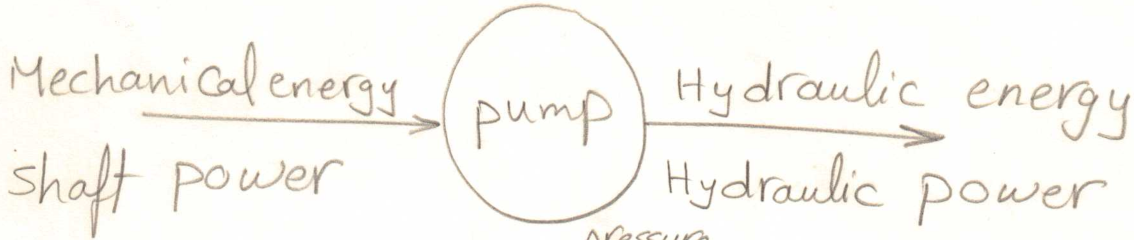
pumps



pressure

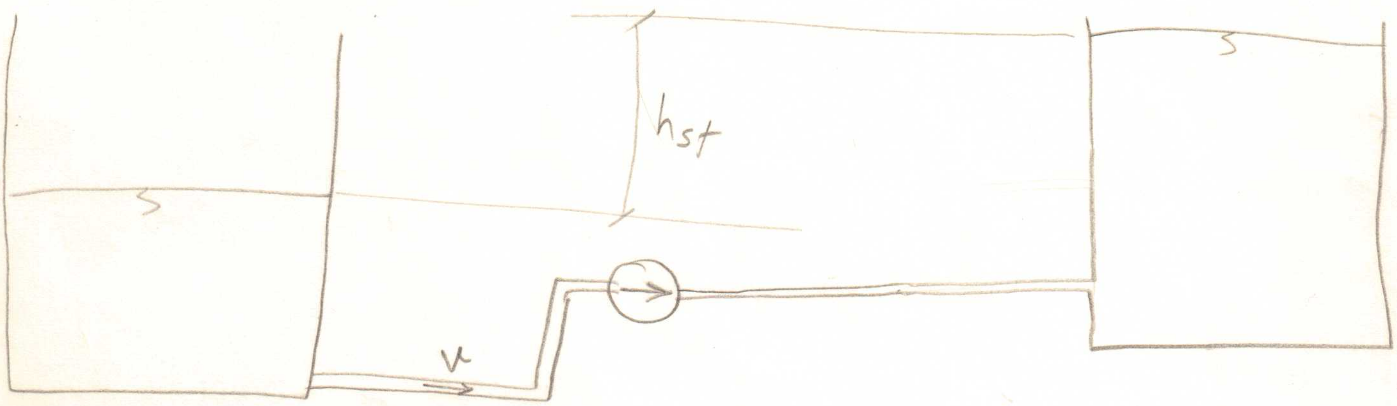
$$\text{Hydraulic power} = PQ = \omega h Q$$

$$= \frac{N}{m^2} * \frac{m^3}{s} = \frac{N.m}{s} \quad (\text{watt})$$

$$\eta_{pump} = \frac{O/P}{I/P} = \frac{\text{Hyd. power}}{\text{shaft power}} = \frac{PQ}{\text{sh. power}}$$

pump efficiency

$$\boxed{\text{shaft power} = \frac{PQ}{\eta_{pump}} = \frac{\omega h Q}{\eta_p}}$$



$$\boxed{h_{pump} = h_{st} + h_{\substack{losses\\total}} + \frac{V^2}{2g}}$$

$h_{static} = h_{st}$ = level difference between delivery and suction tanks.

$$P_{pump} = \omega h_{pump}$$

Types of pumps

positive displacement pumps

a- Reciprocating pumps
  i) piston pump
  ii) Diaphram pump

b) Rotary pumps
  i) Gear pump
  ii) vane pump
  iii) parallel cylinder pump

- used for fluid power systems.

Advantages

1) High-pressure capability.
2) small, compact size.
3) High volumetric efficiency.
4) small changes in efficiency throughout the design pressure range.
5) Great flexibility of performance.

