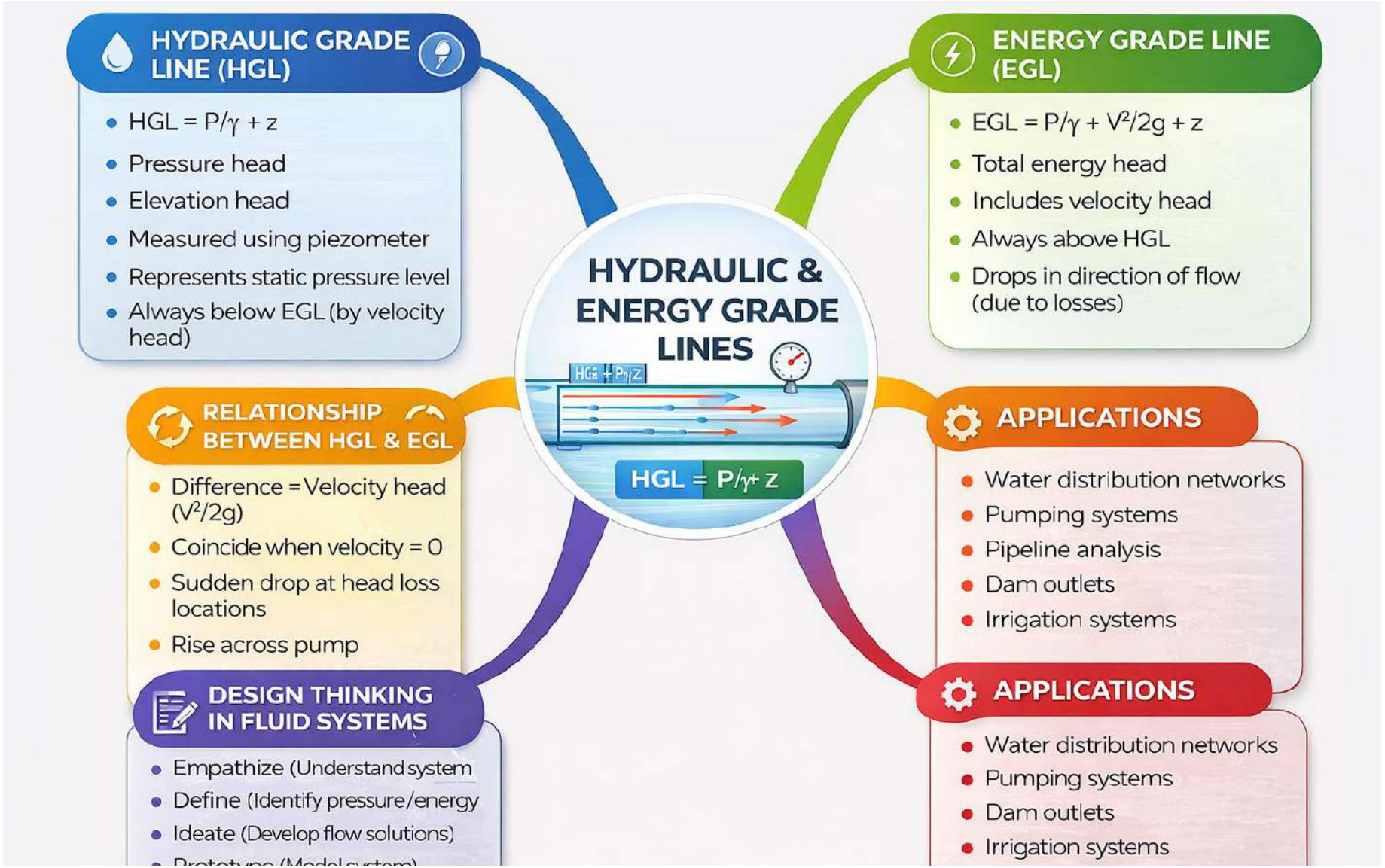
II B.E CIVIL/ IV SEMESTER

UNIT III : FLOW THROUGH PIPES

Topic 2 : Hydraulic and Energy gradient line

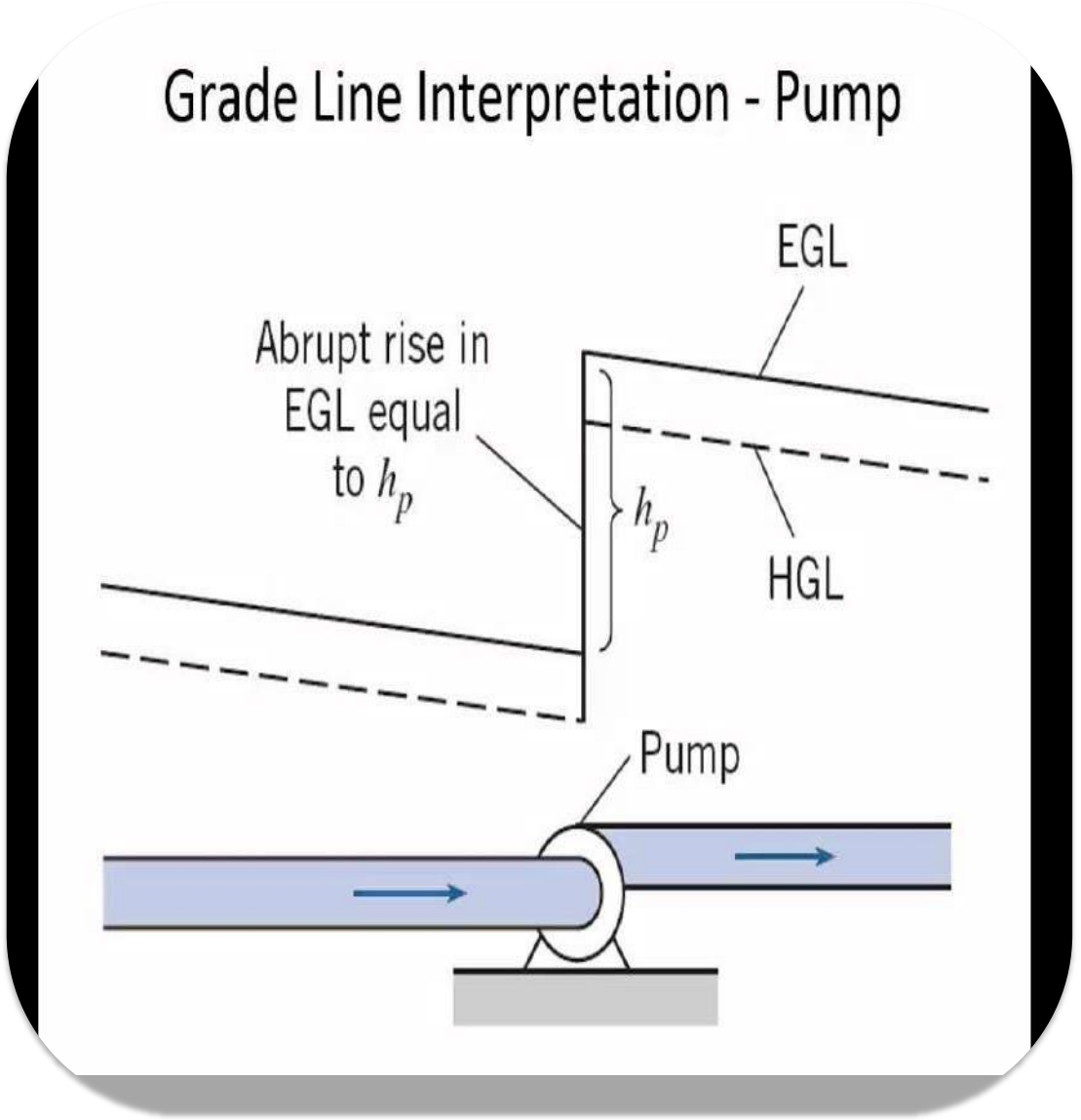
- Fluid properties (density, specific weight, viscosity)
- Pressure & pressure head
- Fluid statics (Hydrostatic law)
- Bernoulli’s equation
- Types of head (P/γ, $V^2/2g$, z)
- Flow through pipes & head losses

Mind Map: Hydraulic & Energy Gradient Lines



Introduction

- Hydraulic Grade Line (HGL) and Energy Grade Line (EGL) are fundamental concepts in fluid mechanics
