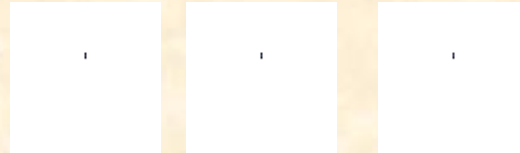




# PENGENALAN SISTEM PAM



*Ir. Razdwan Bin Kasim*



## APAKAH SISTEM PAM ?

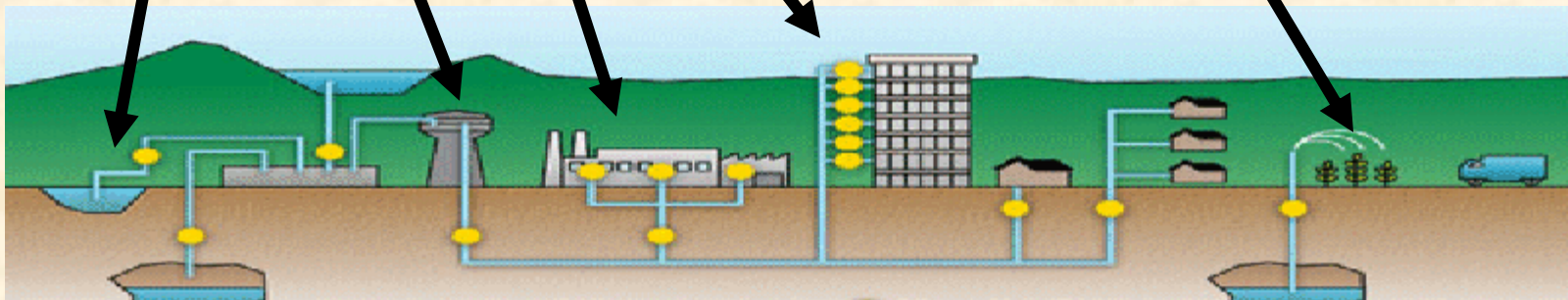
PENGHANTARAN AIR DARI TANGKI SEDUT  
KE TANGKI MENARA

PENGEPAMAN AIR 'CHILLED WATER'

PENGEPAMAN AIR PENCEGAH KEBAKARAN

SISTEM PAM AIR MENTAH

SISTEM SIRAMAN





## OBJEKTIF SESI INI :

### MEMPERKENALKAN SISTEM PAM

- KOMPONEN SISTEM
- JENIS & KOMPONEN PAM
- CIRI PAM & SISTEM
- ASAS REKABENTUK





UNTUK TUJUAN SESI INI :  
**SISTEM PAM ADALAH SISTEM  
PENGHANTARAN AIR DARI  
SATU LOKASI KE LOKASI LAIN  
DENGAN PERALATAN PAM  
SAMADA BERKUASA ELEKTRIK,  
DIESEL.**





