MODULE 05

DESIGN OF PUMP

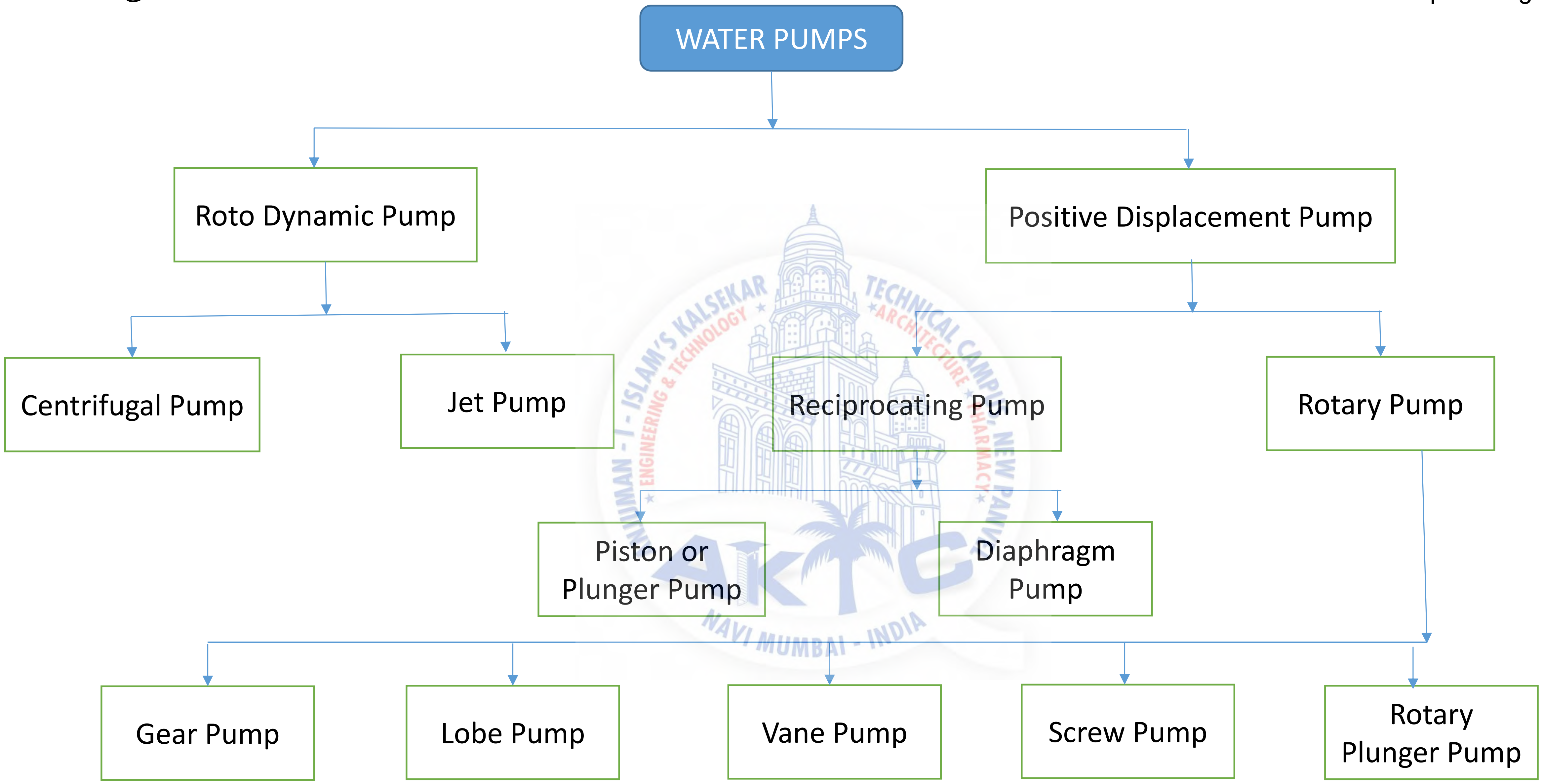
1) Gear Pump
2) Centrifugal Pump

01) Gear Pump

- Suction and Delivery Pipe
- Motor Selection
- Gear Design
- Shaft Design
- Bearing Selection
- Casting and Bolts Design