Non-positive displacement pumps

(Dynamic head pumps)

a- Centrifugal pump
b- Axial flow pump

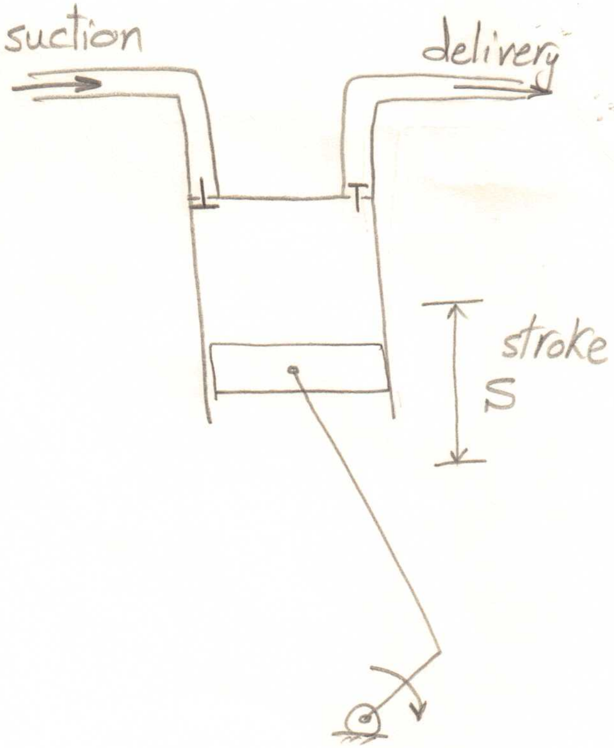
- used for low-pressure, high-volume flow application.

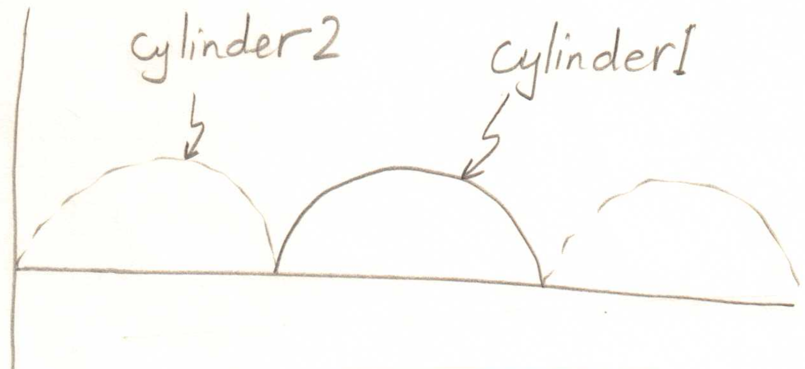
- used for transporting fluids from one location to another.

* Positive displacement pumps

a- Reciprocating pumps

i) piston pump





$$\boxed{Q_{ideal} = \frac{\pi}{4} D^2 * S * \frac{N}{60}}$$

N : rpm of motor

S : stroke

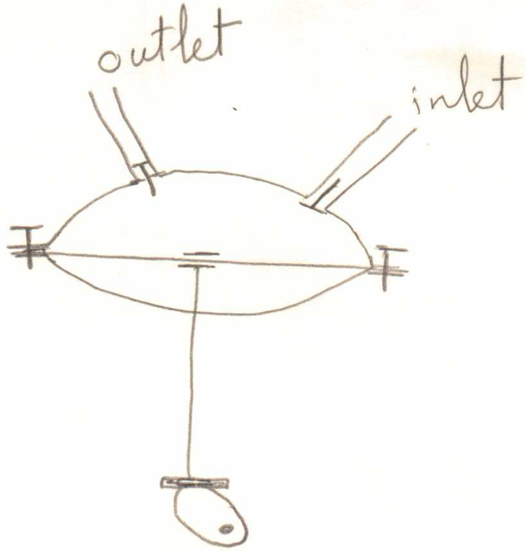
$Q_{act} < Q_{ideal}$ due to leakage

$$\boxed{Q_{act} = \eta_{vol} \, Q_{ideal}}$$

η_{vol} = volumetric efficiency $\simeq 97\%$

* This pump is a type of positive pumps which gives the max. discharge.
* If the delivery valve is closed, the motor or the pump can be destroyed.
* when this pump rotates at constant speed, it should give constant discharge.

