[1] In an open belt drive, pulleys are 500mm and 1200mm in diameter on parallel shafts 4m apart. The maximum tension in the belt is limited to 1800N and coefficient of friction = 0.3. The driving pulley 1200 mm diameter is running at 210 rpm, calculate power transmitted by the belt drive.

Solution:

<u>Data:</u> Open belt drive system, d_2 = 500mm, d_1 = 1200mm, N_1 = 210rpm, X = 4m,

T_1 = 1800N and μ = 0.3.

Ratio of Tension = $\frac{T_1}{T_2} = e^{\mu\theta}$ where θ = (180 - 2ø) for open belt drive system and

Ø = $\sin^{-1}(r_2 - r_1/ X) = \sin^{-1} (0.6-0.25/4)$ = **5.0198°**

θ= (180 – 2x5.0198) = **169.96°**

$\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.3\text{x} (\pi/180\text{x } 169.96)}$ = **2.435**

T_2 = 1800/ 2.435 = 739.219 N

P = $(T_1 - T_2)$ v / 60000 kW, where v = πdN m/min, T_1 & T_2 in Newtons

P = (1800 – 739.219) x 791.68 / 60 x 1000 = **<u>13.996</u> kW**

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[2] A flat belt is required to transmit 35 KW from a pulley of 1.5m diameter running at 300 rpm. The angle of contact is 160^0 and the coefficient of friction between the belt and the pulley is 0.3. Determine the tight and slack side tension in the belt drive.

Solution:

<u>Data:</u> P = 35kW, d = 1.5m, N = 300rpm, θ = 160^0,

T_1 = 1800N and μ = 0.3.

Ratio of Tension = $\frac{T_1}{T_2} = e^{\mu\theta}$

$\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.3\text{x} (\pi/180\text{x } 160)}$ = **1.286** ---------------------------------- (1)

$P = (T_1 - T_2)\ v\ /\ 60000$ kW, where $v = \pi dN$ m/min, T_1 & T_2 in Newtons

$35 = (T_1 - T_2) \times \pi \times 1.5 \times 300/\ 60 \times 1000$

$(T_1 - T_2) =$ **1496.9N** -- (2)

From equation 1 and 2 we get

T_2 = 5230.9N

T_1 = 6726.99N

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[3] A shaft is to be driven at 480 rpm, from a driving shaft that rotates at 200 rpm, through an open flat belt drive. The center distance of the drive is 1000 mm and the diameter of the driving pulley is 240 mm. The coefficient of friction between the belt and the pulleys is μ = 0.3. If the drive can transmit a maximum power of 3 kW without slipping of the belt relative to the pulleys, determine the necessary belt width if the safe permissible belt tension is 15 N per mm of belt width. Neglect any centrifugal effects.

Solution:

Data: Open belt drive system, N_2 = 480rpm, d_1 = 240mm, N_1 = 200rpm, X = 1m,

T_1 = 1800N and μ = 0.3. P = 3kW, permissible belt tension = 15N

Velocity ration = $N_2/N_1 = d_1/\ d_2$, Hence d_2 = 100mm

Ratio of Tension = $\frac{T_1}{T_2} = e^{\mu\theta}$ where θ = (180 - 2ø) for open belt drive system and

$Ø = \sin^{-1}(r_2 - r_1/\ X) = \sin^{-1}(0.12-0.05/1) =$ **4.014°**

$\theta = (180 - 2 \times 4.014) =$ **171.97°**

$\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.3 \times (\pi/180 \times 171.97)} =$ **2.46** ---(1)

$P = (T_1 - T_2)\ v\ /\ 60000$ kW, where $v = \pi dN$ m/min, T_1 & T_2 in Newtons

$3 = (T_1 - T_2) \times \pi \times 0.24 \times 200/\ 60 \times 1000$

$(T_1 - T_2) =$ **1193.66N** -- (2)

From equation 1 and 2 we get,

T_2 = **817.57N**

T_1 = **2011.235N**

Belt width = Maximum tension / Permissible belt tension per belt width

Belt width = 2011.235 / 15 = **134mm**

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[4] A pump is driven by an electric motor through an open type flat belt drive. Determine the belt specifications for the following data. Motor pulley diameter = 300 mm, Pump pulley diameter = 600 mm, Coefficient of friction = 0.25. Center distance between the pulleys = 1000 mm, Rotational speed of the motor =1440 rpm, Power transmission = 20kW; permissible tension = 10kN.

Solution:

Data: Open belt drive system, d_1 = 300mm, N_1 = 1440rpm, d_2 = 600mm X = 1m,

P= 20 kW and μ = 0.25, permissible belt tension = 10 kN

Length of belt = $\pi (r_1 + r_2) + (r_1 - r_2)^2/ X + 2X$

Length of belt = $\pi (0.15 + 0.3) + (0.3 - 0.15)^2/ 1 + 2$

Length of belt = **4.4365m**

Ratio of Tension = $\frac{T_1}{T_2} = e^{\mu\theta}$ where θ = (180 - 2ø) for open belt drive system and

$\text{Ø} = \sin^{-1}(r_2 - r_1/ X) = \sin^{-1} (0.3 - 0.15/1) = \mathbf{8.627^o}$

$\theta = (180 - 2x8.627) = \mathbf{162.746^0}$

$\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.25x (\pi/180x\ 162.746)} = \mathbf{2.034}$ --(1)

P = $(T_1 - T_2)$ v / 60000 kW, where v = πdN m/min, T_1 & T_2 in Newtons

20 = $(T_1 - T_2)$ x πx0.3x1440/ 60 x 1000

$(T_1 - T_2)$ = **884.19N** -- (2)

From equation 1 and 2 we get,

T_2 = 855.116N

T_1 = 1739.306N

Belt width = Maximum tension / Permissible belt tension per belt width

Belt width = 1739.306 / 10X1000 = **0.01739m**

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[5] An open belt running over two pulleys 1.5m and 1.0m diameter connects two parallel shafts 4.80m apart. The initial tension in the belt when stationary is 3000N, if the smaller pulley is rotating at 600 rpm and coefficient of friction between the belt and pulley is 0.3. Determine the power transmitted neglecting centrifugal tension into account.

Solution:

<u>Data:</u> Open belt drive system, d_1 = 1.5m, d_2 = 1m, N_2 = 600rpm, X = 4.8m,

T_o = 3000N and μ = 0.3.

Initial tension in belt is, $T_O = T_1 + T_2 / 2$

$T_1 + T_2$ = **6000N** -- (1)

Ratio of Tension = $\frac{T_1}{T_2} = e^{\mu\theta}$ where θ = (180 - 2ø) for open belt drive system and

Ø = $\sin^{-1}(r_1 - r_2/ X) = \sin^{-1}(0.75 - 0.5/4.8)$ = **2.985°**

θ= (180 – 2x2.985) = **174.03°**

$\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.3\times(\pi/180\times 174.03)}$ = **2.487** -- (2)

From equation 1 and 2 we get,

T_2 = 1720.6768N

T_1 = 4279.3232N

P = $(T_1 - T_2)$ v / 60000 kW, where v = πdN m/min, T_1 & T_2 in Newtons

P = (4279.3232 – 1720.6768) x 1884.9/ 60 x 1000 = **<u>80.38</u> kW**

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[6] Power transmitted between two shafts 3.5m apart by a crossed belt drive around two pulleys 0.6m and 0.3m in diameters is 6KW. The speed of the larger pulley is 220 rpm. The permissible load on the belt is 25M per mm width of the belt which is thick. The coefficient of friction between the smaller pulley surface and the belt is 0.35 Determine:

a) The necessary length of the belt

b) The width of the belt

c) The necessary initial tension in the belt

Solution:

<u>Data:</u> Crossed belt drive system, d_1 = 0.6m, N_1 = 220rpm, d_2 = 0.3m X = 3.5m,

P= 6 kW and μ = 0.35, permissible belt tension = 25N

(a) Length of belt = $\pi\ (r_1 + r_2) + (r_1 + r_2)^2 / X + 2X$

Length of belt = $\pi\ (0.3 + 0.15) + (0.3 + 0.15)^2 / 3.5 + 7$

Length of belt = **8.472m**

(b) Ratio of Tension = $\frac{T_1}{T_2} = e^{\mu\theta}$

where θ = (180 + 2ø) for crossed belt drive system and

$Ø = \sin^{-1}(r_1 + r_2/ X) = \sin^{-1}(0.3 + 0.15/3.5) = \mathbf{7.387^o}$

$\theta = (180 + 2x7.387) = \mathbf{194.774^0}$

$\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.25x\ (\pi/180x\ 194.774)} = \mathbf{3.286}$ --- (1)

P = $(T_1 - T_2)$ v / 60000 kW, where v = πdN m/min, T_1 & T_2 in Newtons

6 = $(T_1 - T_2)$ x πx0.6x220/ 60 x 1000

$(T_1 - T_2)$ = **868.118N** --- (2)

From equation 1 and 2 we get,

T_2 = 379.75N

T_1 = 1247.85N

Belt width = Maximum tension / Permissible belt tension per belt width

Belt width = 1247.85 / 25 = **49.91mm**

(c) Initial tension in the belt

$T_0 = T_1 + T_2 / 2$ = (1247.85 + 379.75) / 2 = **823.8N**

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