## BILA PAM DIPERLUKAN

### \* BEKALAN GRAVITI TAK MENENTU

waktu puncak  
kawasan terpencil  
kawasan baru

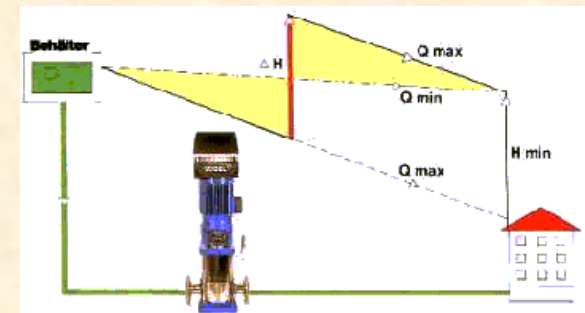
### \* SISTEM GRAVITI BARU MAHAL

### \* JAMINAN TEKANAN PERLU

flush valve, kerusi dentist, landas cucian,  
sistem pencegah kebakaran, ac

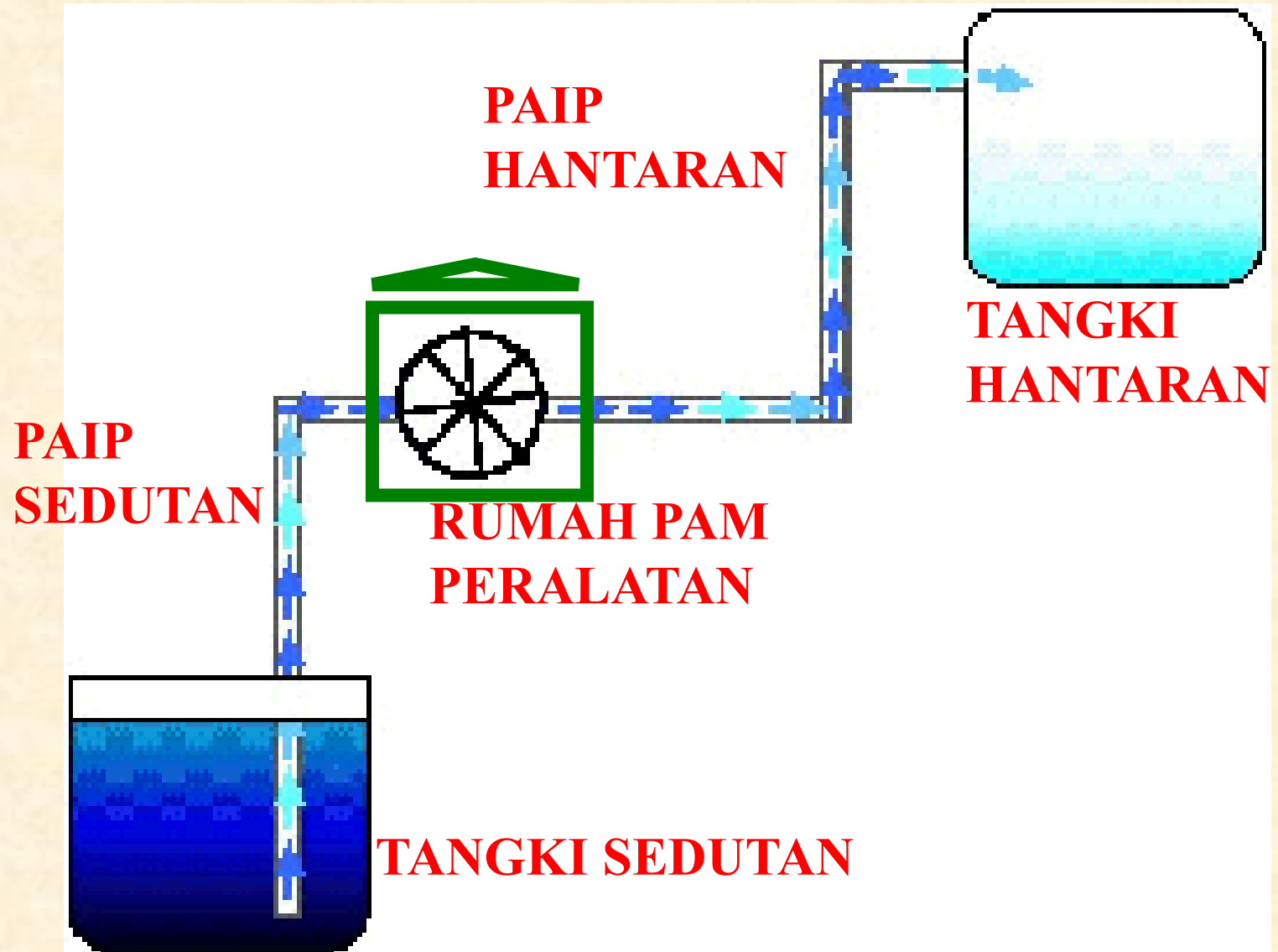
### \* PEMINDAHAN

lokasi rendah ke lokasi tinggi





## KOMPONEN SISTEM



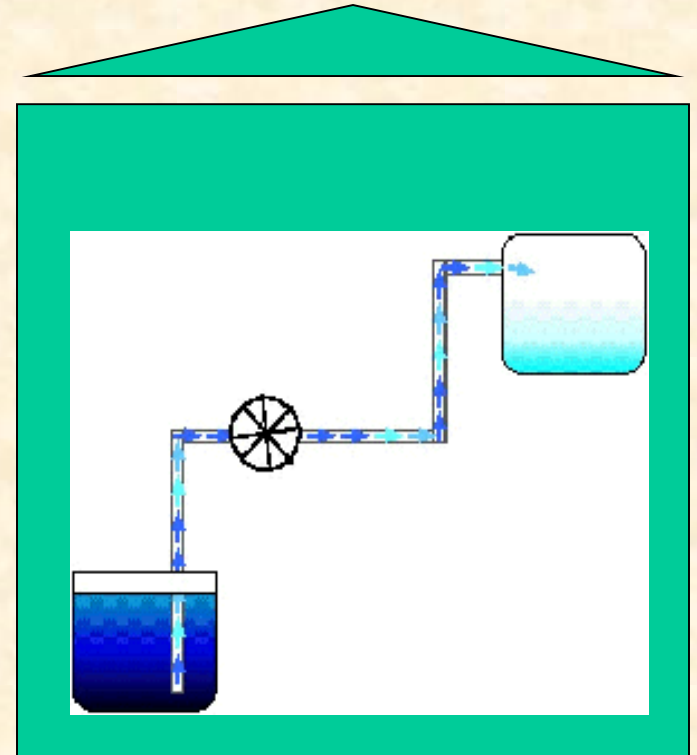
# SISTEM PAM

## KOMPONEN SISTEM

### RUMAH PAM



- MELINDUNGI PERALATAN  
(CUACU, VANDALISM ..)
- MEMUDAHKAN  
PENYENGGAHAN



# SISTEM PAM

## KOMPONEN SISTEM

### RUMAH PAM



**RUANG MENCUKUPI (cth : 600 mm sekeliling) ,**  
**PENGUDARAAN (kipas / tingkap / vent blocks),**  
**PENCAHAYAAN (lampu / tingkap kaca) ...**  
**PINTU KEMBAR BUKA KELUAR**



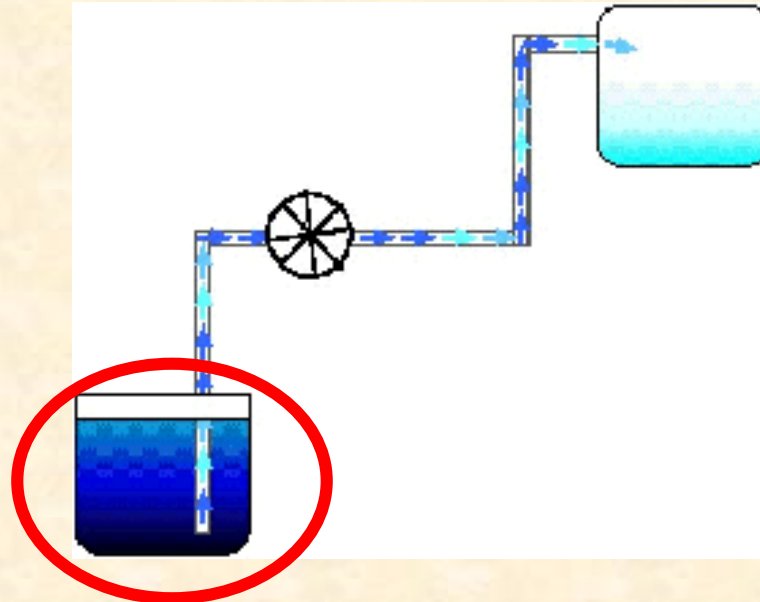
# SISTEM PAM

## KOMPONEN SISTEM



### TANGKI / KEBUK SEDUTAN

1. PERANGKAP BAHAN APONG (kayu dll)
2. MENAMPUNG MENDAKAN (reserve capacity)
3. KAWAL KELAJUAN
4. TIADA 'VORTEX'/ UDARA
5. TIDAK GANGGU BEKALAN HULU SISTEM



