High Vacuum System Engineering Calculations
2.75" Conflat High Vacuum System
Design Iteration #2
Transitional Flow with Argon at 20C

CONDUCTANCE CALCULATIONS – TRANSITIONAL FLOW
(For Use with Argon Plasma Systems and System Purging @ 10^-2 Torr)

1.) Diffusion Pump
→ Max Pumping Speed of Diffusion Pump (Air) @ 10^-2 torr

→ $\boldsymbol{S_{diff(k)} = 100\ l/sec}$

2.) Transitional Flow Conductance for Diffusion Pump to 2.75" Conflat Adapter Plate
→ Conductance of Pipes in Transitional Flow

$$C_k = C_m(0.0736\frac{D}{\lambda} + \frac{1+1.25D/\lambda}{1+1.55D/\lambda})$$

C_k = transitional flow conductance
C_m = conductance for molecular flow = $C_{adapter}$ = 55.942 l/s
D = diameter (cm) = 3.556
λ = mean free path at average pressure (P=10^-2 torr) (cm) = 0.5
$\boldsymbol{C_k = 75.297\ l/sec}$

→ $\boldsymbol{C_{k(adapter)} = 75.297\ l/sec}$

3.) Transitional Flow Conductance for 2.75" Conflat Inline Poppet Valve
→ Conductance of Pipes in Transitional Flow

$$C_k = C_m(0.0736\frac{D}{\lambda} + \frac{1+1.25D/\lambda}{1+1.55D/\lambda})$$

C_k = transitional flow conductance
C_m = conductance for molecular flow = C_{poppet_valve} = 20.642 l/s
D = diameter (cm) = 3.556
λ = mean free path at average pressure (P=10^-2 torr) (cm) = 0.5
$\boldsymbol{C_k = 27.784\ l/sec}$

→ $\boldsymbol{C_{k(poppet\_valve)} = 27.784\ l/sec}$

4.) Transitional Flow Conductance for 2.75" Conflat Butterfly Valve
→ Conductance of Pipes in Transitional Flow

$$C_k = C_m(0.0736\frac{D}{\lambda} + \frac{1+1.25D/\lambda}{1+1.55D/\lambda})$$

C_k = transitional flow conductance
C_m = conductance for molecular flow = $C_{butterfly\_valve}$ = 36.810 l/s
D = diameter (cm) = 3.556
λ = mean free path at average pressure (P=10^-2 torr) (cm) = 0.5
$\boldsymbol{C_k = 49.546\ l/sec}$

→ $\boldsymbol{C_{k(butterfly\_valve)} = 49.546\ l/sec}$

5.) Transitional Flow Conductance for 2.75" Conflat 4-Way Cross

→ Conductance of Pipes in Transitional Flow

$$C_k = C_m(0.0736\frac{D}{\lambda} + \frac{1+1.25D/\lambda}{1+1.55D/\lambda})$$

C_k = transitional flow conductance

C_m = conductance for molecular flow = C_{cross} = 24.442 l/s

D = diameter (cm) = 3.556

λ = mean free path at average pressure (P=10^-2 torr) (cm) = 0.5

$\boldsymbol{C_k = 32.899\ l/sec}$

→ $\boldsymbol{C_{k(cross)} = 32.899\ l/sec}$

6.) Total System Conductance

→ **Conductance of Pipeline**

$$\frac{1}{C_{k(pipeline)}} = \frac{1}{C_{k(adapter)}} + \frac{1}{C_{k(poppet\_valve)}} + \frac{1}{C_{k(butterfly\_valve)}} + \frac{1}{C_{k(cross)}}$$

$$\frac{1}{C_{k(pipeline)}} = \frac{1}{75.297} + \frac{1}{27.784} + \frac{1}{49.546} + \frac{1}{32.899}$$

$$\boldsymbol{C_{k(pipeline)} = 10.015\ l/sec}$$

→ $\boldsymbol{C_{k(pipeline)} = 10.015\ l/sec}$

→ **Effective Pumping Speed of the System**

$$\frac{1}{S_{e(k)}} = \frac{1}{C_{k(pipeline)}} + \frac{1}{S_{diff(k)}}$$

$$S_{e(k)} = \frac{C_{k(pipeline)} \times S_{diff(k)}}{C_{k(pipeline)} + S_{diff(k)}}$$

$C_{k(pipeline)} = 8.737\ l/s$

$S_{diff(k)} = 100\ l/s$

$\boldsymbol{S_{e(k)} = 9.103\ l/s}$

→ $\boldsymbol{S_{e(k)} = 9.103\ l/sec}$