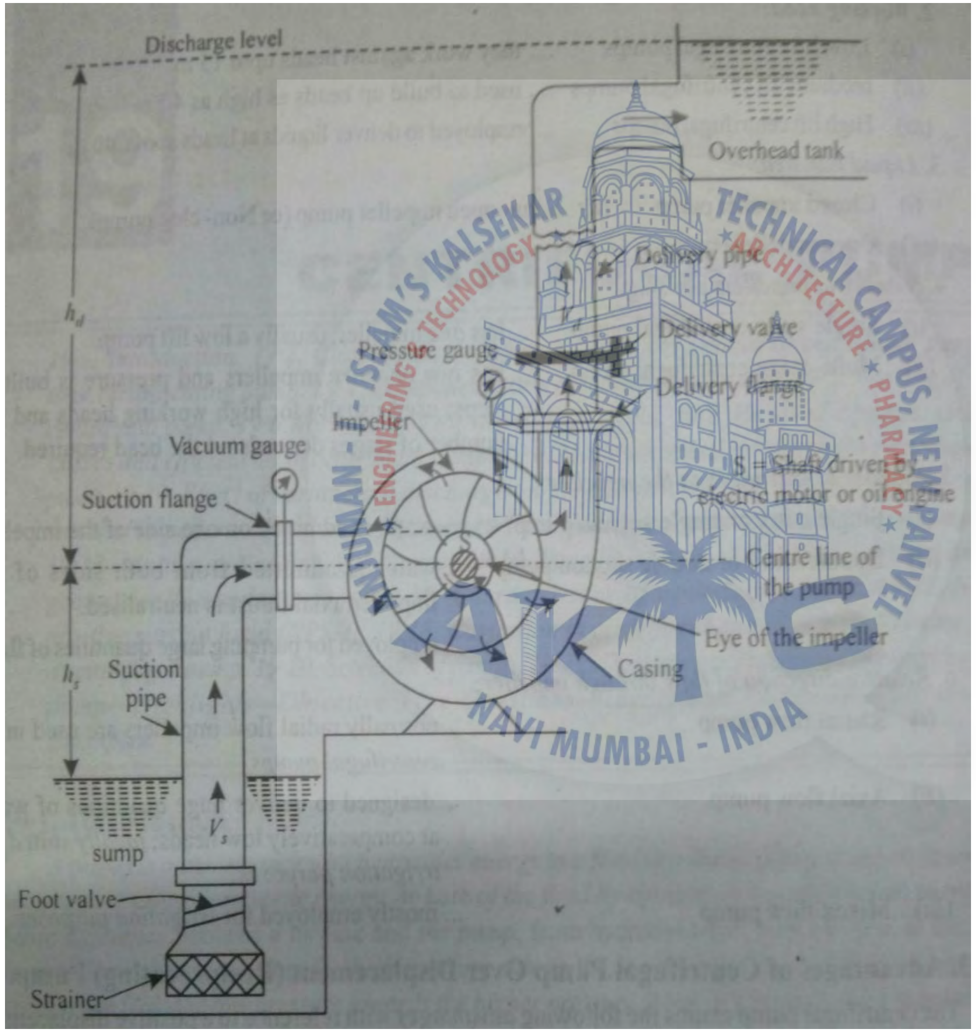
02) Centrifugal Pump

- Suction and Delivery Pipe
- Motor Selection
- Design of Impeller
- Impeller Shaft
- Design of Volute casing


WATER PUMPS
Roto Dynamic Pump
Positive Displacement Pump
Centrifugal Pump
Jet Pump
Reciprocating Pump
Rotary Pump
Piston or Plunger Pump
Diaphragm Pump
Gear Pump
Lobe Pump
Vane Pump
Screw Pump
Rotary Plunger Pump

02) Design of Centrifugal Pump

Step 01] General arrangements:-



STEP 02] ASSUMPTIONS:-

- Volumetric efficiency:
- Mechanical efficiency:
- Velocity in section pipe;

  Vs= 1.5 to 3 m/s
- Velocity in delivery:

  Vd= 4 to 6 m/s

STEP 03] DESIGN OF SUCTION AND DELIVERY PIPES:-

- Theoretical discharge:

$$\eta_{vol} = \frac{Q_{act}}{Q_{th.}}$$

- Design of suction pipe:

$$Q_{th.} = A_s \times V_s$$

- Design of delivery pipe:

$$Q_{th.} = A_s \times V_s$$

STEP 04] CALCULATION OF MANOMETRIC HEAD:-

- Calculate the manometric head by considering losses in suction and delivery pipes.