# SISTEM PAM

## TANGKI / KEBUK SEDUTAN

### - BEKALAN AIR STABIL & MENCUKUPI

#### 1. SISTEM BEKALAN AIR

##### - 1/3 BEKALAN SEHARI

##### - 1 JAM OPERASI



**SISTEM PAM**

**TANGKI / KEBUK SEDUTAN**

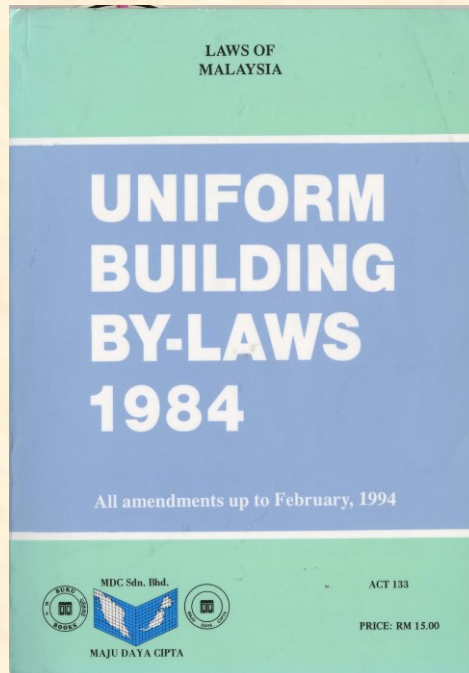
**- BEKALAN AIR STABIL & MENCUKUPI**



## **2. SISTEM PENCEGAH KEBAKARAN**

**- UBBL, 1984**

**- BS 5306 : PART 2**



# SISTEM PAM

## TANGKI / KEBUK SEDUTAN

- BEKALAN AIR STABIL & MENCUKUPI

### 3. SISTEM PENYAMAN UDARA

- KECIL, BESEN MENARA PENYEJUK



# SISTEM PAM

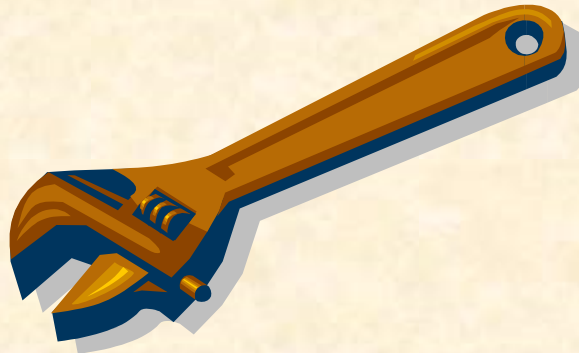
## TANGKI / KEBUK SEDUTAN

### - BEKALAN AIR STABIL & MENCUKUPI



#### 4. UMUM

- BEKALAN AIR TIDAK TERPUTUS
- PAM TIDAK BEROPERASI KERING
- 'BUFFER' UTK RESPONSE



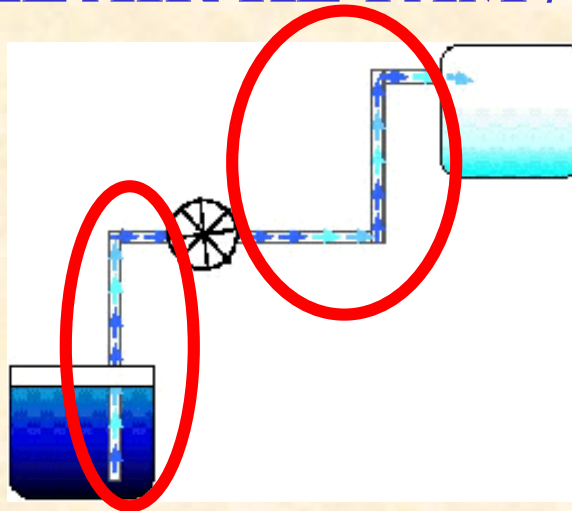
# SISTEM PAM

## KOMPONEN SISTEM



### PAIP SEDUTAN / HANTARAN

- MEMBEKAL AIR KE PAM / TANGKI



### CIRI-CIRI

- PENDEK, LURUS, LONG RADIUS
- TIADA PERANGKAP UDARA
- TIDAK TERLALU LAJU / PERLAHAN
- RADIUS TEE, ANCHOR

# **SISTEM PAM**

## **KOMPONEN SISTEM**



### **PAIP SEDUTAN / HANTARAN**

- MEMBEKAL AIR KE PAM / TANGKI**

### **SISTEM AC**

- HAD LAJU & RINTANGAN**

### **SISTEM FF**

- SPRINKLER ‘Residual pressure, 500 mbar’**
- WET RISER ‘4 ~ 5 bar’**



## KOMPONEN SISTEM

### UMUM

### - PIAWAIAN HAD LAJU

**RECOMMENDED SUCTION VELOCITIES**

| Pipe Bore |     | Water |      |
|-----------|-----|-------|------|
| in        | mm  | ft/s  | m/s  |
| 1         | 25  | 1.5   | 0.5  |
| 2         | 50  | 1.6   | 0.5  |
| 3         | 75  | 1.7   | 0.5  |
| 4         | 100 | 1.8   | 0.55 |
| 6         | 150 | 2     | 0.6  |
| 8         | 200 | 2.5   | 0.75 |
| 10        | 250 | 3     | 0.9  |
| 12        | 300 | 4.5   | 1.4  |
| > 12      |     | 5     | 1.5  |

**RECOMMENDED DELIVERY VELOCITIES**

| Pipe Bore |     | Water |      |
|-----------|-----|-------|------|
| in        | mm  | ft/s  | m/s  |
| 1         | 25  | 3.5   | 1    |
| 2         | 50  | 3.6   | 1.1  |
| 3         | 75  | 3.8   | 1.15 |
| 4         | 100 | 4     | 1.25 |
| 6         | 150 | 4.7   | 1.5  |
| 8         | 200 | 5.5   | 1.75 |
| 10        | 250 | 6.5   | 2    |
| 12        | 300 | 8.5   | 2.65 |
| > 12      |     | 10    | 3    |