ii) Diaphram pump

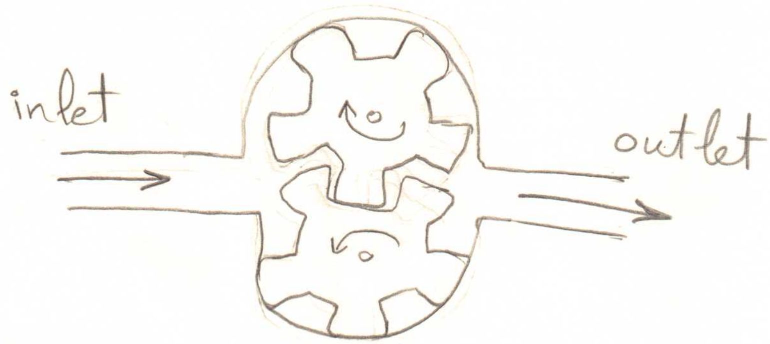


disadvantages

- very low pressure
- low discharge

b) Rotary pumps

i) Gear pump



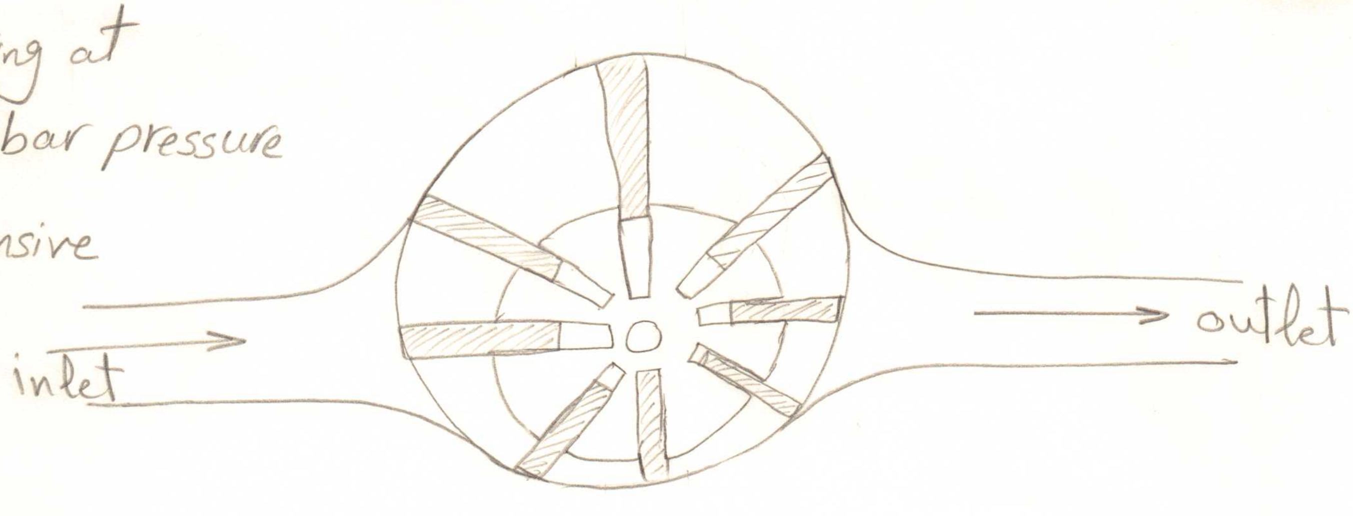
$$Q = \eta_{vol} * 2n(a*l)\frac{N}{60}$$

n = no. of teeth
l = gear length
a = area between two teeth
N = rpm

* This pump is only used for oil.
* One of the cheapest pumps.
* High pressure but low discharge.

