Basic Calculation of Thrust Force and Torque for Gate Valve


(1) For Disc Area:

\[ F_1 = f \cdot \tan(\lambda + \theta) \]
\[ f = P \times \frac{\pi D^2}{4} \]

f: Axial force to disc area against flow direction under the pressure.
P: Pressure
D: Inside diameter of the valve bore.
\( \lambda \): Friction angle.
\( \lambda = \tan^{-1} \lambda \)
\( \lambda \): Coefficient of friction, when seating:
Active coefficient \( \lambda_A \),
when un-seating:
Static coefficient \( \lambda_S \).

(2) For Stem Area:

\[ F_2 = P \times \frac{\pi d^2}{4} \]

d: Diameter of Stem

(3) For Gland Packing Area:

\[ F_3 = \left( \pi \times d \times l \right) \times P_g \times \mu_0 \]

l: Total length of Gland Packing
P_g: Tightening Stress of Gland Packing
\( \mu_0 \): Coefficient of tighten friction factor for Gland Packing

**Toatal Seating Force:** \( F_S = F_1 + F_2 + F_3 + W_T \)

**Toatal Un-seating Force:** \( F_{US} = F_1 - F_2 + F_3 + W_T \)

For intermediate: Seating=\( F_2 + F_3 + W_T \), Un-seating=\( F_3 - F_2 + W_T \)

W_T: Total weight of Stem & Disc. (If, \( F_S \) or \( F_{US} \), W_T may neglect)
2. Seating and Un-seating Torque without *Yoke Sleeve Friction*\(^*\,1\)

(1) For Seating Torque:

\[ T_S = F_S \cdot \left( \frac{d}{2} \right) \cdot \tan(\rho + \beta) \]

(2) For Un-seating Torque:

\[ T_{US} = F_{US} \cdot \left( \frac{d}{2} \right) \cdot \tan(\rho + \beta) \]

Note) If \( F_3 < F_2 \), the un-seating and intermediate opening torque shall be “( □ - □ )”.

where,

\( \beta \): Lead angle of the stem thread,

\[ \beta = \tan^{-1}\left( \frac{L}{2r \cdot \pi} \right) \]

\( L \equiv n \cdot \Pi \cdot PT \)

\( L \): Lead, \( 2r \): Pitch diameter, \( n \): Multi start thread no., \( PT \): Pitch of the stem thread,

\( \square \): Friction angle of the stem thread, \( \square \) : Coefficient of the stem thread,

\( \square ': Angle of the stem thread.

Remarks)

\( *\,1\): Please refer to Calculation Sheet-3.
Engine 
eri 
ing Data 
Calculation Sheet-2 Rev.2

Basic Calculation of Thrust Force and Torque for Globe Valve 
(Turned Stem Type)

1. Seating Force
(1) For Disc Area

\[ F_1 = [\pi \times D_2 \times W' \times P \times \sin(\theta + \lambda) \times C] + \left( P \times \frac{\pi \times D_2^2}{4} \right) \]

where;
\[ W': \text{Wide of seating surface} \]
\[ \theta \text{sin} \]
\[ D_1 \]
\[ D_2 \]
\[ \lambda \]
\[ \mu \]
\[ C: \text{Seating Factor}=3 (JPI Recommend) \]

For intermediate,
\[ F'_1 = P \times \frac{\pi d}{4} \]
\[ d: \text{Stem Diameter} \]

If necessary,
\[ F_1 + F' \]

2. Seating Torque
(1) For Gland Packing Area

\[ T_g = (\pi \times d \times l \times P_g \times \mu_0) \times \frac{d}{2} \]

where;
\[ P_g: \text{Tightening Stress of Gland Packing (specified by the packing maker)} \]
\[ \mu_0: \text{Coefficient of Tightening Friction Factor for Gland Packing (specified by packing maker)} \]
(2) Stem Thread \( \text{Rev.1} \)

\[ T_s = (F'_1 + F') \times \frac{d}{2} \times \tan(\rho \pm \beta) \]

where;

+: Seating

-: Un-seating

\( \square \): Lead Angle of Stem Thread,

\[ = \tan^{-1}\left( \frac{L}{2 \pi r} \right) \]

\( L \): Lead

\( 2r \): Pitch Diameter

\( \square \): Friction Angle of Stem Thread, \( \text{Rev.2} \).

\[ = \tan^{-1}\left[ \frac{\cos\left( \frac{\theta'}{2} \right)}{\tan^{-1} \mu_t} \right] \]

\( \square \): Coefficient of Stem Thread

\( \square '\): Angle of Stem Thread

If intermediate, \( F' \) instead of \( F_1 \).

(3) Total Seating Torque (or Un-seating Torque)

\[ T = T_G + T_s \]
Basic Calculation of Thrust-Torque for Yoke Sleeve

1. Seating Torque

\[ T_{YS} = \frac{2}{3} \times \mu_3 \times F \times \left( \frac{R'^3 - r'^3}{R'^2 - r'^2} \right) \]

\( \mu_3 \) : Coefficient of friction (Yoke-to-Sleeve)

F : Seating Force

2. Un-seating Torque

\[ T_{YS} = \frac{2}{3} \times \mu_3 \times F' \times \left( \frac{R'^3 - r'^3}{R'^2 - r'^2} \right) \]

F' : Un-seating Force
Basic Calculation of Tightening-Torque for Gland Bolting

\[ M_Q \cong 0.2 \times Q \times (d' \times 1.1) \]

where,

- \( M_Q \): Tightening-Torque of Gland Bolt Nut.
  (In case of 30 deg. Metric-Coarse Screw Threads, and \( \theta = 0.15 \))
- \( d' \): Pitch Diameter of Gland Bolt.
- \( Q \): Tightening Force

\[ Q = \left( \frac{\pi (d''^2 - d_i^2)}{8} \right) \times P_g \]

- \( d_i \): Stem Diameter
- \( d'' \): Outside Diameter of Stuffing Box
- \( P_g \): Specified Tightening Packing Stress