- Visualize energy and pressure distribution in fluid systems
- Essential for designing and analyzing pipe networks, pumps, and water distribution systems
- Help identify pressure management issues and prevent system failures



Hydraulic Grade Line (HGL)

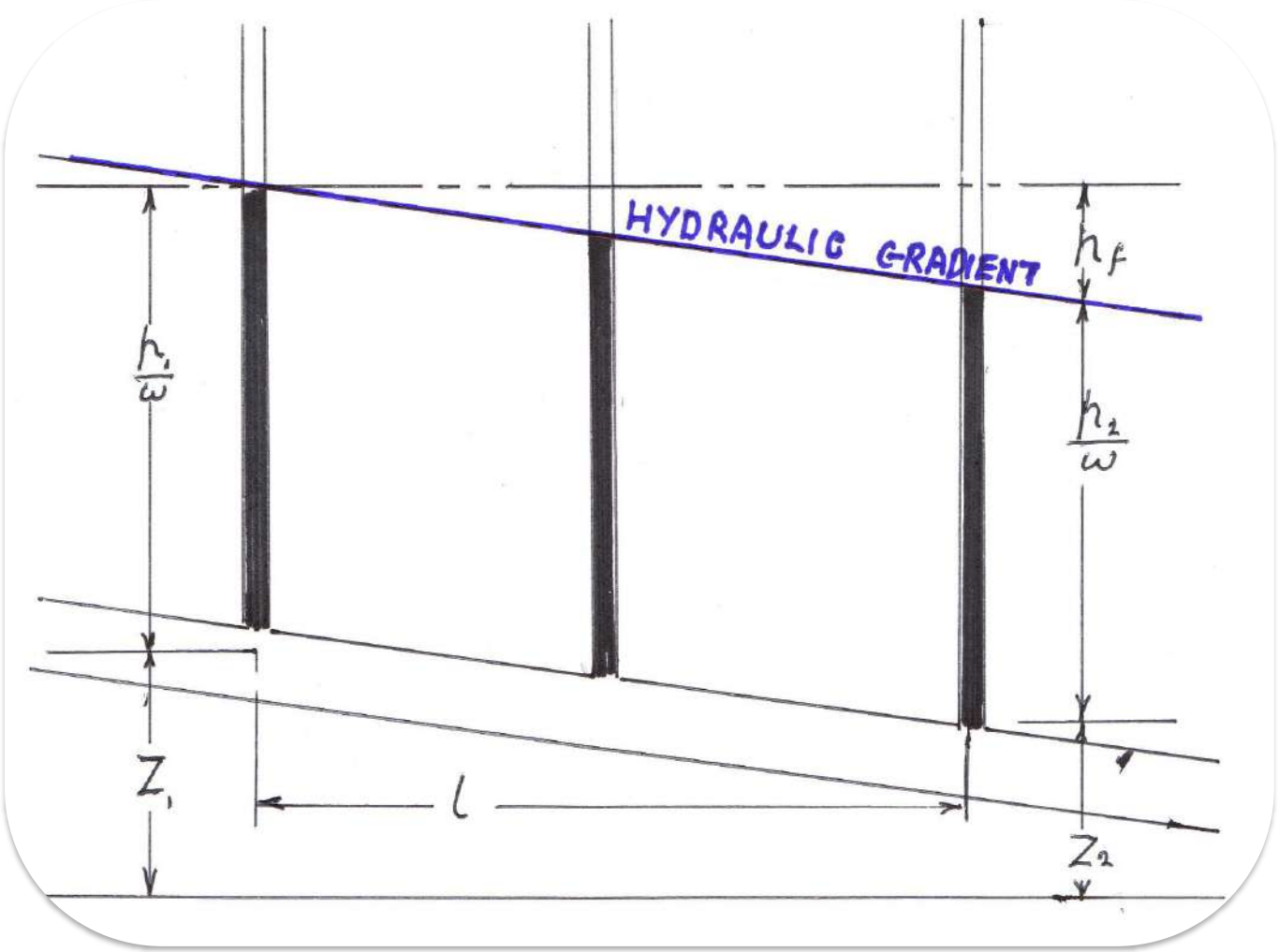
Definition

Height to which liquid rises from pressure tap

Formula

$$HGL = P/\gamma + z$$

P = Pressure
γ = Specific weight
z = Elevation head



Energy Grade Line (EGL)