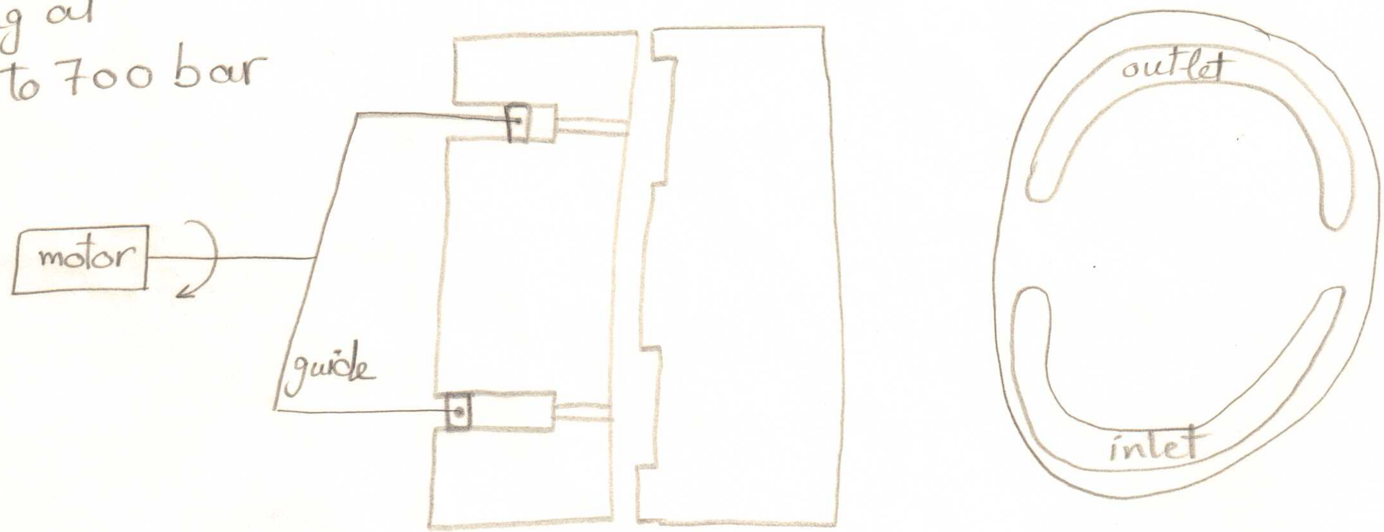
ii) vane pump

* working at 500 bar pressure
* expensive



iii) parallel cylinder pump

* working at 600 to 700 bar

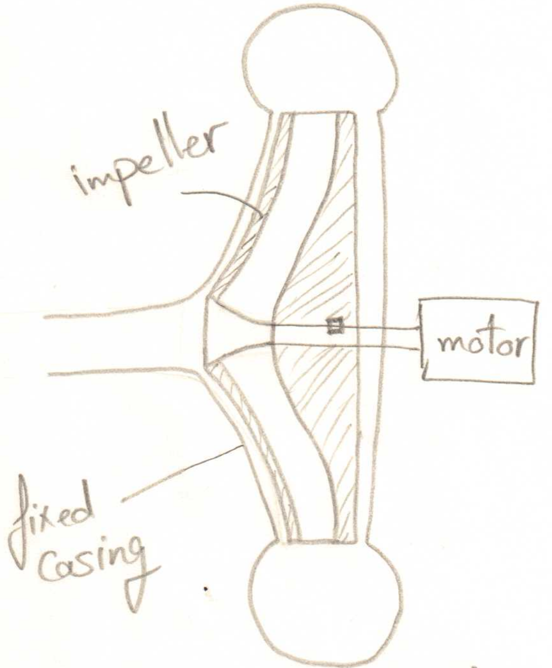


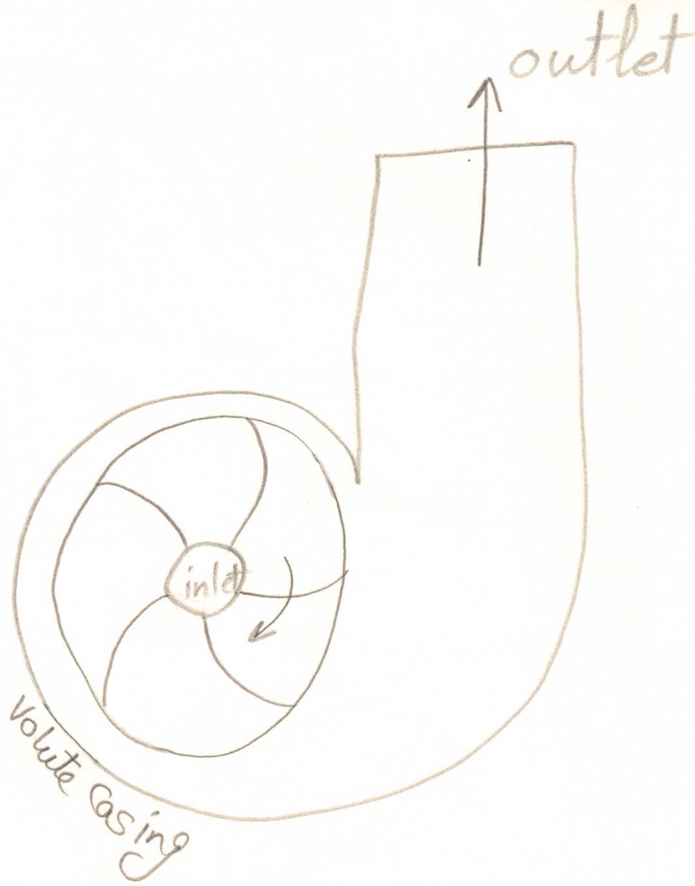
* The most expensive pump

Non-positive displacement pumps

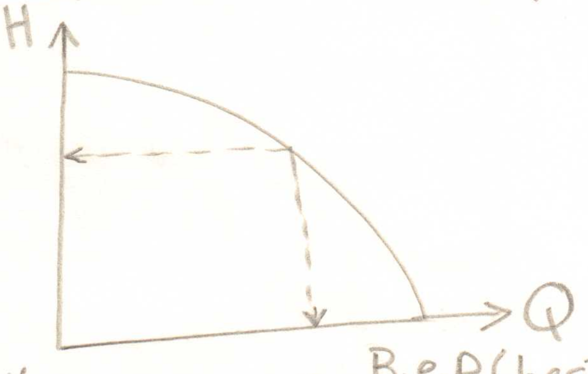
(Dynamic head pumps)