# SISTEM PAM

## KOMPONEN SISTEM

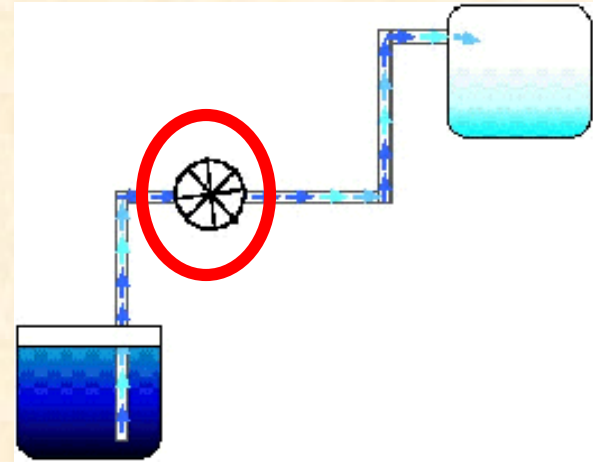


**PAM**

**- PENGGERAK AIR**

**CIRI-CIRI**

**- AKAN DIPERINCIKAN  
KEMUDIAN**



# SISTEM PAM

## KOMPONEN SISTEM



### TANGKI HANTARAN

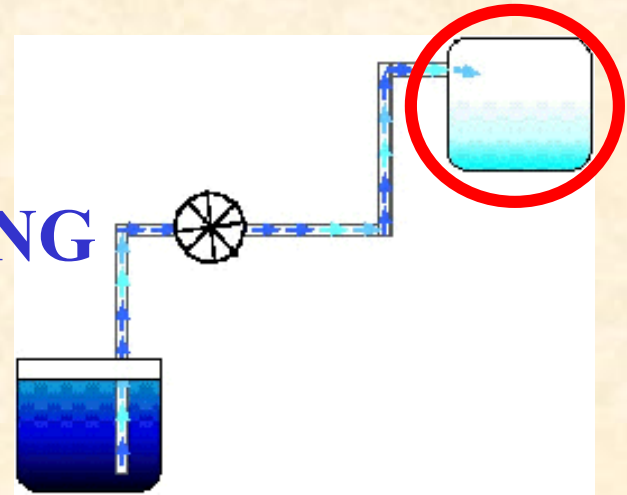
- MENYIMPAN AIR UNTUK  
KEGUNAAN AKAN DATANG