- **Definition**

  Total energy head of flowing water

- **Formula**

  $EGL = P/\gamma + V^2/2g + z$

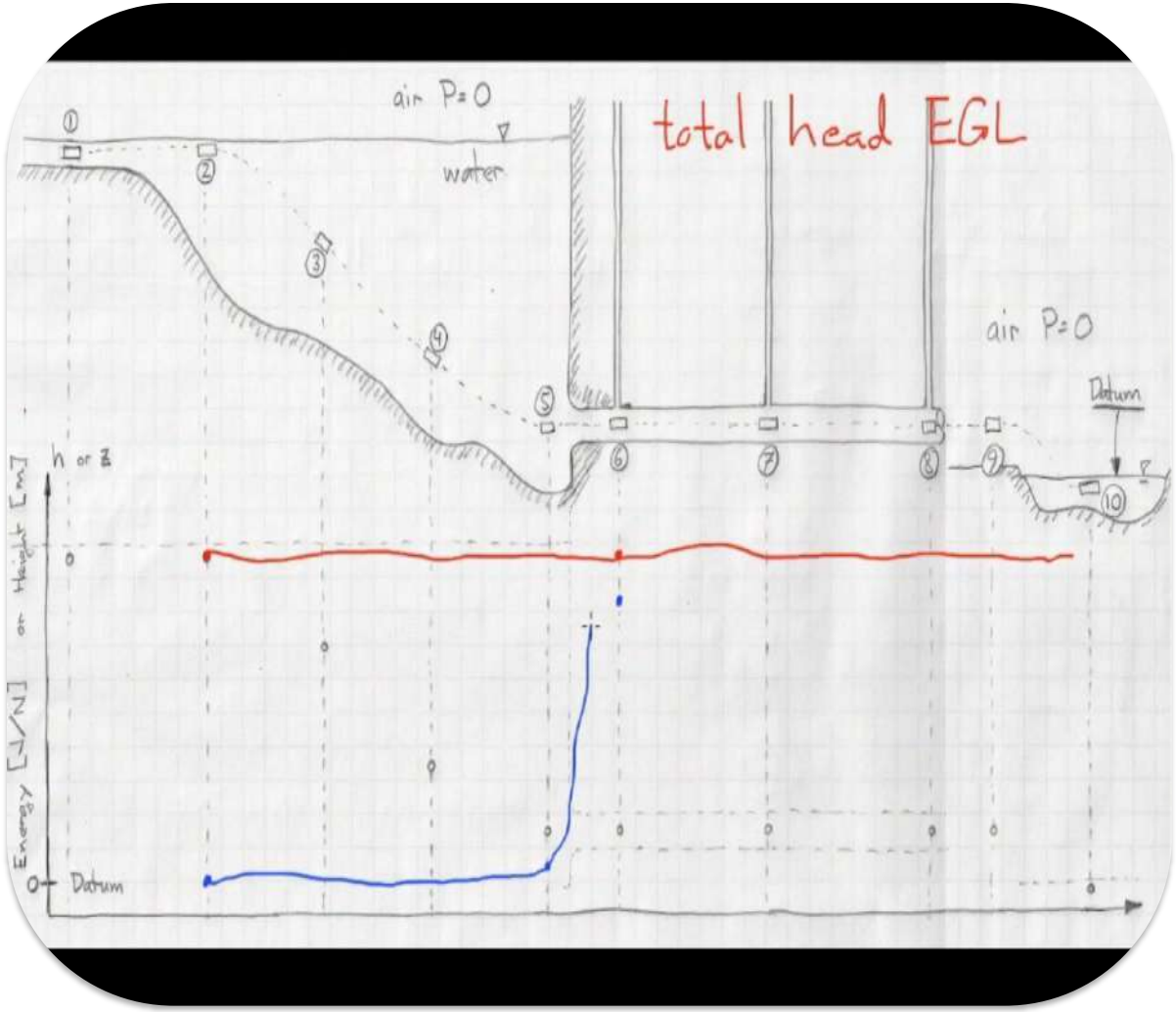
  P = Pressure

  γ = Specific weight

  V = Velocity

  g = Gravity

  z = Elevation head



Relationship between HGL and EGL

Key Relationship

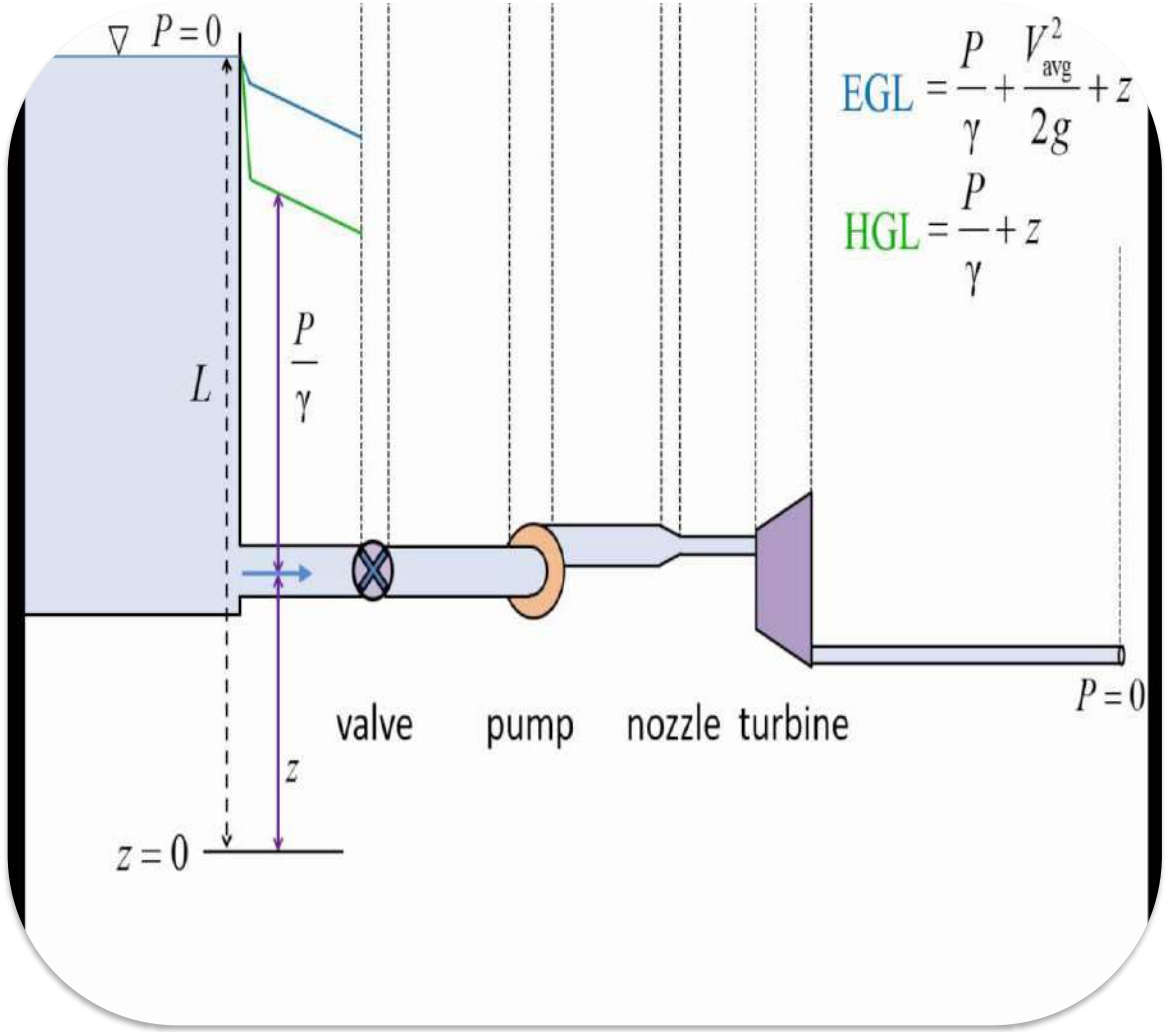
EGL = HGL + V²/2g

Energy Losses

- Pipe friction
- Fittings and bends
- Valves and meters