a) centrifugal pump

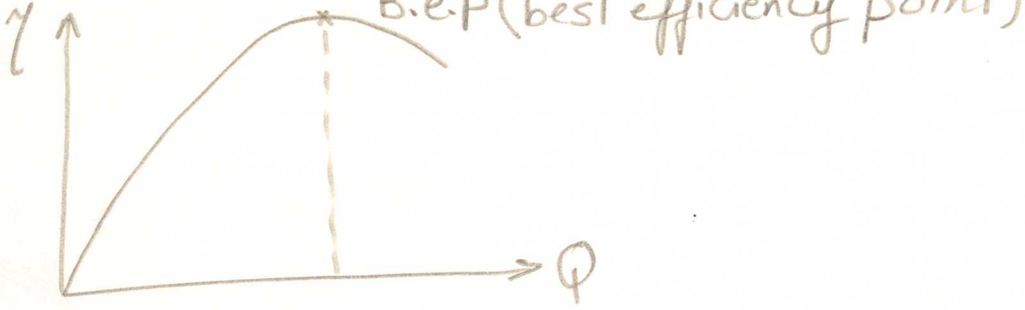


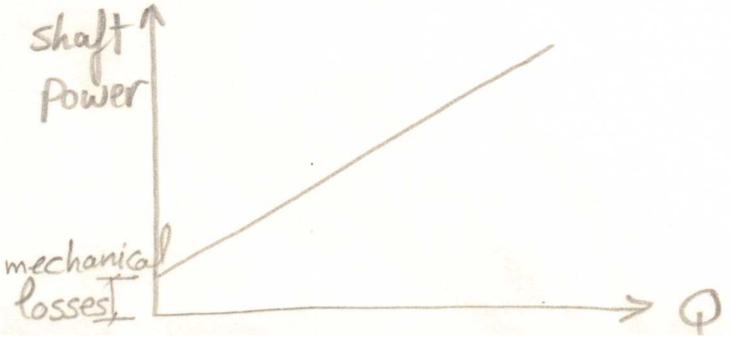


* performance curves of pumps



هذه المنحنيات يتم رسمها
للطلمبة عند تصنيعها





$$\text{shaft power} = \frac{w Q H}{\eta}$$

* piping system curve

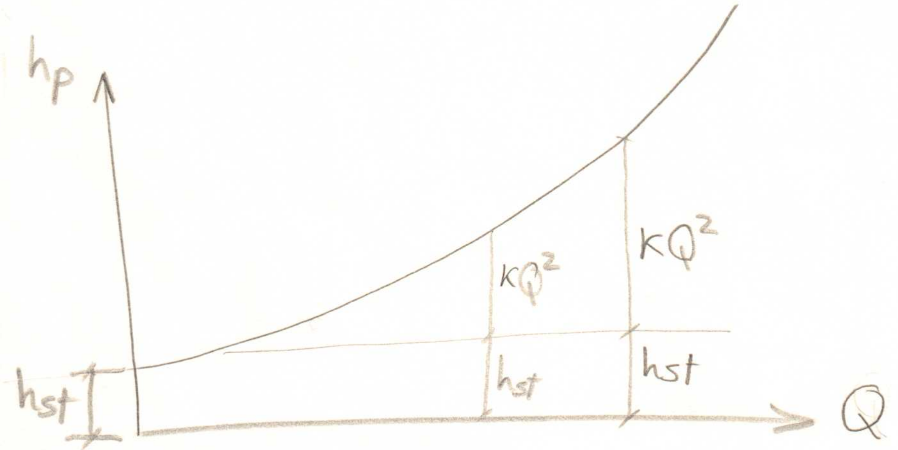
$$h_{piping} = h_{st} + h_{losses\,total} + \frac{V^2}{2g}$$

