APPLIED ION SYSTEMS

High Vacuum Engineering Calculations

Integrated High Vacuum Test Stand - High Vacuum Pumping Assembly

System Conductance and Effective Speed - Transitional Flow with Hydrogen at 20C, 10^-2 Torr

1.) Diffusion Pump

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

→ $\boldsymbol{S_{diff(k)} = 120\ l/sec}$

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 = $C_{baffle\_adapter}$ = 5998.626 l/s

D = diameter (cm) = 12.70

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

$\boldsymbol{C_k = 16080.433\ l/sec}$

→ $\boldsymbol{C_{k(baffle\_adapter)} = 16080.433\ l/sec}$

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} = 6008.771 l/s

D = diameter (cm) = 18.415

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

$\boldsymbol{C_k = 21153.708\ l/sec}$

→ $\boldsymbol{C_{k(baffle)} = 21153.708\ l/sec}$

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 = $C_{adapter}$ = 3717.886 l/s

D = diameter (cm) = 10.16

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

$$\boldsymbol{C_k = 8580.731\ l/sec}$$

→ $\boxed{\boldsymbol{C_{k(plate\_adapter)} = 8580.731\ l/sec}}$

5.) Total System Conductance

→ Conductance of Pipeline

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

$$\frac{1}{C_{k(pipeline)}} = \frac{1}{16080.433} + \frac{1}{21153.708} + \frac{1}{8580.731}$$

$$\boldsymbol{C_{k(pipeline)} = 4424.767\ l/sec}$$

→ $\boxed{\boldsymbol{C_{k(pipeline)} = 4424.767\ l/sec}}$

→ Effective Pumping Speed of the System

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

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

$$C_{k(pipeline)} = 4434.767\ l/s$$

$$S_{diff(k)} = 120\ l/s$$

$$\boldsymbol{S_{e(k)} = 116.832\ l/s}$$

→ $\boxed{\boldsymbol{S_{e(k)} = 116.832\ l/sec}}$