STEP 05] MOTOR SELECTION:-

- Motor power:

$$Power = \frac{\omega . Q_{th} . H_{man}}{overall\ efficiency}$$

- Speed :

Have to select from design data book.

STEP 06] DESIGN OF IMPELLER:-

Calculate thickness, width and number of blades.

- Eye Diameter=Suction pipe dia.
- Blade speed at inlet (u1):

$$u_1 = \frac{\pi D_1 N}{60}$$

- Blade speed at outlet (u2):

$$K_u = \frac{u_2}{\sqrt{2\ g\ Hman}}$$

- Dia. of impeller at out let:

$$u_1 = \frac{\pi D_1 N}{60}$$

- Number of blade (Z):

$$Z = 6.5 \left(\frac{D_1+D_2}{D_1-D_2}\right) sin \left(\frac{\alpha+\beta}{2}\right)$$

$$\alpha \;\&\; \beta \rightarrow can\ be\ calculate\ by\ using\ inlet\ and\ outlet\ velocity\ diagram$$

- Width and thickness at inlet and outlet:

$$Q_{th} = K\,\pi D_1 b_1 V f_1$$

$$Q_{th} = K\,\pi D_2 b_2 V f_2$$

Take K= 0.92

From above equation we can calculate width b1 and b2 at inlet and outlet respectively.

- Assuming thickness of blade at inlet is,

t1= 3 to 5mm

- Assuming thickness of blade at outlet is,

t2= 6 to 8mm

STEP 07] DESIGN OF IMPELLER SHAFT:

- Calculate torque:

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

- Calculate bending moment:

Calculate static and Dynamic load of impeller.

i) Static load of impeller (Fs): weight of impeller and weight of front and back shroud.

ii) Dynamic load of impeller (Fd): centrifugal force due to unbalance mass of impeller. [Unbalance mass have to take 10% of the whole mass]

iii) bending load on shaft F=Fs+Fd

- Calculate equivalent torque:
- Calculate shaft diameter by using equivalent torque.

Step 08] Selection of Bearing:

- Radial load on bearing:

  Fr= Support reaction at shaft.
- Axial load on bearing:
- Bearing speed(N):

  N= Speed of Gear
- Life of bearing:
- Equivalent load (Peq):

  Peq =1.5 x Fr
- Dynamic load C:

  $C = (L)^{1/k} . P$
- Select the bearing from PSG by using dynamic load carrying capacity. And check for life required.

STEP 09] DESIGN OF CASING:-

- Design volute casing, have to calculate radius of casing at different angle:

$$R_\theta = R_2 + 5mm + d_\theta$$

R2→ outside radius of impeller

$$d_\theta = d_{th}\sqrt{\frac{\theta}{360-26}}$$

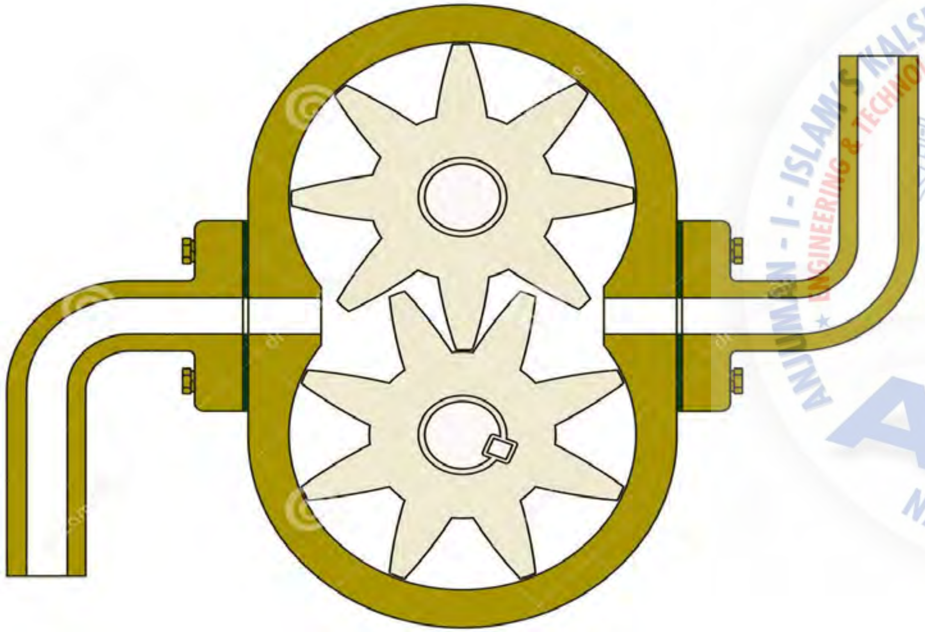
$$Q_{th} = \frac{\pi}{4}\, dth^2 V_{th}$$