$$\boxed{Q = Av \qquad \frac{Q}{A} = v}$$

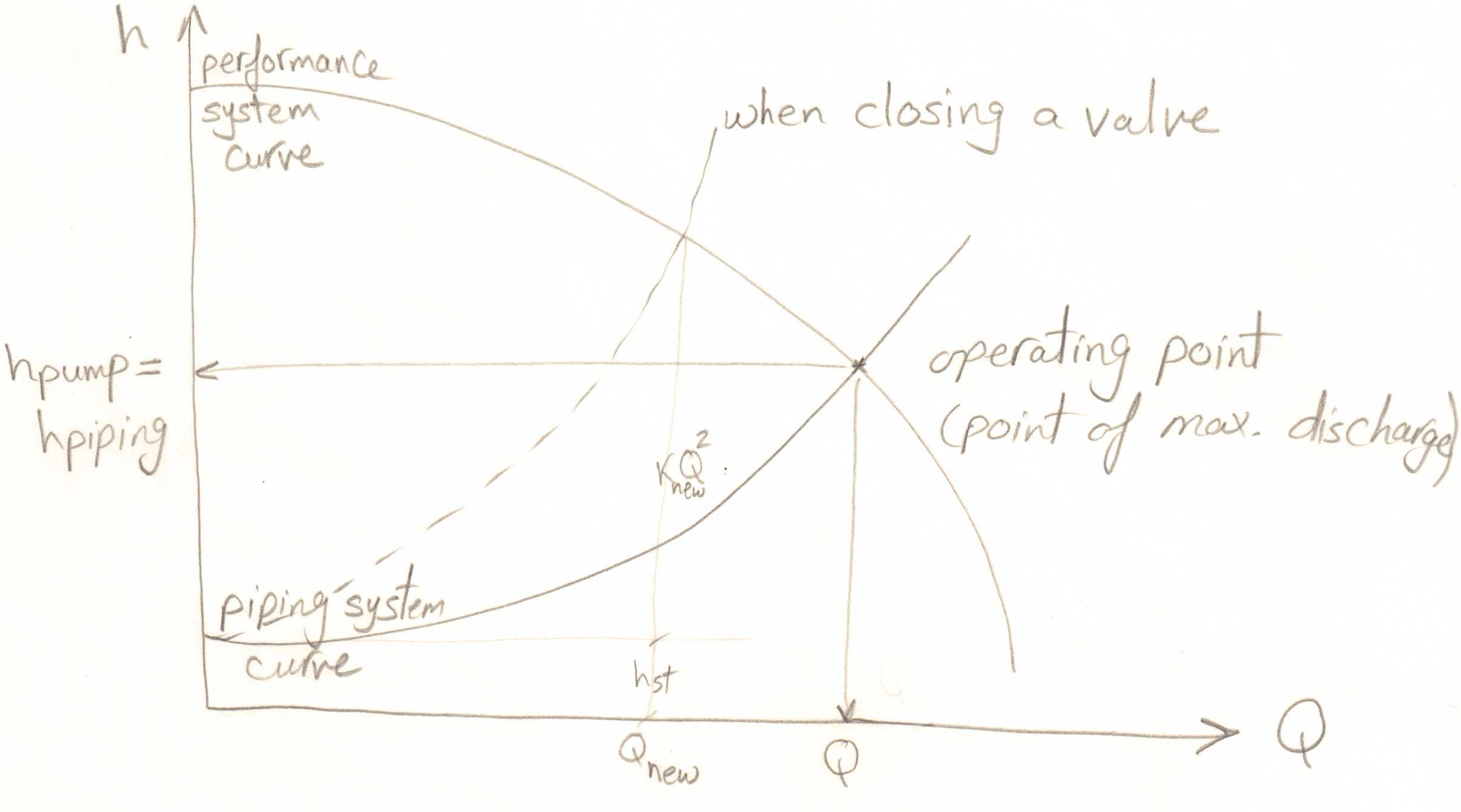
$$= h_{st} + V^2\left(\frac{fL}{d\,2g} + \frac{K_1}{2g} + \frac{K_2}{2g} + \cdots\right) + \frac{V^2}{2g}$$

$$= h_{st} + \frac{Q^2}{A^2}\left(\frac{fL}{d*2g} + \frac{K_1}{2g} + \frac{K_2}{2g} + \cdots\right) + \frac{Q^2}{2gA^2}$$

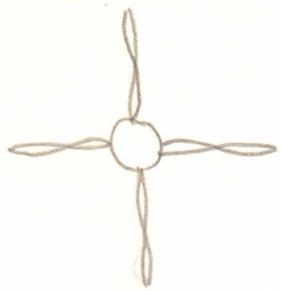
$$\boxed{h_p = h_{st} + KQ^2}$$ piping system curve