#### 1. MUATAN MENCIUKUPI

- BEKALAN SEHARI  
(utk sistem dalam bangunan)
- Pihak berkuasa tempatan

#### 2. MENAMPUNG MENDAKAN

- Kekerapan cucian / selenggara
- 'Buffer' utk tindakan masalah bekalan

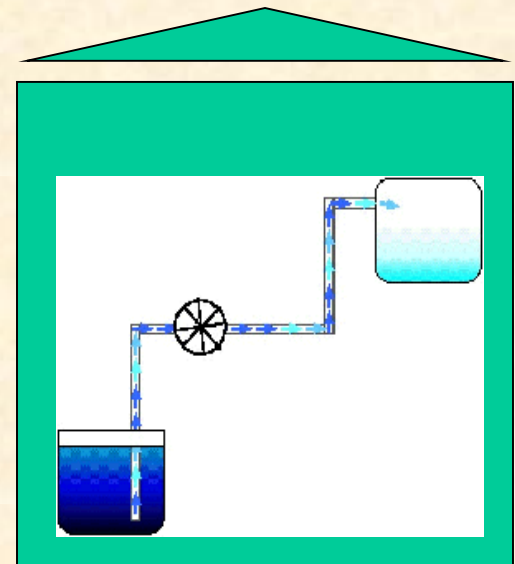


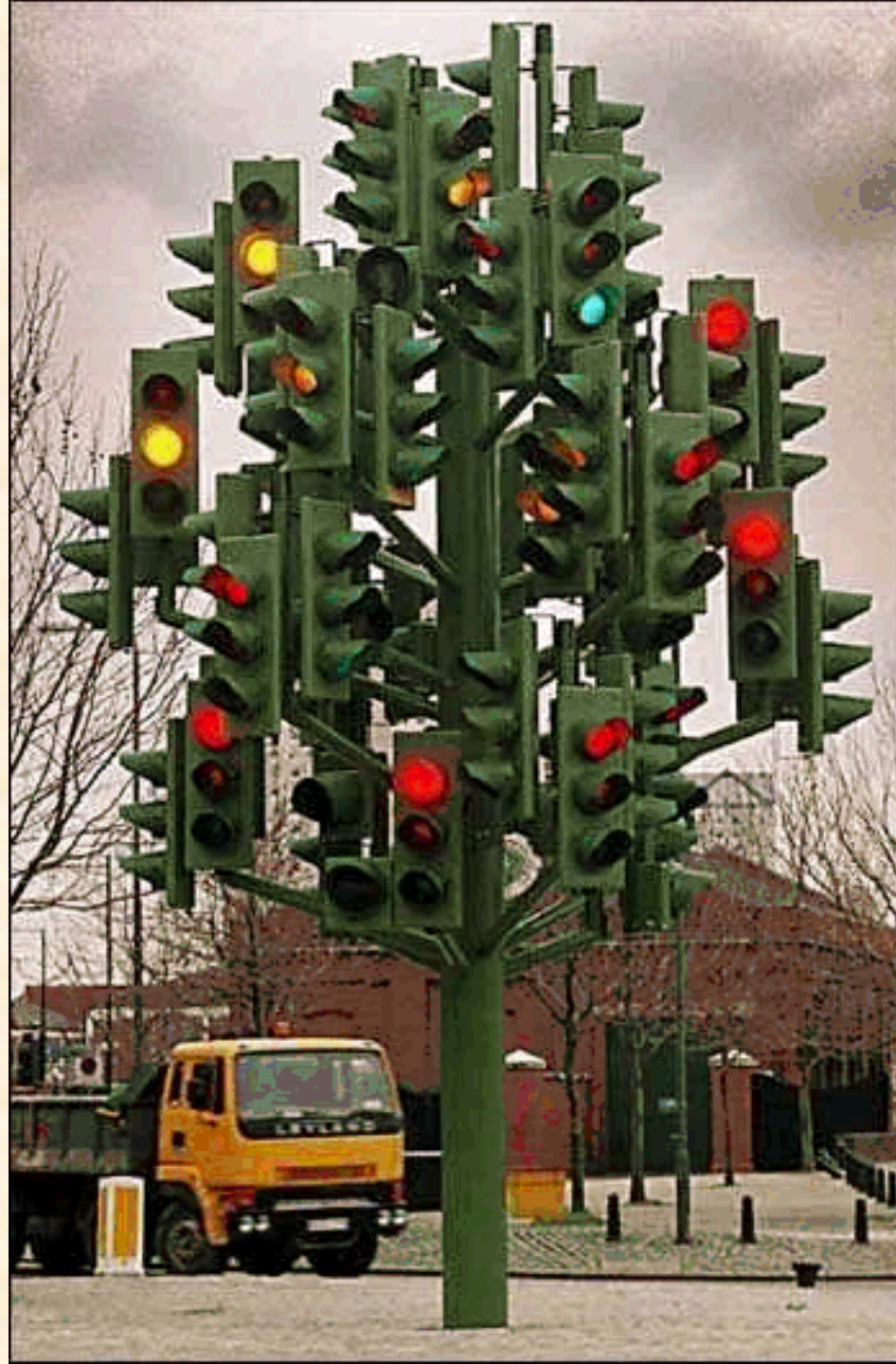


## MEMPERKENALKAN SISTEM PAM

- **KOMPONEN SISTEM**
- **KOMPONEN PAM**
- **CIRI PAM & SISTEM**
- **ASAS REKABENTUK**

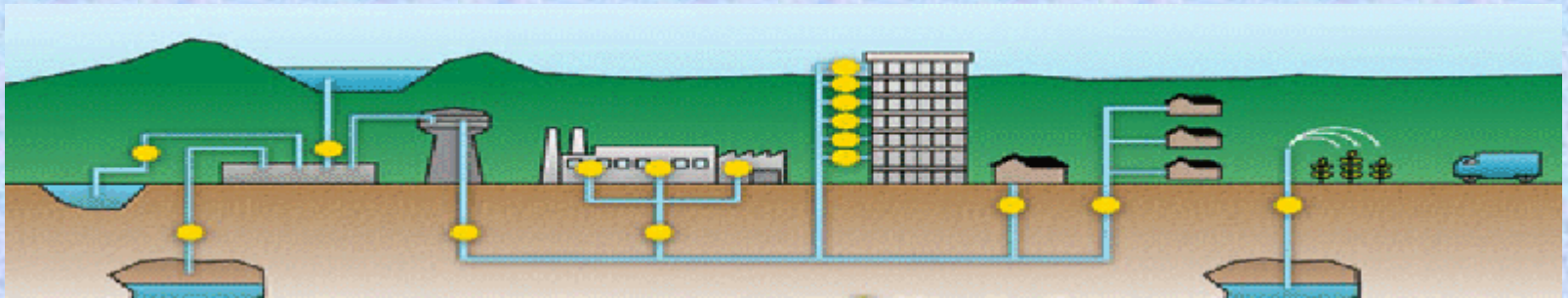
**Q & A  
REHAT**







## PENGENALAN SISTEM PAM



*Ir. Razdwan Bin Kasim*



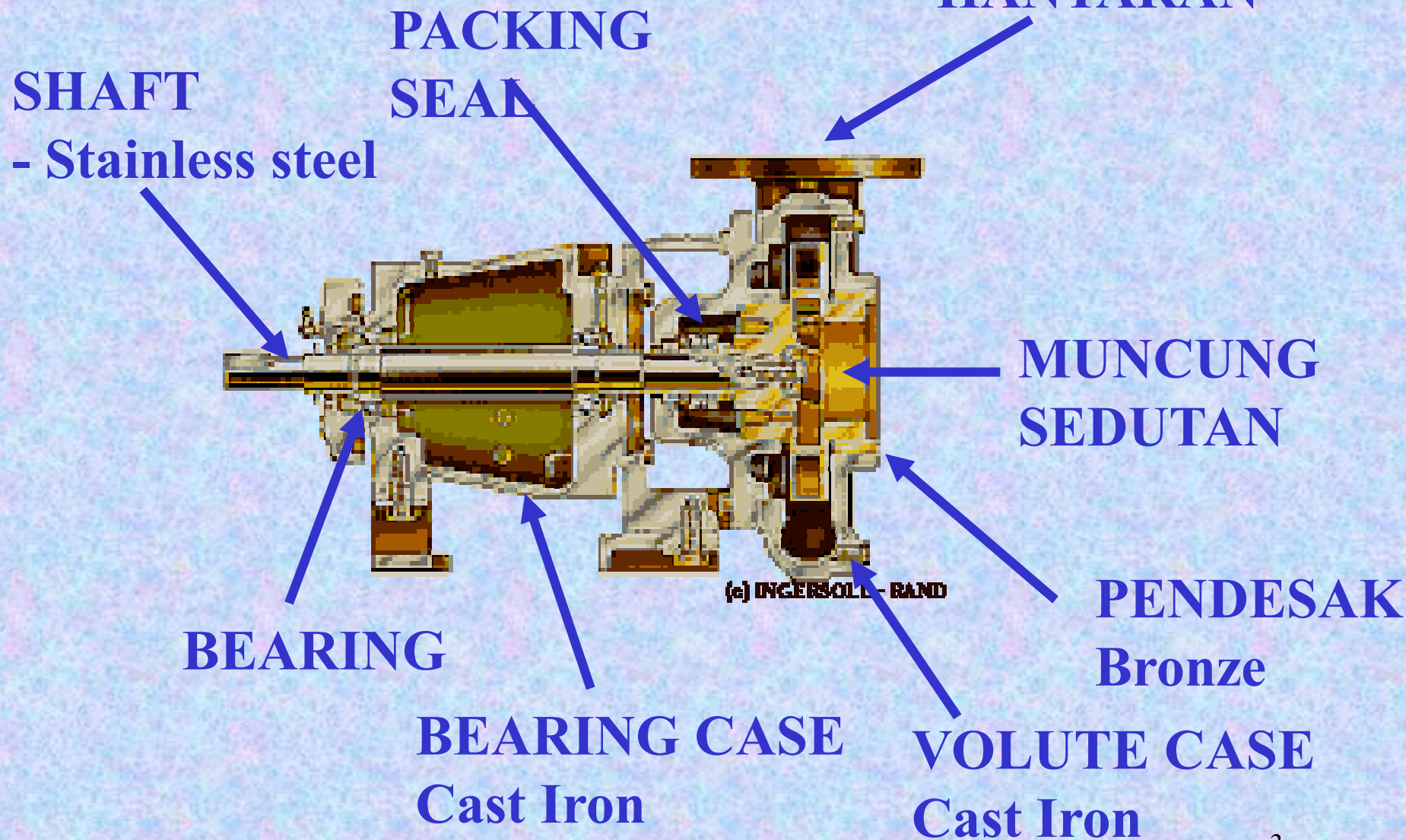
## OBJEKTIF SESI INI :