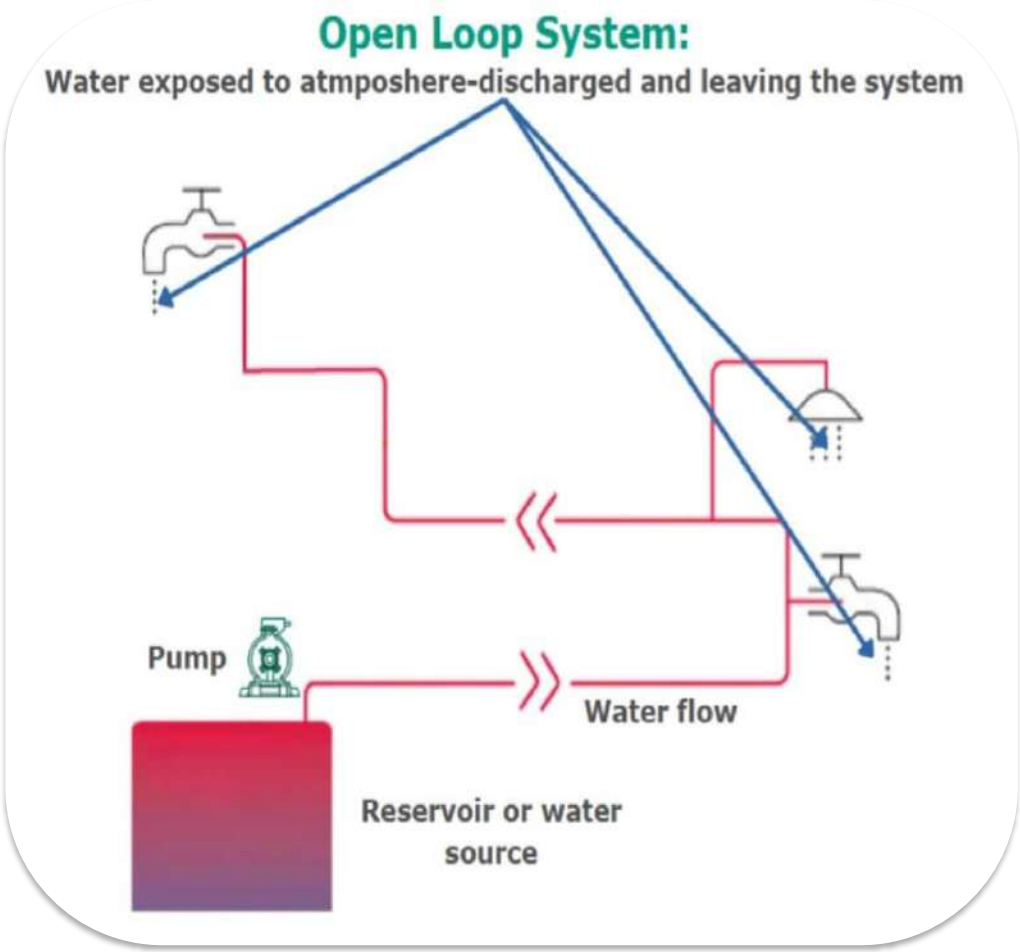
Note

EGL always lies above HGL except where V = 0



Applications - Part 1

- **Water Distribution Systems**
  Design and analysis of municipal water networks
- **Pressure Management**
  Monitor and control pressure throughout system
- **Pipeline Protection**
  Prevent damage from excessive pressure or cavitation
- **Reliable Supply**
  Ensure consistent water delivery to consumers



