f_c= 2,0
St 60= 60 kg/mm^2
Perhitungan diameter poros:
Pd= f_c P
Pd = 2,0 (0,2)
Pd = 0,4
T= 9,74 x $10^5 \frac{P_d}{n}$
T= 9,74 x $10^5 \frac{0,4}{40}$
T= 9740 kgmm
Bahan St 60 σ_b= 60 kg/mm^2; S_{f1} = 6,0; S_{f2} = 2,0

$$\tau_a = \frac{\sigma_b}{S_{f1} x S_{f2}}$$

$$\tau_a = \frac{60}{6,0 x 2,0}$$

$$\tau_a = 5\ kg/mm^2$$

Cb = 2,0; Kt = 1,5

$$d_s = \left(\frac{5,1}{\tau_a} K_t C_b\ T\right)^{1/3}$$

$$d_s = \left(\frac{5,1}{4,4} x1,5x2,0x9740\right)^{1/3}$$

$$d_s = 26,21 \text{ mm}$$

Jadi diameter poros yang digunakan adalah 26,21 mm.

3.2.3 Perhitungan Bantalan Poros

Diketahui:
d_s = 26,21 mm
$m_{rotor\ turbin}$ = 24 kg
Bahan poros besi St 60 σ_b= 60 kg/mm^2; S_{f1} = 6,0; S_{f2} = 2,0

$$\tau_a = \frac{\sigma_b}{S_{f1} x S_{f2}}$$

$$\tau_a = \frac{60}{6,0 x 2,0}$$

$$\tau_a = 5\ Kgmm$$

n = 40 rpm
Bahan besi perunggu Pa = 0,7 – 2,0 kg/mm^2

$$\frac{1}{d} \leq \sqrt{\frac{1}{5.1}} + \frac{\sigma a}{Pa}$$

$$\frac{1}{d} \leq \sqrt{\frac{1}{5.1}} + \frac{5}{1,8}$$

l = 20 mm
d= 26,21 mm

$$P = \frac{W}{ld}$$

$$P = \frac{24}{20\ x\ 26,21} = 0,04 \text{ kg/mm}^2$$

$0{,}04 < 2{,}0$ jadi dapat diterima

$V = \pi\, d\, \frac{n}{60\, x\, 1000}$ = $3{,}14\, x\, 26{,}21\, \frac{40}{60\, x\, 1000}$ = 0,05 m/s

$(Pv)_a$ = 0,45 x 0,05 = 0,02 kg m/mm^2 s

$P_v = 0{,}2\ kg\ m/mm^2\ s$ (poros transmisi)

Harga $(Pv)_a$poros transmisi maksimal yang diijinkan 0,02 kg m/mm^2 s

0,02< 0,2 jadi dapat diterima.

3.2.4 Perhitungan Roda Gigi

Diketahui:

HP = 200Watt = 0,27 HP

n_{turbin} = 40 rpm N1 = 69 N2 = 12 N3 = 69 N4 = 17 N5 = 69 N6 = 27

3.2.4.2 Roda gigi 1

Diketahui:

N1 = 69 Yp = 0,428

N2 = 12 Yg = 0,245

HP = 200 =0,27 HP

Sudut Kontak = 20 deg FD

Jawab:

Asumsi Bahan *Pinion* = ASTM25 So = 8000

Asumsi Bahan *Gear* = ASTM35 So = 12000

So Yp = 8000x0,428 = 3424Psi

So Yg = 12000x0,245 = 2940 Psi

1. Perhitungan Torsi

$$T = \frac{hpx63.000}{n}$$

$$T = \frac{0,27x63.000}{40}$$

T = 422,25 lb-in

2. Penentuan Diameter *Pitch Line*

Diambil asumsi P = 16

$$P = \frac{Ntp}{dp}$$

$$dp = \frac{69}{16}$$

$$dp = 4,31\ in$$

3. Perhitungan Kecepatan *Pitch Line*

$$vp = \frac{\pi\, d_p\, n}{12}$$

$$vp = \frac{3,14x4,31x\ 40}{12}$$

$$vp = 45,14\ ft/min$$

4. Perhitungan Gaya-gaya Yang bekerja

$$Ft = \frac{T}{dp/_2}$$

$$Ft = \frac{422,25}{4,31/_2}$$

$Ft =$ 195,83 lb

Karena Vp terletak antara 0< Vp<2000 ft/min, maka:

$$F_d = \frac{600 + V_p}{600} F_t$$

$$F_d = \frac{600 + 45,14}{600}\ 195,83$$

$$F_d = 210,56\ lb$$

$$Q = \frac{2\ Nt_g}{Nt_p + Nt_g}$$

$$Q = \frac{2\,x12}{69 + 12}$$
$$Q = 0{,}3$$

5. Perhitungan Dimensi *Gear*

$$b = \frac{F_d}{d_p Q K}$$
$$b = \frac{212{,}05}{4{,}31x0{,}3x264}$$ karena bahannya ASTM maka nilai k = 264
$$b = 0{,}63\ in$$
$$\frac{9}{p} \leq b \leq \frac{13}{p}$$
$$0{,}56 \leq 0{,}63 \leq 0{,}81$$ (memenuhi)