## MEMPERKENALKAN SISTEM PAM

- KOMPONEN SISTEM
- JENIS & KOMPONEN PAM
- CIRI PAM & SISTEM
- ASAS REKABENTUK



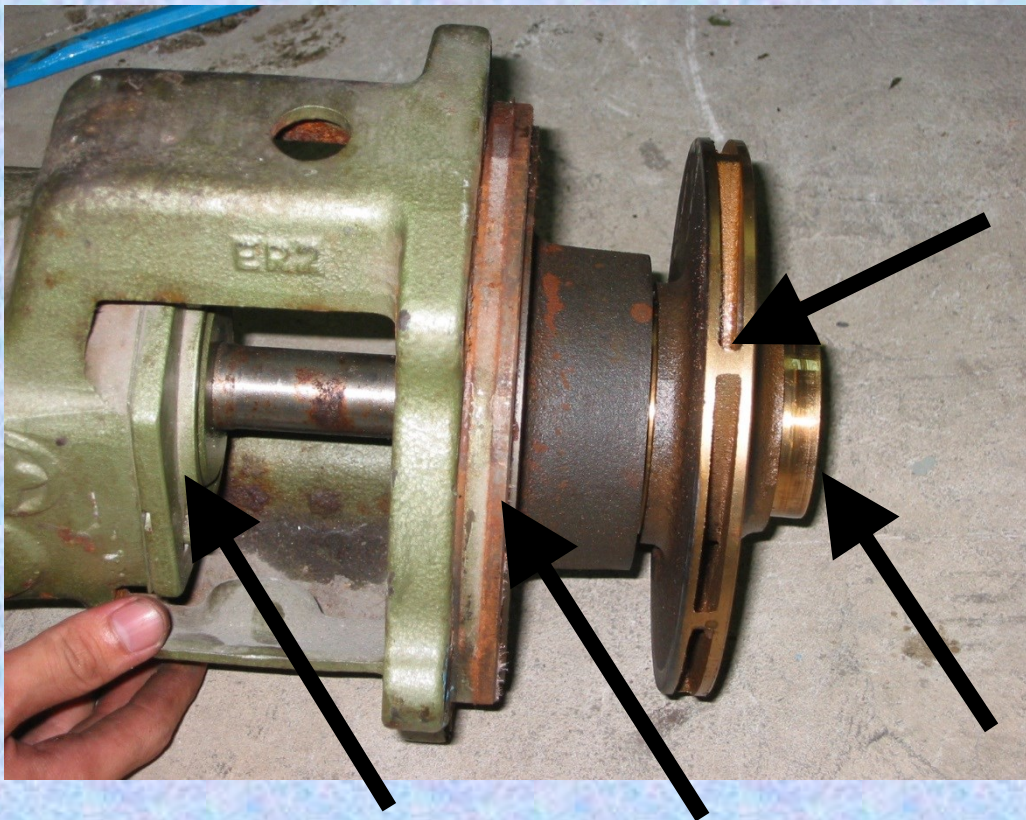
## KOMPONEN PAM





## KOMPONEN PAM

### LATIHAN NAMA / FUNGSI KOMPONEN



# SISTEM PAM

## KOMPONEN PAM

### SEAL

Tahan kebocoran air dari pam

#### - PACKING

murah, perlu diselenggara

#### - MECHANICAL

hayat lebih lama, mahal

minyak/air bersih utk pelinciran

Kebocoran kecil perlu  
untuk 'packing'!

### KENAPA ?

- pelinciran 'packing/shaft'
- halang udara masuk
- pengalir haba



# SISTEM PAM



## KOMPONEN PAM

### PENDESAK / IMPELLER

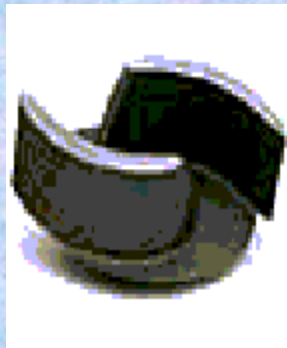
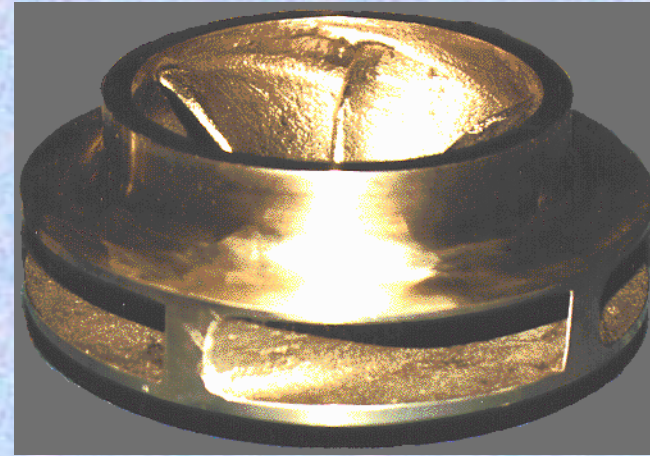
- JENIS 'CLOSE'

- JENIS 'OPEN'

