Calculation Sheets (Valve Dia. : 1.3 m)

Torque Calculation of Butterfly Valve

1. Dynamic Torque (Td)

   This torque is generated when the valve has different pressure (ΔP) between former and later of valve during the fluid which has dynamic velocity is flowing. And this is not occurred when open or close of valve is completely, when an angle of 45 degrees is opened it is max. And that time this torque effect to closing direction.

   This is calculated by following formula.

   \[
   \Delta P = \frac{\xi v \times y \times V^2}{2 \times g}
   \]

   \[
   = 19928.5714 \text{ (kgf/m}^2) \]

   \[
   \xi v : 43.4
   \]

   \[
   y : 1000 \text{ (kgf/m}^2) \]

   \[
   V : 3 \text{ (m/s)}
   \]

   \[
   g : 9.8 \text{ (m/s)}
   \]

   \[
   Td = Ct \times Dd^3 \times \Delta P
   \]

   \[
   = 569.1799 \text{ (kgf.m)}
   \]

2. Bearing Friction Torque (Tb)

   This torque is generated by friction between stem of valve and bearing.

   This is calculated by following formula.

   (1) When valve is opened:

   \[
   T_{bc} = \frac{\pi}{4} \times Dd^2 \times \Delta P_c \times \frac{d \times \mu_b}{2}
   \]

   \[
   = 2415.7277 \text{ (kgf.m)}
   \]

   (2) When valve is opened an angle of 30 deg.

   \[
   T_{bc} = \frac{\pi}{4} \times Dd^2 \times \Delta P_o \times \frac{d \times \mu_b}{2}
   \]

   \[
   = 370.3231 \text{ (kgf.m)}
   \]

3. Seating Torque (Ts)

   When the valve is opened or closed, this is generated due to friction between soft and metals.

   This is calculated by following formula.

<table>
<thead>
<tr>
<th>Valve Diameter</th>
<th>Dd : 1.3 (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference Pre.</td>
<td>ΔPc: 130000</td>
</tr>
<tr>
<td>(Closing)</td>
<td>(kgf/m²)</td>
</tr>
<tr>
<td>Difference Pre.</td>
<td>ΔPo: 19928.57</td>
</tr>
<tr>
<td>(Opening)</td>
<td>(kgf/m²)</td>
</tr>
<tr>
<td>Stem diameter</td>
<td>d : 0.14 (m)</td>
</tr>
<tr>
<td>Bearing friction factor</td>
<td>μb : 0.2</td>
</tr>
</tbody>
</table>
\[ Ts = P_s \times \pi \times D_d \times b \times \frac{D_d}{2} \times 0.64 \times \mu_s \]
\[ = 662.5996 \text{ (kgf.m)} \]

4. Hydrostatic Torque (Th)

This is generated when butterfly valve is settled up with horizontal.
This is same as water head.
This is calculated by following formula.

\[ Th = \gamma \times l \times x \]
\[ Th = \gamma \times \frac{\pi \times D_d^4}{64} \]
\[ = 140.1985 \text{ (kgf.m)} \]

5. Total Torque (Tt)

The total torque of valve according to open or close of valve is different. So, we should select the max. value among two results calculated by following two formula.

(1) When opening, it is added up with two torques, seating and bearing friction torque. namely, when valve is completely closed:

\[ Ttc = Tbc + Ts = Th \]
\[ = 3218.5257 \text{ (kgf.m)} \]

(2) When the valve is opened some angle, this is calculated by adding up of two torques, dynamic and bearing friction torque.
- An angle of 30 Degrees

\[ Ttc = Td + Tbo \]
\[ = 939.5030 \text{ (kgf.m)} \]

Accordingly the highest value is No. (1)
\[ = 3218.5 \text{ (kgf.m)} \]