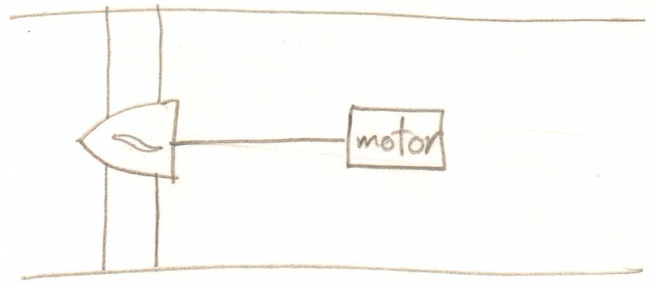


* when putting the pump in the piping system



B) Axial flow pump (propeller pump)

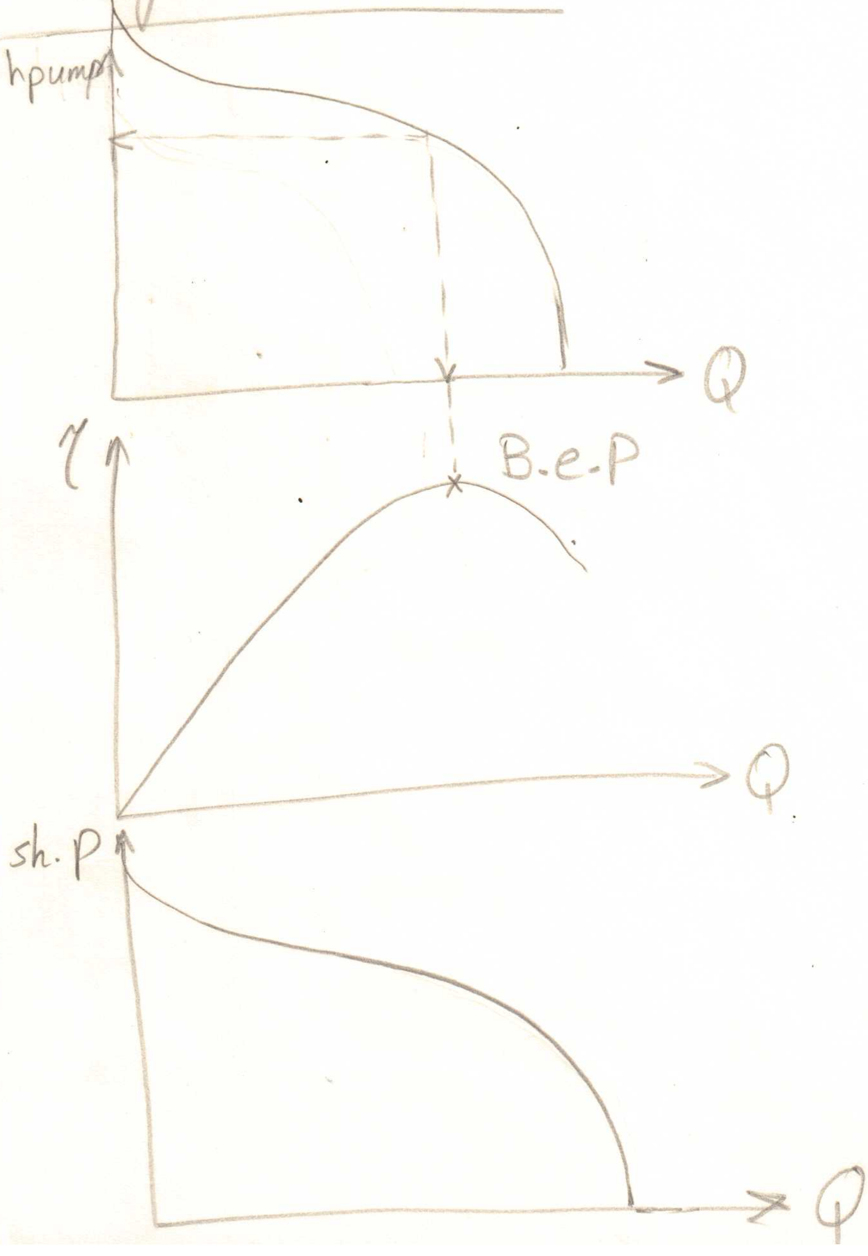




* This pump gives very high discharge
& very low pressure (head) up to 15 m

* It used for irrigation, sanitation.

