Liquid Hydrogen Regulated Low Pressure High Flow Pneumatic Panel AFT Arrow Analysis

Project Definition: Design a high flow pneumatic regulation panel to be used with helium and hydrogen. The panel will have two circuits, one for gaseous helium (GHe) supplied from the GHe Movable Storage Units (MSUs) and one for gaseous hydrogen (GH2) supplied from an existing GH2 Fill Panel. The helium will supply three legs, to existing panels and on the higher pressure leg and Simulated Flight Tanks (SFTs) for the lower pressure legs. The hydrogen line will pressurize a 33,000 gallon vacuum jacketed vessel.

Pressure Drop Comparison

\[
\text{friction factor } \frac{1}{D} = \frac{2}{D} \left( \frac{\Delta P}{Q^2} \right)
\]

Velocity: \( v = \frac{Q}{\pi D^2} \)

- Q is the actual flow rate of the fluid: acfm = scfm
- pipe head loss: \( h_p = \frac{D}{L} \frac{Q^2}{2g} \)
- component loss: \( h_c = \frac{K}{V} \) where \( K = \frac{g}{c^2} \)

Multiply the head losses by the density to get the delta pressure (psid).

\[
P_{\text{out}} = P_{\text{in}} - \text{pipe loss} - \text{component loss} - \text{fitting loss} - \text{pump loss} - \text{elevation}
\]

***Elevation, fitting (where the design is now), and pump losses assumed to be zero.

Temperature increases therefore pressure increases.

Helium Operation

Hydrogen Operation

Purge - Used to validate that adequate flow is purging the hydrogen line.

Failed Hydrogen Regulator

Flow rate Results

- Failed Regulator - Used to validate relief valve size if the regulator fails open.

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