- JENIS LAIN

kesan pada kecekapan

saiz dan jenis bahan yg boleh dipam





## **CIRI PAM**

### **LATIHAN CIRI**

# SISTEM PAM

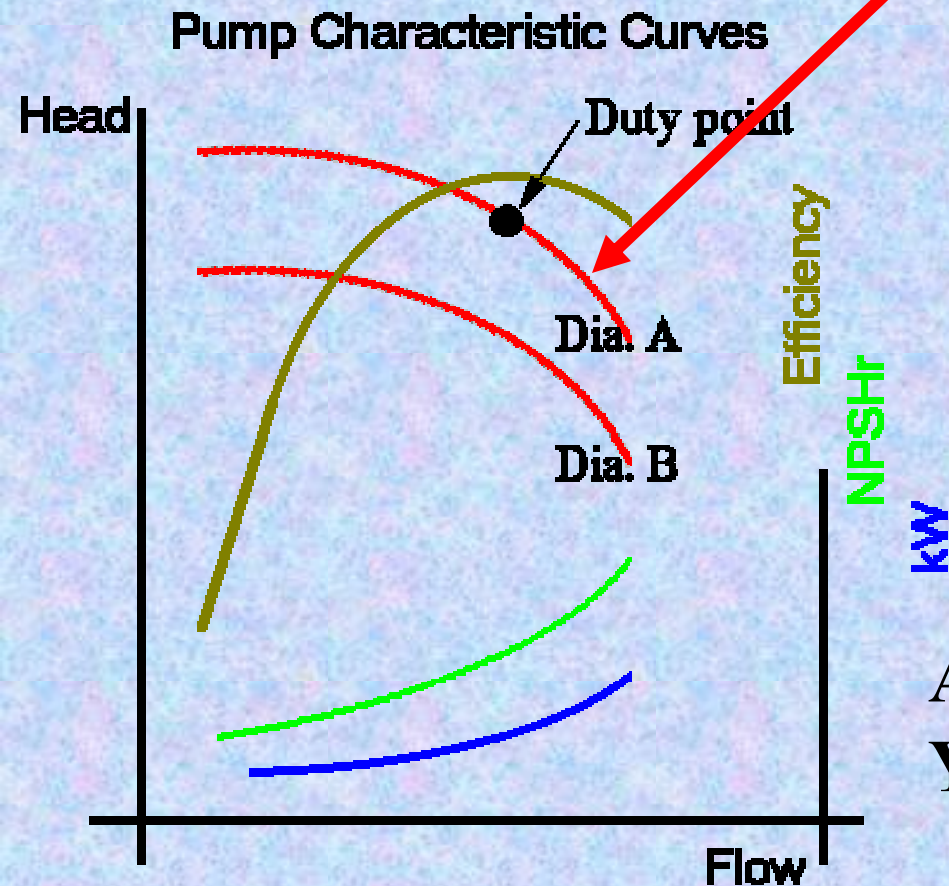
## CIRI PAM



### H-Q CURVE

(warna merah)

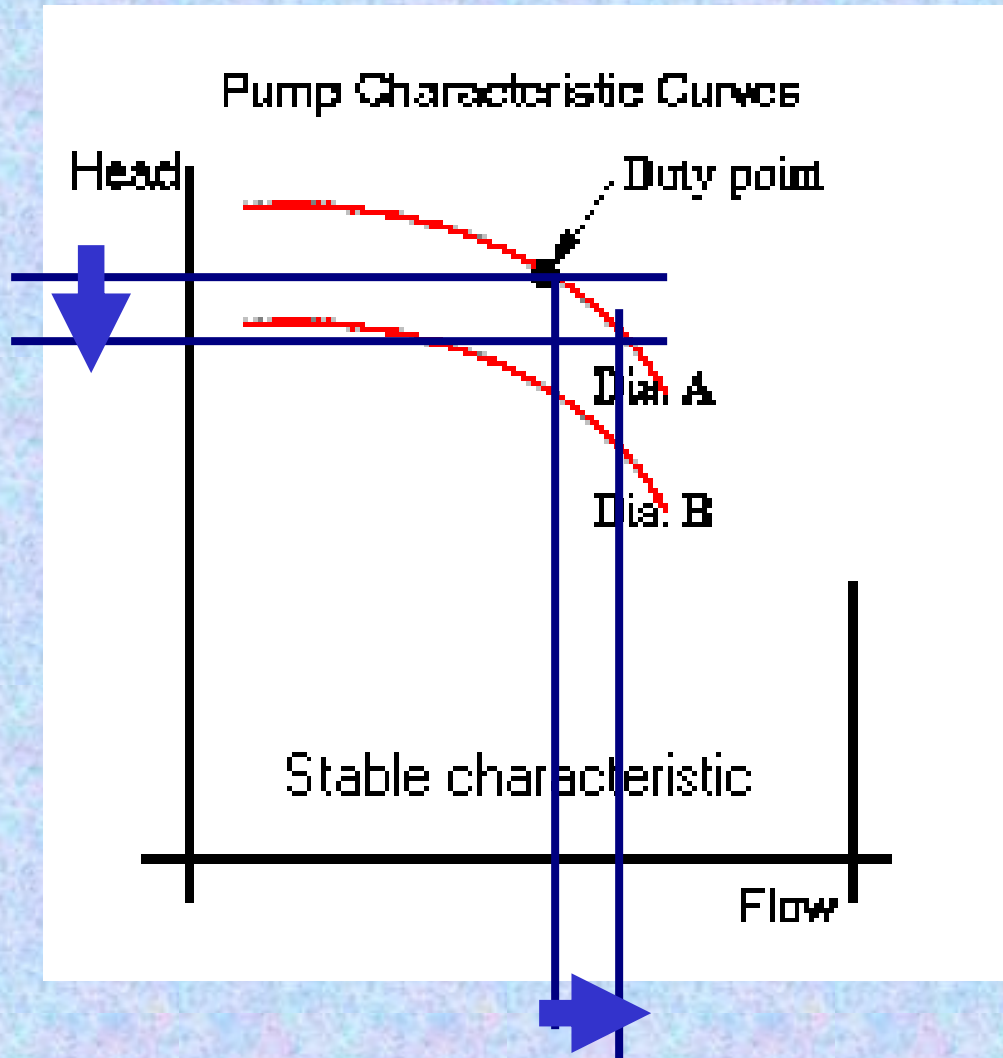
- hubungan aliran & tekanan
- penting untuk pemilihan



APAKAH KESAN H-Q  
YANG CURAM / LANDAI ?