* Performance curves



* نفس كلام الطلمبة الطاردة المركزية
ينطبق على هذه الطلمبة
ماعدا sh.P عند البداية

Cavitation in pumps

* إذا وصل ضغط السائل داخل المضخه أو قبلها (فى ماسوره السحب) .
إلى ضغط البخار يتحول جزء من السائل الى بخار

* يبدء ضغط السائل فى الارتفاع داخل المضخه الى ضغط أكبر من ضغط البخار الذى يتكثف على الجدران و يندفع السائل حول الفقاعات ليصطدم بالاجزاء الداخليه بالمضخه مسببا ما يلى :-

(١) صوت طرقات متتاليه
(٢) اهتزازات ميكانيكيه
(٣) انخفاض فى كفاءه عمل المضخه والتصرف والضغط
(٤) يتحول السائل الخارج من المضخه إلى لون جيرى (milky Color)

* تكرار هذه الظاهره تحدث تآكل فى المضخه بما يشبه تسوس الاسنان

---

* لتجنب حدوث التكهف من المعادله يجب :-

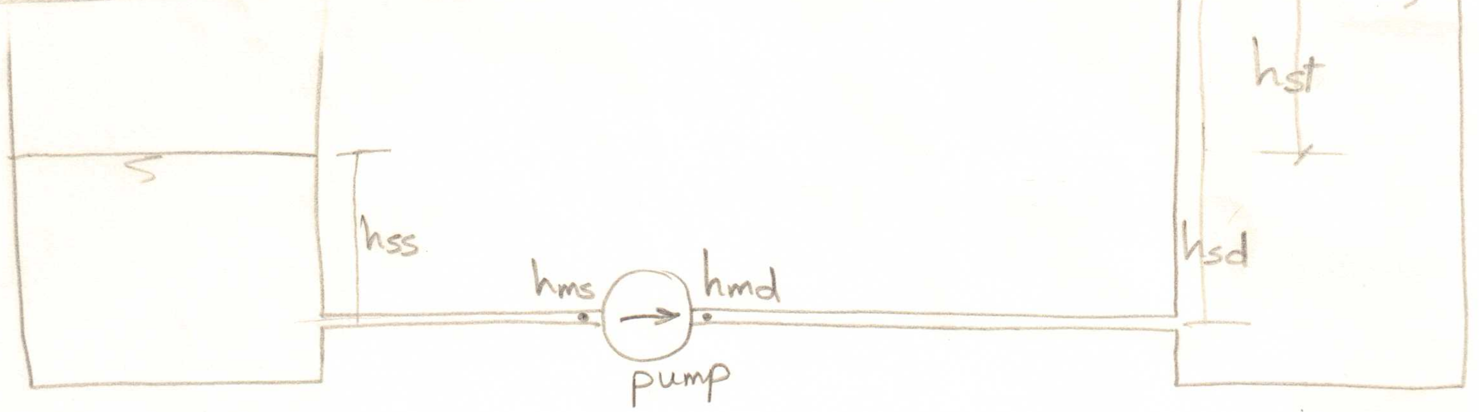
(*) زياده الطرف الايسر من المعادله الى أكبر ما يمكن وذلك بمراعاه الآتى :-

(١) يجب وضع المضخه فى أقل منسوب ممكن بالنسبه لمستوى السحب
(ليؤدى ذلك الى زياده h_{ss})

(٢) تقليل الفاقد فى ماسوره السحب بقدر الامكان

(أ) عن طريق وضع المضخه فى أقرب مكان ممكن بالنسبه لخزان السحب (تقليل طول ماسوره السحب) (ب) زياده قطر ماسوره السحب لتقليل السرعه وبالتالى تقليل الاحتكاك (ج) تجنب استخدام أى مصدر من مصادر فواقد الدوامات الا للضروره القصوى .

to avoid cavitation



$$P_{min} > P_{vap} - P_{atm}$$

$$\boxed{h_{min} > h_{vap} - h_{atm}}$$

*it happens just before pump

h_{ss} : static suction head

h_{sd} : ~ delivery ~

h_{ms} : manometric suction head

h_{md} : ~ delivery ~

$$\boxed{h_{min} = h_{ms} = h_{ss} - h_{ls} - \frac{V^2}{2g}}$$

h_{ls} : head loss in suction side

$$\boxed{h_{ss} - h_{ls} - \frac{V^2}{2g} > h_{vap} - h_{atm}}$$

for positive displacement pumps

&

$$h_{ss} - h_{ls} - \frac{V^2}{2g} - NPSH > h_{vap} - h_{atm}$$

تخص المضخة

$$\boxed{h_{ss} - h_{ls} - \frac{V^2}{2g} + (h_{atm} - h_{vap}) > NPSH}$$

for dynamic head pumps

تخص المستخدم

Net positive suction head

من كتالوج المضخة