Dengan melihat konsentrasi tegangan,diperoleh persamaan gaya bending:

a. Untuk *Pinion*

$$F_{bp} = S\,b\frac{Yp}{p}$$
$$F_b = 12000x0{,}63x\frac{0{,}428}{16}$$
$$F_b = 260{,}81\ lb$$

Jika $F_b \geq F_d$ syarat aman

$260{,}81 \geq 212{,}05$ maka aman

Dimensi *Pinion* (b) =0,63

b. Untuk *Gear*

$$F_{bg} = S\,b\frac{Yg}{p}$$
$$F_b = 18000x0{,}81x\frac{0{,}245}{16}$$
$$F_b = 223{,}95\ lb$$

Jika $F_b \geq F_d$ syarat aman

$223{,}95 \geq 212{,}05$ maka aman

Dimensi *Gear* (b) =0,81

Jadi untuk rodagigi 1 :Untuk *Pinion* Bahan ASTM35, b=0,63

Untuk *Gear* Bahan SAE1020, b=0,81

6. Perhitungan Module (*m*)

Diketahui:

$Nt_p = 69$, D = 138 mm

$Nt_g = 12$, D = 24 mm

Jawab:

a. Untuk Pinion

$$m = \frac{D}{Nt_p}$$
$$m = \frac{138}{69}$$
$$m = 2\ mm$$

b. Untuk Gear

$$m = \frac{D}{Nt_g}$$
$$m = \frac{24}{12}$$
m = 2 *mm*

3.2.4.2 Roda gigi 2

Diketahui:

N1 = 69 Yp = 0,428

N2 = 17 Yg = 0,302

HP =200 - (30% x 200) = 0,19 HP

Sudut Kontak = 20 deg FD

Jawab:

Asumsi Bahan Pinion = ASTM35 So = 12000

Asumsi Bahan Gear = ASTM50 So = 15000

So Yp = 12000 x 0,428 = 5136 Psi

So Yg = 15000 x 0,302 = 4530 Psi

1. Perhitungan Torsi

$$T = \frac{hpx63.000}{n}$$

$$T = \frac{0,19x63.000}{230}$$

T = 51,4 lb-in

2. Penentuan Diameter *Pitch Line*

Diambil asumsi P = 33

$$P = \frac{Ntp}{dp}$$

$$dp = \frac{69}{33}$$

$$dp = 2,09\ in$$

3. Perhitungan Kecepatan *Pitch Line*

$$v_p = \frac{\pi d_p n}{12}$$

$$v_p = \frac{3,14x2,09x\ 230}{12}$$

$$v_p = 125,84\ ft/min$$

4. Perhitungan Gaya-gaya Yang bekerja

$$Ft = \frac{T}{dp/_2}$$

$$Ft = \frac{51,4}{2,09/_2}$$

Ft = 49,17 lb

Karena vp terletak antara 0< vp<2000 ft/min, maka:

$$F_d = \frac{600 + v_p}{600} F_t$$

$$F_d = \frac{600 + 125,84}{600}\ 49,17$$

$$F_d = 59,48\ lb$$

$$Q = \frac{2\ Nt_g}{Nt_p + Nt_g}$$

$$Q = \frac{2\ x17}{69 + 17}$$

$$Q = 0,4$$

5. Perhitungan Dimensi *Gear*

$$b = \frac{F_d}{d_p QK}$$

$b = \frac{59,48}{2,09x0,4x264}$ karena bahannya ASTM maka nilai k=264

$b = 0,29\ in$

$\frac{9}{p} \leq b \leq \frac{13}{p}$

$0,27 \leq 0,27 \leq 0,39$ (memenuhi)

Dengan melihat konsentrasi tegangan, diperoleh persamaan gaya bending:

a. Untuk *Pinion*

$F_{bp} = S\ b \frac{Yp}{p}$

$F_b = 12000x0,27x\frac{0,428}{33}$

$F_b = 61,31\ lb$

Jika $F_b \geq F_d$ syarat aman

$61,31 \geq 59,48$ maka aman

Dimensi *Pinion* (b) =0,273

b. Untuk *Gear*

$F_{bg} = S\ b \frac{Yg}{p}$

$F_b = 18000x0,27x\frac{0,302}{33}$

$F_b = 64,89\ lb$

Jika $F_b \geq F_d$ syarat aman = $64,89 \geq 59,48$ maka aman

Dimensi *Gear* (b) =0,27

Jadi untuk roda gigi 2:Untuk *Pinion* Bahan ASTM35,b=0,27

Untuk *Gear* Bahan SAE1020, b=0,27

6. Perhitungan Module (*m*)

Diketahui:

$Nt_p = 69$, D = 138 mm

$Nt_g = 17$, D = 34 mm

Jawab:

a. Untuk Pinion

$m = \frac{D}{Nt_p}$

$m = \frac{138}{69}$

$m = 2\ mm$

b. Untuk Gear

$m = \frac{D}{Nt_g}$

$m = \frac{34}{17}$

m = 2 *mm*

3.2.4.3 Roda gigi 3

Diketahui:

N1 = 69 Yp = 0,428

N2 = 27 Yg = 0,348

HP = 200 – (50% x 200) =0,13 HP

Sudut Kontak = 20 deg FD

Jawab:
Asumsi Bahan *Pinion* = ASTM25 So = 8000
Asumsi Bahan *Gear* = ASTM35 So = 12000
So Yp = 8000 x 0,428 = 3424 Psi
So Yg = 12000 x 0,348 = 4176 Psi

1. Perhitungan Torsi

$$T = \frac{hpx63.000}{n}$$

$$T = \frac{0{,}16x63.000}{933{,}53}$$

T = 9,05 lb-in

2. Penentuan Diameter *Pitch Line*
   Diambil asumsi P = 63

$$P = \frac{Ntp}{dp}$$

$$dp = \frac{69}{63}$$

$$dp = 1{,}1\ in$$

3. Perhitungan Kecepatan *Pitch Line*

$$v_p = \frac{\pi d_p n}{12}$$

$$v_p = \frac{3{,}14x1{,}1x933{,}53}{12}$$

$$v_p = 267{,}54\ ft/min$$

4. Perhitungan Gaya-gaya Yang bekerja

Ft = $\frac{T}{dp/_2}$

Ft = $\frac{9{,}05}{1{,}1/_2}$

Ft = 16,52 lb

Karena v_p terletak antara 0<v_p<2000 ft/min, maka:

$$F_d = \frac{600 + V_p}{600} F_t$$

$$F_d = \frac{600 + 267{,}54}{600}\ 16{,}52$$

$$F_d = 23{,}89\ lb$$

$$Q = \frac{2\ Nt_g}{Nt_p + Nt_g}$$

$$Q = \frac{2\ x27}{69 + 27}$$

$$Q = 0{,}56$$

5. Perhitungan Dimensi *Gear*

$$b = \frac{F_d}{d_p QK}$$

$b = \frac{23{,}89}{1{,}1x0{,}56x264}$ karena bahannya ASTM maka nilai k = 264

$b = 0{,}15\ in$

$\frac{9}{p} \leq b \leq \frac{13}{p}$

$0{,}14 \leq 0{,}15 \leq 0{,}21$ (memenuhi)

$F_b = S\ b \frac{Y}{p}$

Dengan melihat konsentrasi tegangan,diperoleh persamaan gaya bending:

a. Untuk *Pinion*

$F_{bp} = S\ b \frac{Yp}{p}$

$F_b = 18000x0{,}15x\frac{0{,}428}{63}$

$F_b = 25{,}23\ lb$

Jika $F_b \geq F_d$ syarat aman

$25{,}23 \geq 23{,}89$ maka aman

Dimensi *Pinion* (b) =0,21

b. Untuk *Gear*

$F_{bg} = S\ b \frac{Yg}{p}$

$F_b = 23000x0{,}21x\frac{0{,}302}{63}$

$F_b = 25{,}23\ lb$

Jika $F_b \geq F_d$ syarat aman

$25{,}23 \geq 23{,}89$ maka aman

Dimensi *Gear* (b) =0,21

Jadi untuk roda gigi 3:Untuk *Pinion* Bahan SAE1020, b=0,22

Untuk *Gear* Bahan SAE1035, b=0,22

6. Perhitungan Module (*m*)

Diketahui:

$Nt_p = 69$, D = 138 mm

$Nt_g = 27$, D = 54 mm

Jawab:

a. Untuk Pinion

$m = \frac{D}{Nt_p}$

$m = \frac{138}{69}$

$m = 2\ mm$

b. Untuk Gear

$m = \frac{D}{Nt_g}$

$m = \frac{54}{27}$

m = 2 *mm*

3.2.5 Generator

Generator yang digunakan dari magnet dan spul speda motor dengan tegangan 12 volt 5 Ampere.