VISUALIZATION OF ENERGY EQUATION

HYDRAULIC GRADE LINE:
• Pressure head + elevation head \( \left( \frac{p}{\gamma} + z \right) \)
• Measured by piezometers

ENERGY LINE:
• Total head: Pressure head + elevation head + velocity head, \( \left( \frac{p}{\gamma} + z + \frac{V^2}{2g} \right) \)
• Measured by pitot tube

1. difference between EL and HGL = \( \left( \frac{V^2}{2g} \right) \)

2. EGL slopes towards flow due to losses.
• Pump

Note:
- Jump in EGL and HGL at pump
- HGL parallel to EGL
- EGL and HGL slope downwards towards flow directions.
• Turbine

A to B
• EGL slopes down (direction of flow)
• HGL is parallel to EGL (constant diameter pipe)
• Note slope of EGL is NOT slope of pipe

At B
• Turbine
• EGL and HGL drop down

B to C
• EGL slopes down (direction of flow)
• Gradual expansion, so velocity head is constantly decreasing, velocity head is converting to pressure head, hence HGL approaches EGL.
• **Nozzle**

![Diagram of nozzle with EGL, HGL, and velocity head](image)

**A to B**

- EGL slopes down (direction of flow)
- HGL parallel to EGL (constant diameter pipe)

**B to C**

- Pipe diameter decreases so velocity head increases, hence HGL is lowered
• Changing pipe diameter and abrupt expansion
• Pipe is above HGL

• HGL coincides with system when pressure = 0

\[(p/\gamma) = 0\]

• If HGL falls below pipe, \(p/\gamma\) is negative

\[(\gamma \text{ is always positive, so pressure is negative} \rightarrow \text{vacuum or pressure is below atmospheric})\]