Problems on Multiplate clutch

1) A multiple disc clutch have five plates having 4 pairs of active friction Surface. If the intensity of pressure is not to be exceed 0.127 N/mm². Find the power transmitted at 500 rpm. The outer and inner radii of friction Surface are 125 mm and 75 mm respectively. Assume uniform wear and take $\mu = 0.3$.

Given

$n_1 + n_2 = 5$

$P_{max} = 0.127\ N/mm^2$

$N = 500\ rpm$

$r_1 = 75\ mm$

$r_2 = 125\ mm$

$\mu = 0.3$

Given that uniform wear is assumed

To find:

P

Solution:

$n = n_1 + n_2 - 1$

$= 5 - 1$

$\boxed{n = 4}$

$T = \mu W R n$

$R = \frac{r_1 + r_2}{2} = \frac{75 + 125}{2}$

$R = 100\ mm$

$W = 2\pi c (r_2 - r_1)$

$C = P_{max} \times r_1 = 0.127 \times 75$

$C = 9.525\ N/mm$

$W = 2 \times \pi \times 9.525 \times (125 - 75)$

$W = 2992.37\ N$

$T = \mu W R n$

$T = 0.3 \times 2992.37 \times 100 \times 4$

$T = 359.08 \times 10^3\ N.mm$ $\Rightarrow 359.08\ N.m$

$P = \frac{2\pi N T}{60} = \frac{2 \times \pi \times 500 \times 359.08}{60}$

$P = 18.8 \times 10^3\ W$ (or) $18.8\ KW$

Result:

$P = 18.8\ KW$

2. A multiple disc clutch has three discs on the driving shaft and two on the driven shaft. The inside diameter of the contact surface is 120 mm. The maximum pressure between the surface is limited to 0.1 N/mm². Design a clutch for transmitting 25 kW at 1575 rpm. Assume uniform wear condition and coefficient of friction as 0.3

Given data:

$$n_1 = 3$$

$$n_2 = 2$$

$$d_1 = 120\,mm \Rightarrow r_1 = 60\,mm$$

$$P_{max} = 0.1\,N/mm^2$$

$$P = 25\,kW = 25 \times 10^3\,W$$

$$N = 1575\,rpm$$

$$\mu = 0.3$$

Given that uniform wear is assumed

To find:

r_2

Solution:

$$P = \frac{2\pi N T}{60}$$

$$25 \times 10^3 = \frac{2 \times \pi \times 1575 \times T}{60}$$

$$T = 151.57 \text{ N.m}$$

(or)

$$T = 151.57 \times 10^3 \text{ N.mm}$$

$T = \mu W R n$

$$R = \frac{r_1 + r_2}{2} = \frac{60 + r_2}{2}$$

$$R = \frac{60 + r_2}{2}$$

$W = 2\pi c (r_2 - r_1)$

$C = P_{max} \times r_1 = 0.1 \times r_1$

$C = 0.1 \times r_1 \Rightarrow 0.1 \times 60$

$W = 2 \times \pi \times 0.1 \times 60 (r_2 - 60)$

$$W = 37.7 (r_2 - 60)$$

$T = \mu W R n$

$$151.57 \times 10^3 = 0.3 \times 37.7 (r_2 - 60) \times \left(\frac{60 + r_2}{2}\right)$$

$$\frac{151.57 \times 10^3}{2 \times 0.3 \times 37.7} = (r_2 - 60) \times (r_2 + 60) \times 2$$

$$6700.865 = r_2^2 - 60^2$$

$$r_2 = 101.49 \text{ mm}$$

Result: $r_2 = 101.49$ mm

3. A plate clutch has three discs on the driving Shaft and two discs on the driven shaft, providing four pairs of contact Surface. The outside diameter of the contact Surface is 240 mm and inside diameter 120 mm. Assuming uniform pressure and $\mu = 0.3$, find the total Spring load pressing the plates together to transmit 23 kW power at 1475 revolution per minute.

If there are 6 Springs each of Stifness 13 kN/m and each of the contact Surfaces has worn away by 1.25 mm. Find the maximum power that can be transmitted, assuming uniform wear.

Given

(i) $n_1 = 3$

$n_2 = 2$

$d_2 = 240\,mm \Rightarrow r_2 = 120\,mm$

$d_1 = 120\,mm \Rightarrow r_1 = 60\,mm$

$\mu = 0.3$

$P = 23\,kW = 23 \times 10^3\,W$

$N = 1475\,rpm$

uniform pressure is assumed

(ii) No of Springs = 6

Stifness = 13 kN/m

uniform wear is assumed

worn = 1.25 mm in each contact Surface

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To find:

(i) W

(ii) P_{max}

Solution

$$T = \mu W R n$$

$$n = n_1 + n_2 - 1 = 3 + 2 - 1$$

$$\boxed{n = 4}$$

$$P = \frac{2\pi N T}{60}$$

$$23 \times 10^3 = \frac{2 \times \pi \times 1475 \times T}{60}$$

$$\boxed{T = 148.9\ N.m}$$

(or)

$$\boxed{T = 148.9 \times 10^3\ N.mm}$$

$$R = \frac{2}{3}\left[\frac{r_2^3 - r_1^3}{r_2^2 - r_1^2}\right] = \frac{2}{3}\left[\frac{120^3 - 60^3}{120^2 - 60^2}\right]$$

$$\boxed{R = 93.33\ mm}$$

$$T = \mu W R n$$

$$148.9 \times 10^3 = 0.3 \times W \times 93.33 \times 4$$

$$\boxed{W = 1329.46\ N}$$

(ii) Number of friction surface = 8

Total wear = 8 × 1.25

= 10 mm

Reduction in Spring force = Total wear × Stifness of Spring × no of spring

= 10 × 13 × 6 = 780

Reduction in Spring force = 780 N

$$R = \frac{r_1 + r_2}{2} = \frac{60+120}{2}$$

R = 90 mm

Actual load (W) = Total load − Reduction in Spring force

= 1329.46 − 780

W = 549.46 N

T = μ W R n

T = 0.3 × 549.46 × 90 × 4

$T = 59.34 \times 10^3$ N.mm

T = 59.34 N.m

$$P = \frac{2\pi NT}{60}$$

$$P = \frac{2 \times \pi \times 1475 \times 59.34}{60} = 9.16 \times 10^3$$

$$\boxed{P = 9.16\,kW}$$

Result:

(i) $W = 1329.46\,N$

(ii) $P = 9.16\,kW$