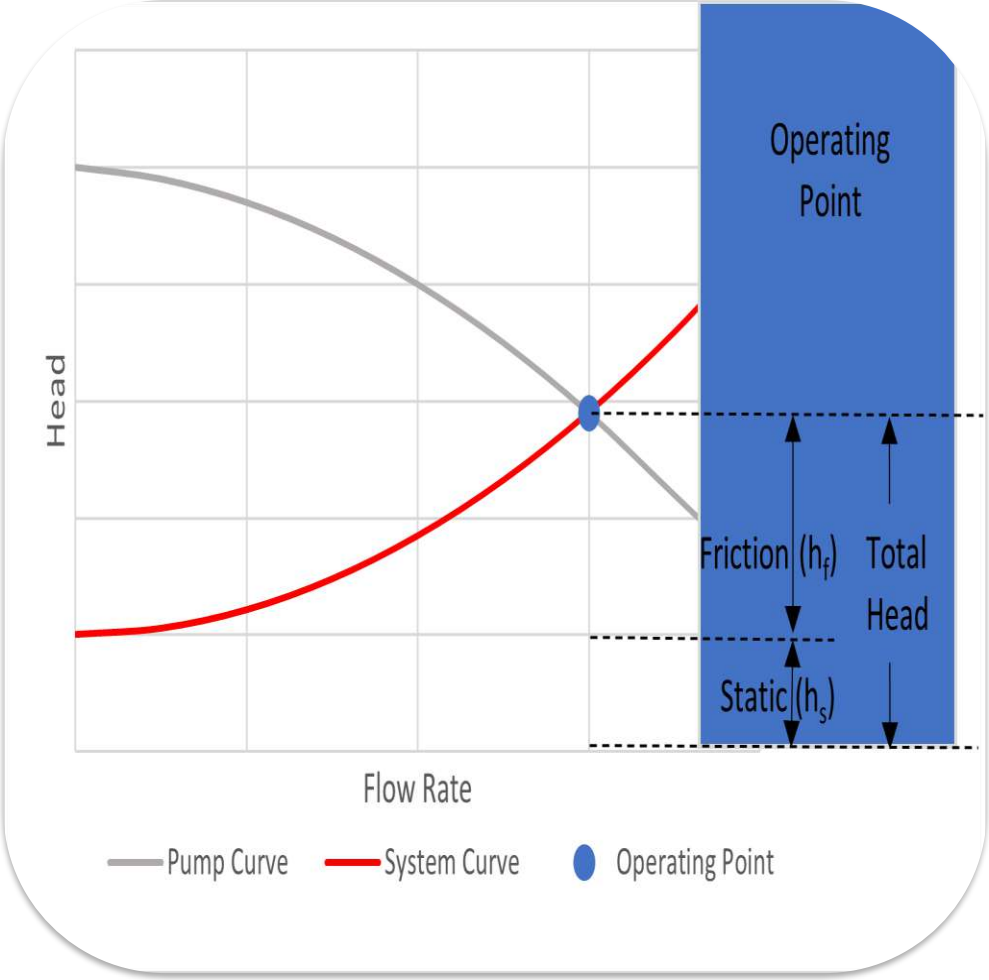
Applications - Part 2

Pipeline Design
Optimize diameter and layout for efficient flow

Pump Selection
Proper sizing and type selection for system requirements

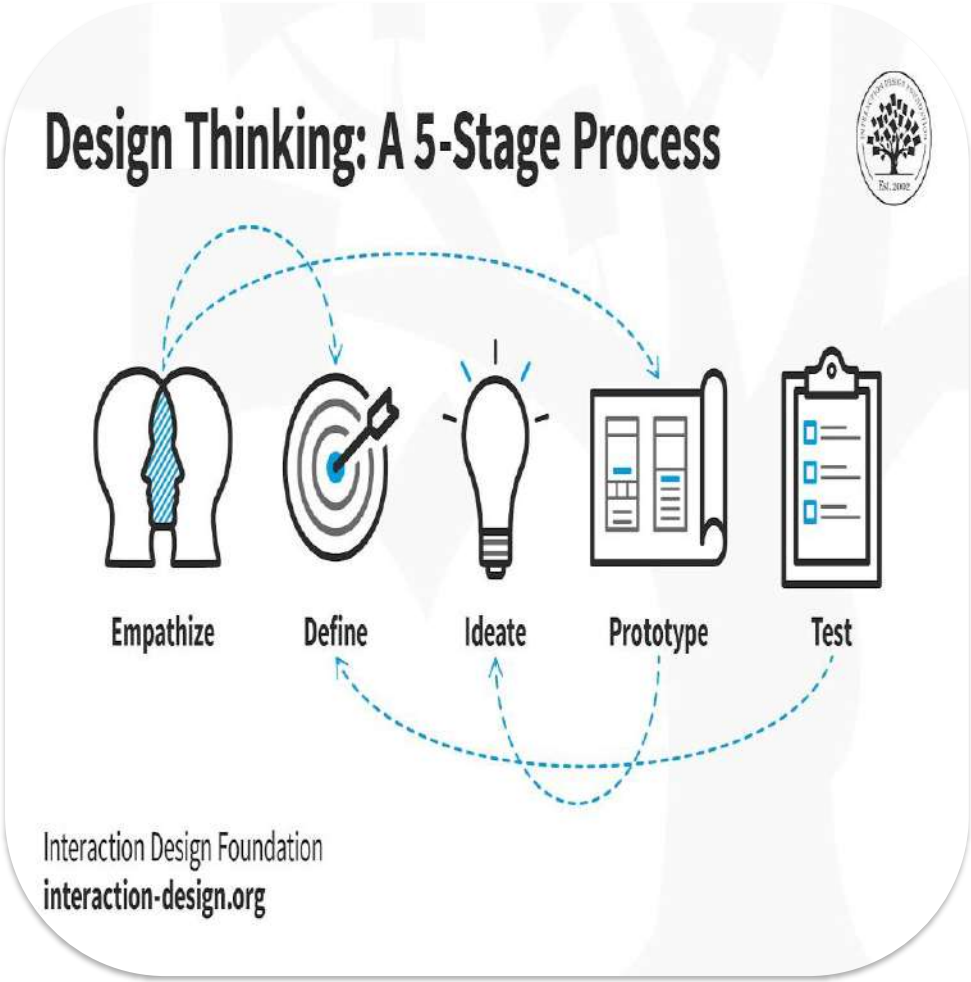
Long-Distance Transport
Analyze energy losses across extensive pipeline networks

