# TRANSFER LINE HEAT LOSSES

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Heat Flux Through a Pipe in the Radial Direction, per unit surface area

$$q_R = \frac{k}{R}\left[\frac{T_2 - T_1}{\ln\left(\frac{r_2}{r_1}\right)}\right] \tag{1}$$

Multiply by Surface Area

$$Q = A \cdot q_R = 2\pi LR \cdot \frac{k}{R}\left[\frac{T_2 - T_1}{\ln\left(\frac{r_2}{r_1}\right)}\right] = 2\pi Lk\left[\frac{T_2 - T_1}{\ln\left(\frac{r_2}{r_1}\right)}\right] \tag{2}$$

Length of the Transfer Line (from drawing E-358)

$$L = 28.2 \text{ m} \tag{3}$$

Heat Transfer Coefficient for MLI (based on paper by Spradley, Nast, Frank)

$$k = C_1 N^{1.56}(T_{\text{hot}} + T_{\text{cold}}) + \frac{C_2\epsilon(T_{\text{hot}}^{4.67} + T_{\text{cold}}^{4.67})}{N(T_{\text{hot}} + T_{\text{cold}})} \tag{4}$$

Some of the values we have

- $C_1 = 4.48 \times 10^{-12}$
- $C_2 = 5.40 \times 10^{-14}$
- $\epsilon = 0.03$
- Layer Thickness = 0.019mm
- $N = 52$ layers per cm
- $T_{\text{hot}} = 300\text{K}$
- $T_{\text{cold}} = 80\text{K}$ or 4.5K.
- $r$ (inner) = 1"
- $r$ (outer) = 1" + Layer Thickness × Number of Layers

Table 1. Results: heat losses (W) in the cryoline

| | Helium | Nitrogen |
|---|---|---|
| 10 layers | 50.72 | 46.62 |
| 25 layers | 21.34 | 19.62 |
| 45 layers | 12.61 | 11.59 |

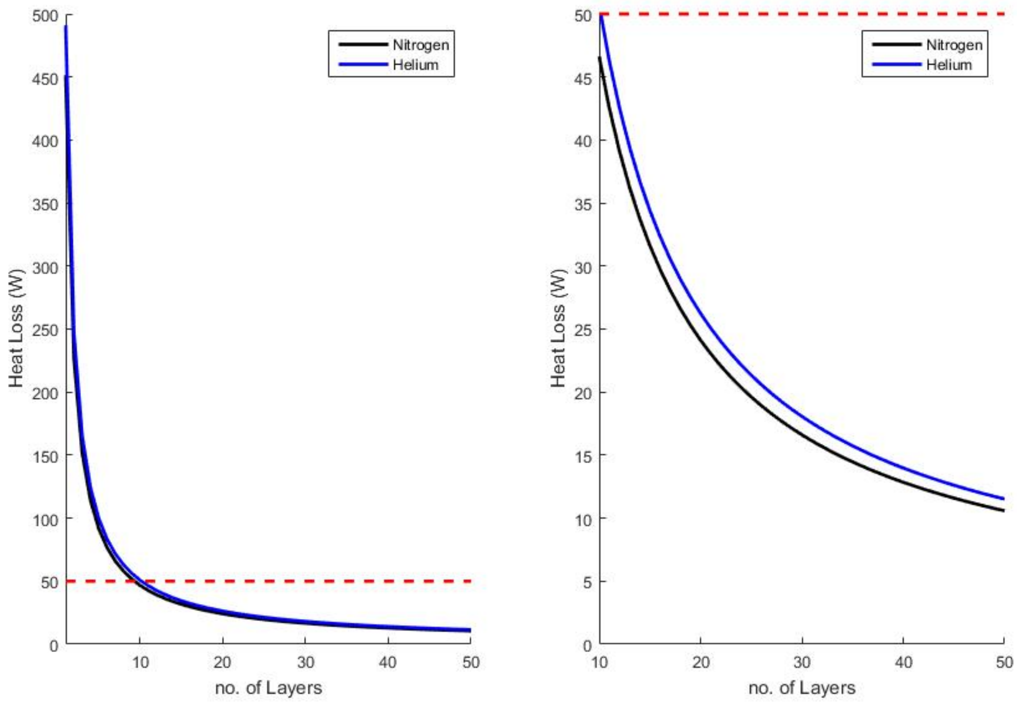


Figure 1. Heat Losses as a Function of no. of Layers.