APPLIED ION SYSTEMS

High Vacuum Engineering Calculations

Integrated High Vacuum Test Stand - High Vacuum Pumping Assembly
System Conductance and Effective Speed - Transitional Flow with Argon at 20C, 10^-2 Torr

1.) Diffusion Pump

→ Max Pumping Speed of Diffusion Pump @ 10^-2 torr (derived Estimate for Argon)

→ $\boldsymbol{S_{diff(k)} = 98\ l/sec}$

2.) Transitional Flow Conductance for Diffusion Pump to Water Cooled Baffle Adapter (@ 20C)

→ 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 = $C_{baffle\_adapter}$ = 952.872 l/s

D = diameter (cm) = 12.70

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

$\boldsymbol{C_k = 2554.351\ l/sec}$

→ $\boldsymbol{C_{k(baffle\_adapter)} = 2554.351\ l/sec}$

3.) Transitional Flow Conductance for Water Cooled Baffle (@ 20C)

→ 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_{baffle} = 954.483 l/s

D = diameter (cm) = 18.415

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

$\boldsymbol{C_k = 3360.230\ l/sec}$

→ $\boldsymbol{C_{k(baffle)} = 3360.230\ l/sec}$

4.) Transitional Flow Conductance for Diffusion Pump to 6” 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 = $C_{adapter}$ = 590.580 l/s

D = diameter (cm) = 10.16

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

$$\boldsymbol{C_k = 1363.035\ l/sec}$$

→ $\boxed{\boldsymbol{C_{k(plate\_adapter)} = 1363.035\ l/sec}}$

5.) Total System Conductance

→ Conductance of Pipeline

$$\frac{1}{C_{k(pipeline)}} = \frac{1}{C_{k(baffle\_adapter)}} + \frac{1}{C_{k(baffle)}} + \frac{1}{C_{k(plate\_adapter)}}$$

$$\frac{1}{C_{k(pipeline)}} = \frac{1}{2554.351} + \frac{1}{3360.230} + \frac{1}{1363.035}$$

$$\boldsymbol{C_{k(pipeline)} = 702.867\ l/sec}$$

→ $\boxed{\boldsymbol{C_{k(pipeline)} = 702.867\ l/sec}}$

→ Effective Pumping Speed of the System

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

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

$$C_{k(pipeline)} = 702.867\ l/s$$

$$S_{diff(k)} = 98\ l/s$$

$$\boldsymbol{S_{e(k)} = 86.008\ l/s}$$

→ $\boxed{\boldsymbol{S_{e(k)} = 86.008\ l/sec}}$