MECHANICAL ENGINEERING SCIENCE

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NUMERICALS

A casting weighs 6 kN and is freely suspended from a rope which makes 2.5 turns round a drum of 200 mm diameter. If the drum rotates at 40 rpm, determine the force required by a man to pull the rope from the other end of the rope. Also, determine the power to raise the casting. The coefficient of friction is 0.25.

NUMERICALS

Solution $T_1 = 6000$ N $\quad d = 0.2$ m
$N = 40$ rpm $\quad \mu = 0.25$
$\theta = 2.5 \times 2\pi = 15.7$ rad

$$v = \frac{\pi dN}{60} = \frac{\pi \times 0.2 \times 40}{60} = 0.419 \text{ m/s}$$

$$\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.25 \times 15.7} = 50.8 \text{ or } T_1 = 50.8 T_2$$

or $\quad 6000 = 50.8\ T_2$ or $T_2 = 118$ N

and $\quad P = (T_1 - T_2)\ v = (6000 - 118) \times 0.419$
$= 2464$ W or <u>2.464 kW</u>

NUMERICALS

Two pulleys mounted on two parallel shafts that are 2 m apart are connected by a crossed belt drive. The diameters of the two pulleys are 500 mm and 240 mm. Determine the power transmitted if the larger pulley rotates at 180 rpm and the maximum permissible tension in the belt is 900 N. The coefficient of friction between the belt and pulley is 0.28

NUMERICALS

Solution:

Angle of contact

$$\theta = 180 + 2\alpha$$

Where $\alpha = \sin^{-1}\left[\frac{(r_1 + r_2)}{x}\right] = \sin^{-1}\left[\frac{(250+120)}{2000}\right] = 10.7^{o}$

$\therefore$ $\theta = 180 + 2 \times 10.7 = \mathbf{201.4^{o}}$

$$\theta = 201.4 \times \frac{\pi}{180} = 3.51\, rad$$

NUMERICALS

Solution:

w.k.t $\frac{T_1}{T_2} = e^{\mu\theta}$ or $T_1 = T_2 e^{\mu\theta}$

$900 = T_2 e^{0.28\times3.51}$

$900 = 2.67\ T_2$

Therefore $\boldsymbol{T_2 = 337\ N}$

Power transmitted

$$V = \frac{\pi d_1 N_1}{60} = \frac{\pi\times0.5\times180}{60} = 4.71\ \frac{m}{s}$$

$P = (T_1 - T_2)\ V = (900 - 337) \times 4.71$

$= 2651.73\ W$

or $\boldsymbol{P = 2.65\ kW}$

NUMERICALS

A belt drive transmits 5 kW of power between two parallel shafts. The distance between the shaft centers is 1.5 m and the diameter of the smaller pulley (driven pulley) is 440 mm. The driving and the driven shafts rotate at 60 rpm and 150 rpm respectively. The coefficient of friction is 0.22. Determine the tension in tight side of the belt if the two pulleys are connected by (i) open belt drive (ii) crossed belt drive.

NUMERICALS

Solution:

We have, velocity of the belt given by,

$$v = \frac{\pi d_2 N_2}{60} = \frac{\pi \times 440 \times 10^{-3} \times 150}{60} = 3.46\ m/s$$

We know that, power transmitted is given by,

$$P = (T_1 - T_2)v$$

Substituting P =5000 W, v = 3.46 m/s, we get,

$$5000 = (T_1 - T_2)3.46$$

$$(T_1 - T_2) = 1445.09\text{---------(1)}$$

a) Open belt drive

We have, angle of contact on the smaller pulley of the open belt drive given by,

$$\theta = 180 - 2sin^{-1}\left(\frac{r_1 - r_2}{x}\right) = 180 - 2sin^{-1}\left(\frac{550 - 220}{1500}\right) = 154.58\ degrees\ or\ 2.7\ radians$$

NUMERICALS

Solution:

We have,

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

$\frac{T_1}{T_2} = e^{0.22\times2.7} = 1.81$---------(2)

Using (1) and (2), we get $T_1 = 3229.15$ N

a) Crossed belt drive

We have, angle of contact in case of crossed belt drive given by,

$$\theta = 180 + 2sin^{-1}\left(\frac{r_1 + r_2}{x}\right) = 180 + 2sin^{-1}\left(\frac{550 + 220}{1500}\right) = 241.77\ degrees\ or\ 4.22\ radians$$

NUMERICALS

Solution:

We have,

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

$\frac{T_1}{T_2} = e^{0.22\times4.22} = 2.53$---------(2)

Using (1) and (2), we get $T_1 = 2389.6$ N

ADVANTAGES OF BELT DRIVES

Belt drives offer the following advantages compared with other types of drives:

- Belt drives can transmit power over considerable distance between the axes of driving and driven shafts.
- The operation of belt drive is smooth and silent.
- They can transmit only a definite load, which if exceeded, will cause the belt to slip over the pulley, thus protecting the parts of the drive against overload.
- They have the ability to absorb the shocks and damp vibration.
- They are simple to design.
- They have low initial cost.