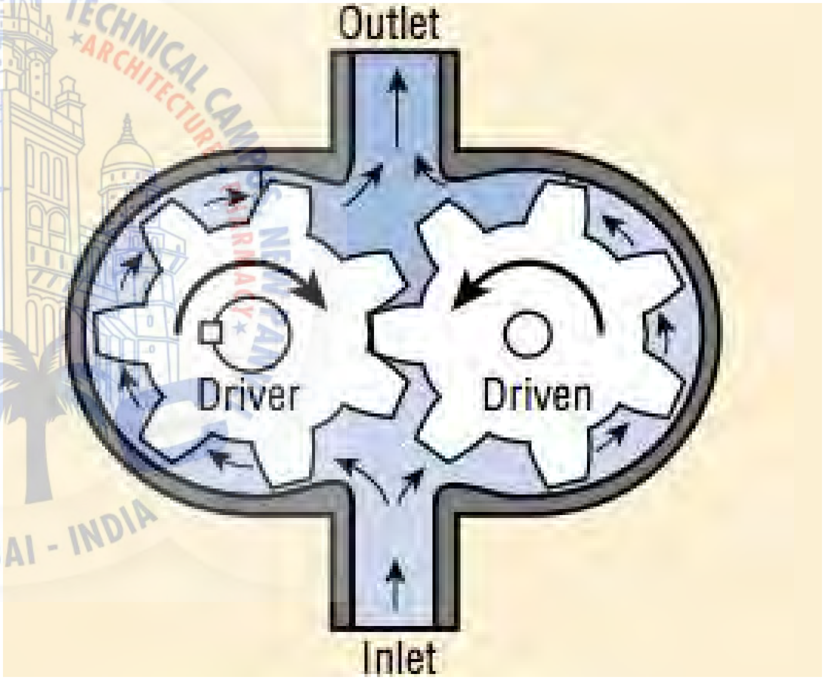
Vth=0.25 u2

STEP 10] DESIGN OF FLANGE AND FASTENER:-

01) Design of Gear Pump

Step 01] constructions:-





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STEP 04] CALCULATION OF MANOMETRIC HEAD:

- Calculate the manometric head by considering losses in suction and delivery pipes.

Step 05] Motor Selection:

- Motor power:

$$Power = \frac{pressure \times discharge}{overall\ efficiency}$$

- Speed :
- Have to select from design data book.

STEP 06] DESIGN OF SPUR GEAR:

- Speed and number of teeth of gear and pinion:

  consider number of teeth for gear and pinion: 12 to 14.

- Material for gear:

  Select from [PSG 1.9]

  and calculate bending and contact stress [PSG 8.18 & 8.16]

- Calculate module (m):

  $$Q_{th} = 2\,\pi\,b\,m^2\,z\,N$$

- Checking Lewis dynamic load: [PSG 8.50]
- Checking Buckinghams dynamic load:[PSG 8.51]
- Calculate principle dimensions of gear. [PSG 8.22]
- Design the shaft and hub to support the gears.

STEP 07] SELECTION OF BEARING:

- Radial load on bearing:

  Fr= Support reaction at Gear shaft.

- Bearing speed(N):

  N= Speed of Gear

- Life of bearing:
- Equivalent load (Peq):

  Peq =1.5 x Fr

- Dynamic load C:

  $C = (L)^{1/k} . P$

Select the bearing from PSG by using dynamic load carrying capacity.

STEP 08] DESIGN OF CASING:

- Thickness of casing:

$$\frac{t}{r_1} = \left[{}^{1+\frac{P_1}{[\sigma]}} \Big/ {}_{1+\frac{P_1}{[\sigma]}} \right]^{1/2} - 1$$

…………………[PSG 6.15]

Step 09] Design of fastener:

Step 10] Design of Coupling: