EARS Tool Pressure Drop Calcs

BJS Apr 23 2007

Constants

$$\text{toolReqFlow} := 8\frac{\text{ft}^3}{\text{min}}$$

$$\text{toolSupplyP} := 90\text{psi}$$

$$\text{toolExhaustP} := 15\text{psi}$$

$$\text{hoseLength} := 20\text{ft}$$

$$\text{supplyRho} := 0.505\frac{\text{lb}}{\text{ft}^3}$$ Crane manual, air density at 90psi, 90 degF

$$\text{exhaustRho} := 0.119\frac{\text{lb}}{\text{ft}^3}$$ Crane manual, air density at 10psi, 90 degF

$$\text{mu} := 1.78\cdot 10^{-5}\text{Pa}\cdot\text{s}$$ Crane manual, air viscosity at 90degF

$$\text{hoseID} := 0.25\text{in}$$

$$\text{roughness} := 0.0015\text{mm}$$ For rubber straight hose

$$\text{standardP} := 14.7\text{psi}$$

$$\text{standardT} := 520\text{R}$$

$$\text{roomT} := 550\text{R}$$

Formulas

$$\text{dP}(\text{ff},\text{rho},\text{L},\text{d},\text{v}) := \text{ff}\cdot\frac{\text{L}}{\text{d}}\cdot\frac{\text{rho}\,\text{v}^2}{2}$$ Darcy Weisbach Eq.

$$\text{Re}(\text{d},\text{v},\text{rho},\text{mu}) := \frac{\text{d}\cdot\text{v}\cdot\text{rho}}{\text{mu}}$$ Reynolds Number

$$\text{actualFlow}(\text{P},\text{T},\text{standardFlow}) := \frac{\text{standardP}}{\text{standardP}+\text{P}}\cdot\frac{\text{T}}{\text{standardT}}\cdot\text{standardFlow}$$

$$\text{velocity}(\text{actualFlow},\text{hoseID}) := \frac{\text{actualFlow}\cdot 4}{\pi\cdot(\text{hoseID})^2}$$

Calcs

$\text{supplyFlow} := \text{actualFlow}(\text{toolSupplyP}, \text{roomT}, \text{toolReqFlow})$ $\text{supplyFlow} = 1.188 \frac{ft^3}{min}$

$\text{exhaustFlow} := \text{actualFlow}(\text{toolExhaustP}, \text{roomT}, \text{toolReqFlow})$ $\text{exhaustFlow} = 4.188 \frac{ft^3}{min}$

$\text{supplyV} := \text{velocity}(\text{supplyFlow}, \text{hoseID})$ $\text{supplyV} = 58.085 \frac{ft}{s}$

$\text{exhaustV} := \text{velocity}(\text{exhaustFlow}, \text{hoseID})$ $\text{exhaustV} = 204.763 \frac{ft}{s}$

$\text{supplyRe} := \text{Re}(\text{hoseID}, \text{supplyV}, \text{supplyRho}, \text{mu})$ $\text{supplyRe} = 5.109 \times 10^{4}$

$\text{exhaustRe} := \text{Re}(\text{hoseID}, \text{exhaustV}, \text{exhaustRho}, \text{mu})$ $\text{exhaustRe} = 4.244 \times 10^{4}$

$\text{relRoughness} := \frac{\text{roughness}}{\text{hoseID}}$ $\text{relRoughness} = 2.362 \times 10^{-4}$

From the moody diagram, the friction factor is about the same for supply & exhaust

$\text{ff} := 0.025$

$\text{supplyHoseDP} := \text{dP}(\text{ff}, \text{supplyRho}, \text{hoseLength}, \text{hoseID}, \text{supplyV})$

$\text{exhaustHoseDP} := \text{dP}(\text{ff}, \text{exhaustRho}, \text{hoseLength}, \text{hoseID}, \text{exhaustV})$

$\boxed{\text{supplyHoseDP} = 4.413\,\text{psi}}$

$\boxed{\text{exhaustHoseDP} = 12.923\,\text{psi}}$