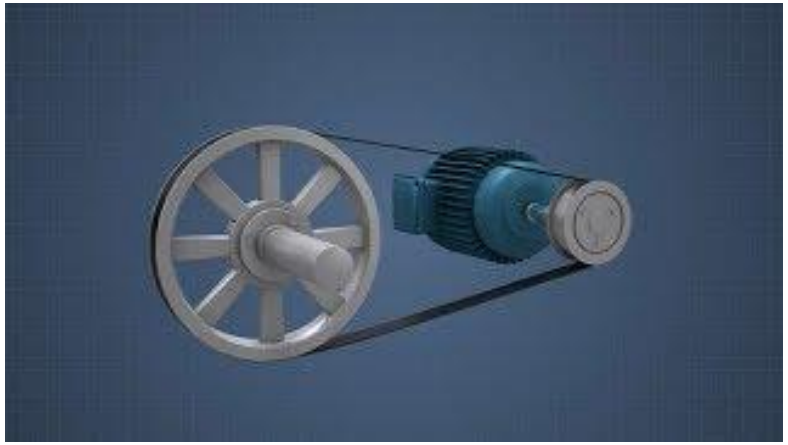
DISADVANTAGES OF BELT DRIVES

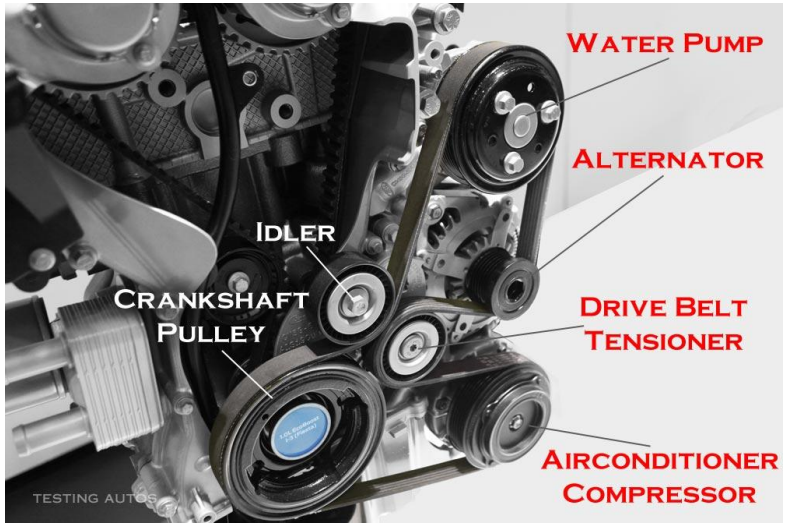
The disadvantages of belt drives compared to other types of drives are as follows:

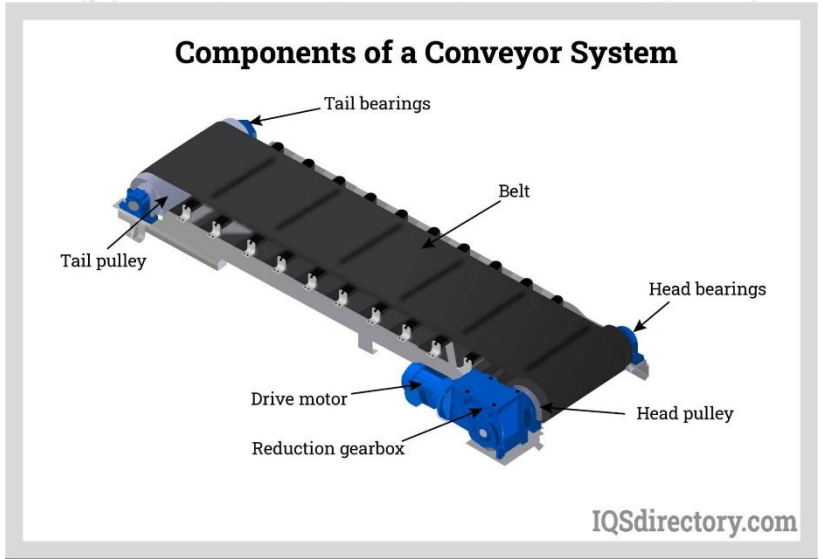
- Belt drives have large dimensions and occupy more space.
- The velocity ratio is not constant due to belt slip.
- They impose heavy loads on shafts and bearings.
- There is considerable loss of power resulting in low efficiency.
- Belt drives have comparatively short service life.

APPLICATIONS OF BELT DRIVES

- Electric motors
- Automobiles
- Machine tools
- Conveyors







THANK YOU

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