System Analysis
Evaluate hydraulic performance and identify issues



Design Thinking - Empathize

- **Understand Challenges**
  Identify fluid system problems and constraints
- **User Needs**
  Assess water system requirements and expectations
- **Stakeholder Perspectives**
  Consider engineers, operators, and end-users
- **Observe Systems**
  Study real-world hydraulic installations



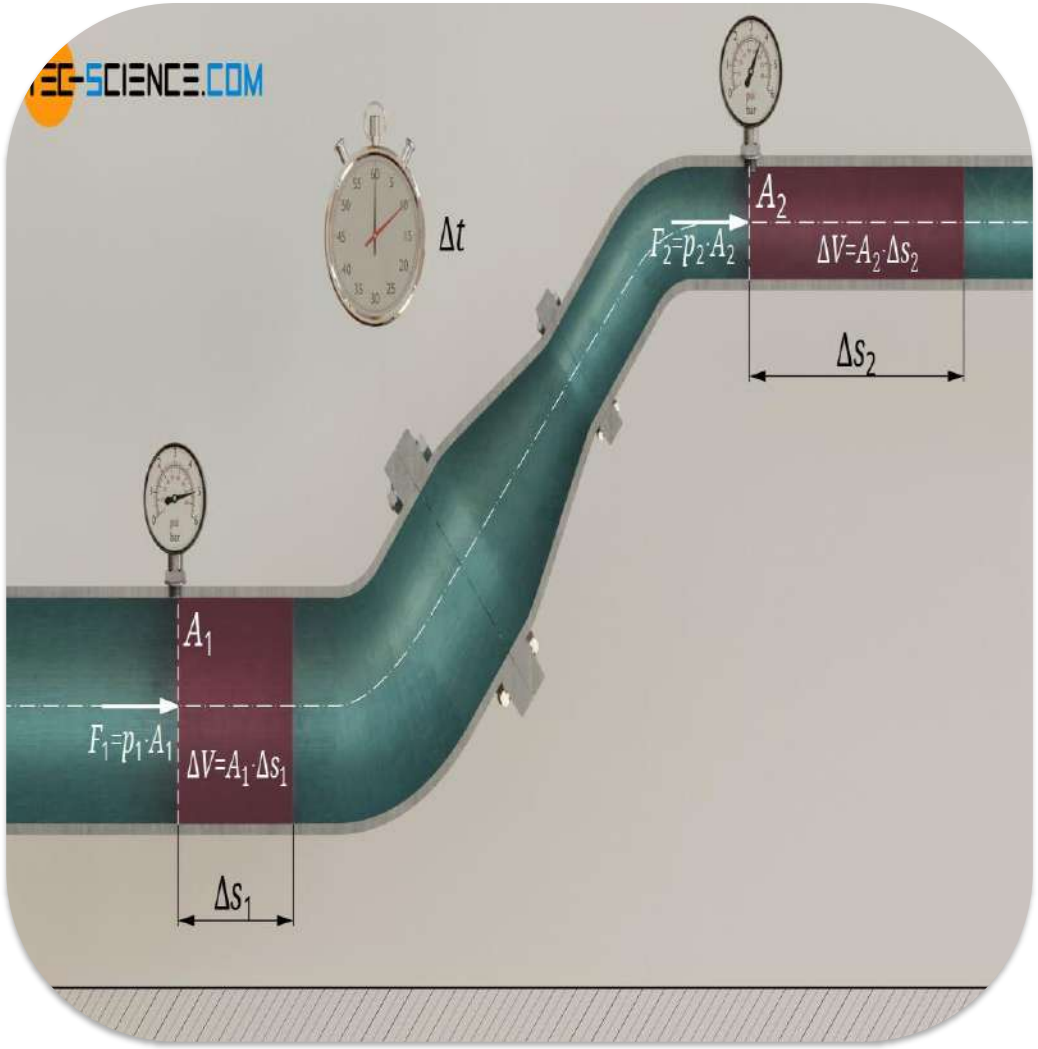
Design Thinking - Define

Problem Identification
Clearly state hydraulic challenges and issues

Pressure Issues
Analyze pipeline pressure distribution problems

Specify Requirements
Define system performance criteria and needs

Scope & Constraints
Establish boundaries and limitations for solution



Design Thinking - Ideate

Generate Solutions
Develop innovative approaches for fluid systems

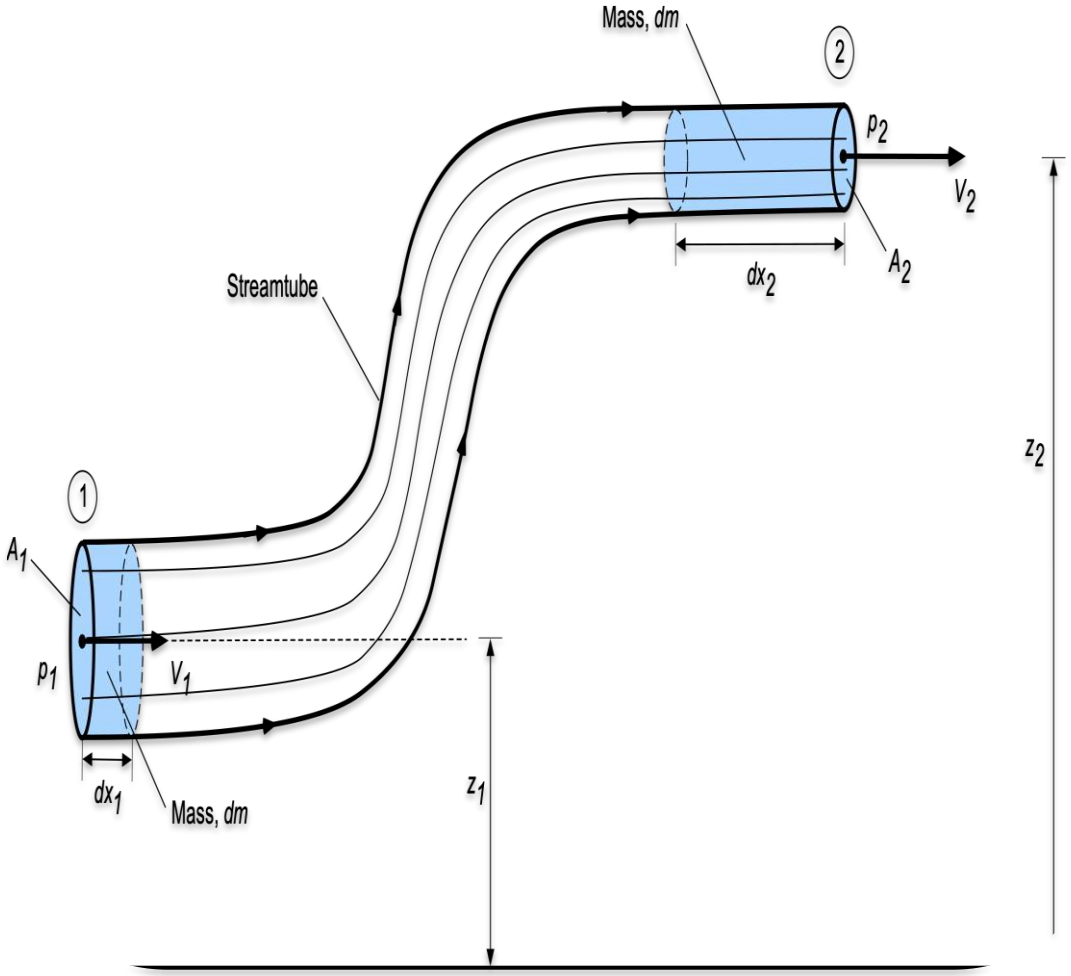
Alternative Methods
Explore different hydraulic design options

Brainstorming
Creative idea generation without constraints

Pumping Strategies
Design efficient energy-saving solutions

Design Thinking - Prototype

- **Model HGL & EGL**
  Create visual representations of energy lines
- **System Simulation**
  Use software to analyze hydraulic performance
- **Create Models**
  Build physical or computational prototypes
- **Test Assumptions**
  Validate design principles and calculations



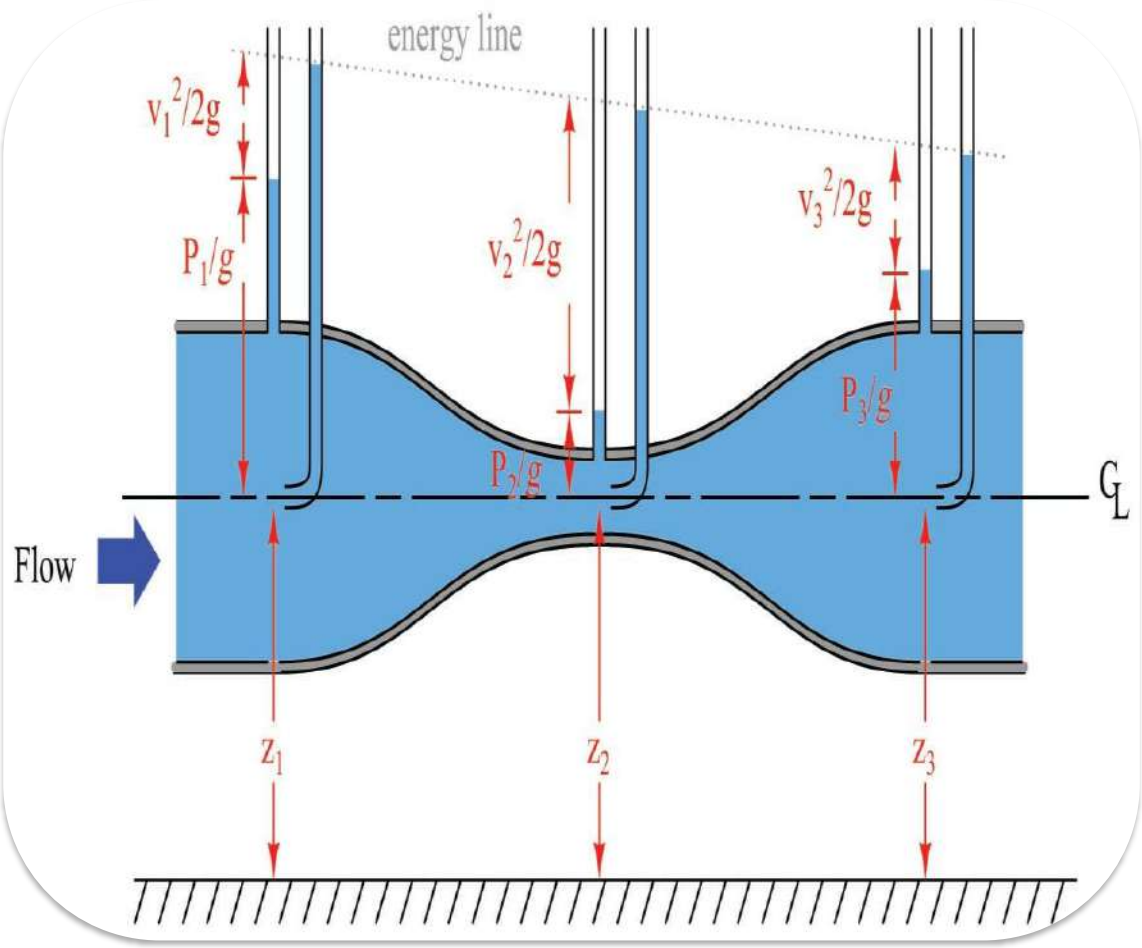
Design Thinking - Test

Analyze Systems
Evaluate fluid flow and energy distribution

Verify Solutions
Confirm design meets all requirements

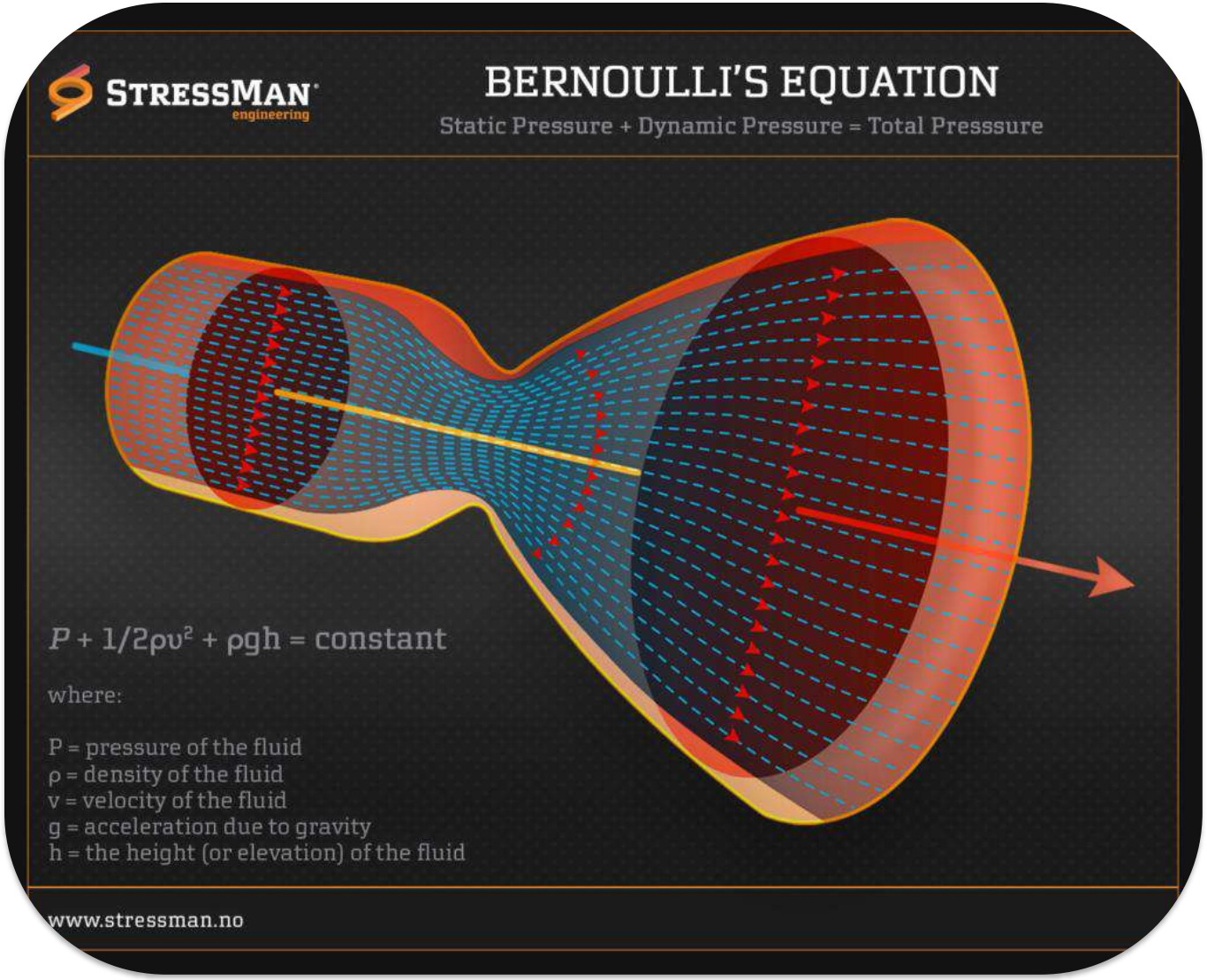
Performance Evaluation
Measure efficiency and effectiveness

Refine Designs
Optimize based on test results



Recap

- **Hydraulic Grade Line**
  HGL = P/γ + z
  Pressure elevation head
- **Energy Grade Line**
  EGL = P/γ + V²/2g + z
  Total energy head
- **Key Relationship**
  EGL = HGL + V²/2g
  Velocity head connects the lines
- **Applications**
  - Water distribution systems
  - Pipeline design & analysis
  - Pump selection & sizing



Summary and Conclusion

- **Fundamental Concepts**
  HGL and EGL are essential tools in fluid mechanics
- **System Design**
  Critical for efficient fluid system design
- **Design Thinking**
  Enhances problem-solving capabilities
- **Practical Applications**
  Water distribution, pipelines, pump systems
- **Future Directions**
  Smart water management and IoT integration

Assessment - Quiz

1. **The difference between EGL and HGL at any section of a pipe equals:**

A) Pressure head

B) Elevation head

C) Velocity head

D) Head loss

✓ **Answer: C**

2. In a pipe with increasing diameter (diffuser), velocity decreases. What happens to HGL?

A) Decreases

B) Increases

C) Remains same

D) Becomes zero

✓ **Answer: B**