## APAKAH KESAN H-Q YANG CURAM / LANDAI ?



### H-Q CURAM

- perubahan H,
- kurang kesan Q

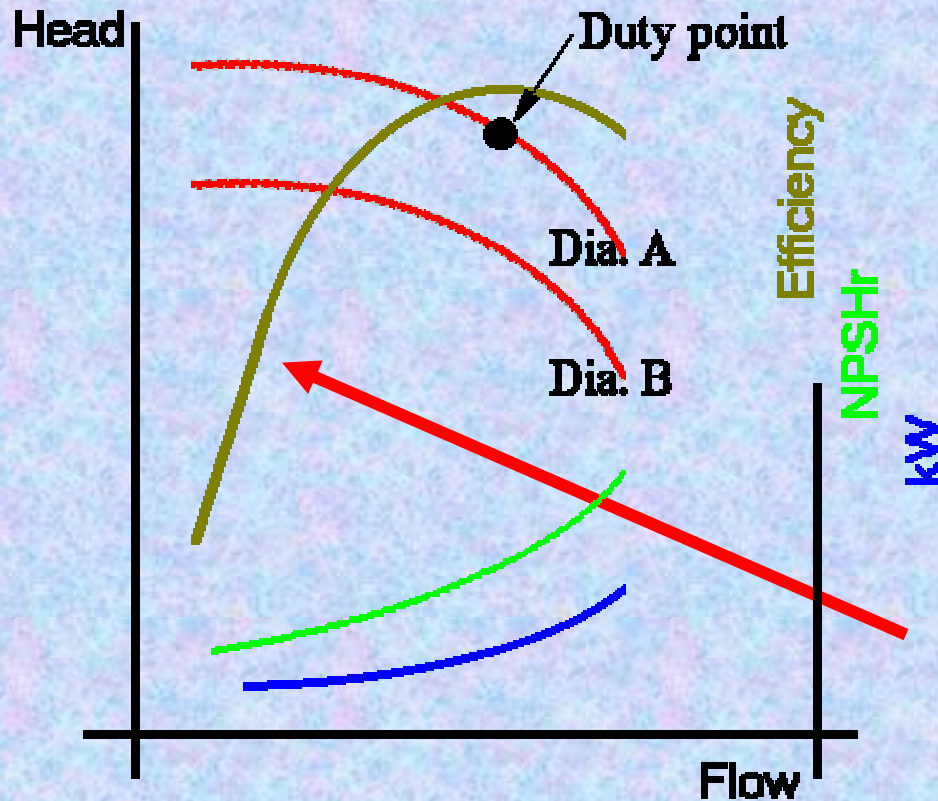
Sebaliknya untuk H-Q  
Landai.

# SISTEM PAM

## CIRI PAM



Pump Characteristic Curves



**EFFICIENCY CURVE**  
-penting untuk penilaian  
-penunjuk kesihatan pam  
-bandingan tender

# SISTEM PAM

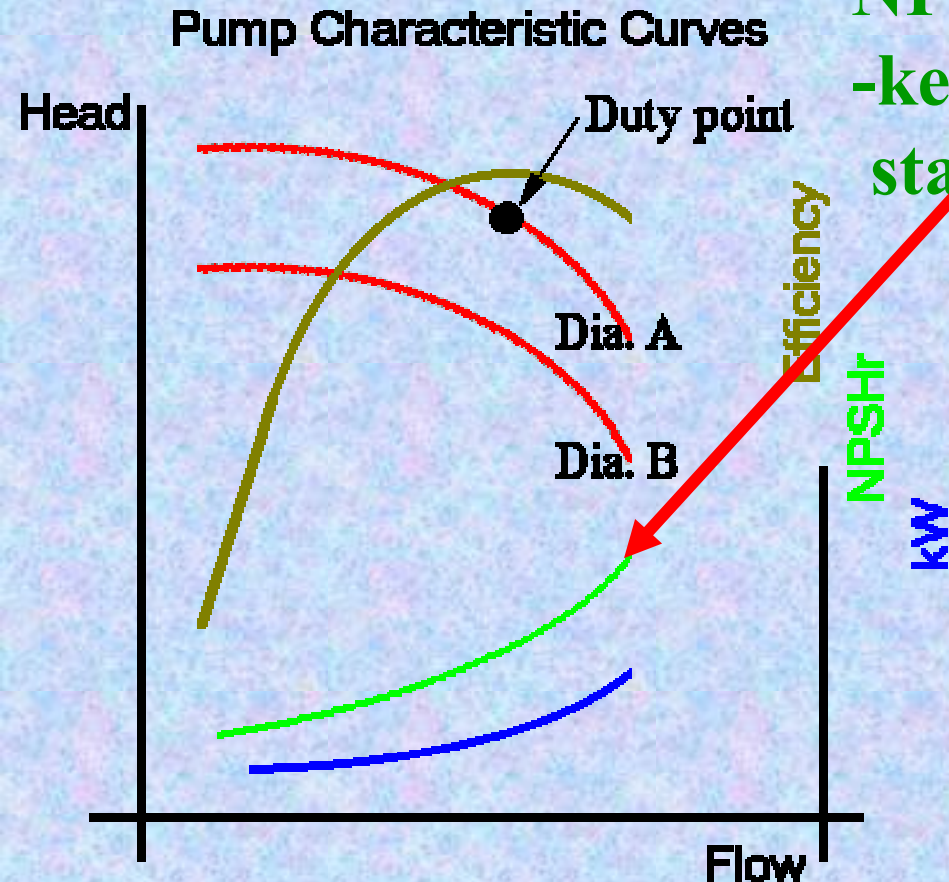
## CIRI PAM



## NET POSITIF SUCTION HEAD NPSHr

-kelebihan tekanan atmosfera & statik diperlukan pam

PERKIRAAN NPSH ?





$$\text{NPSH}_a = H_a + H_s - H_f - H_v - H_{sv}$$

Where ;

$H_a$  = atmospheric pressure ( $\simeq 10.33$  m or 33.9 ft)

$H_s$  = positive suction head

$H_f$  = friction loss in suction pipe

$H_v$  = vapour pressure of liquid at ambient temperature

$H_{sv}$  = velocity head at suction pipe

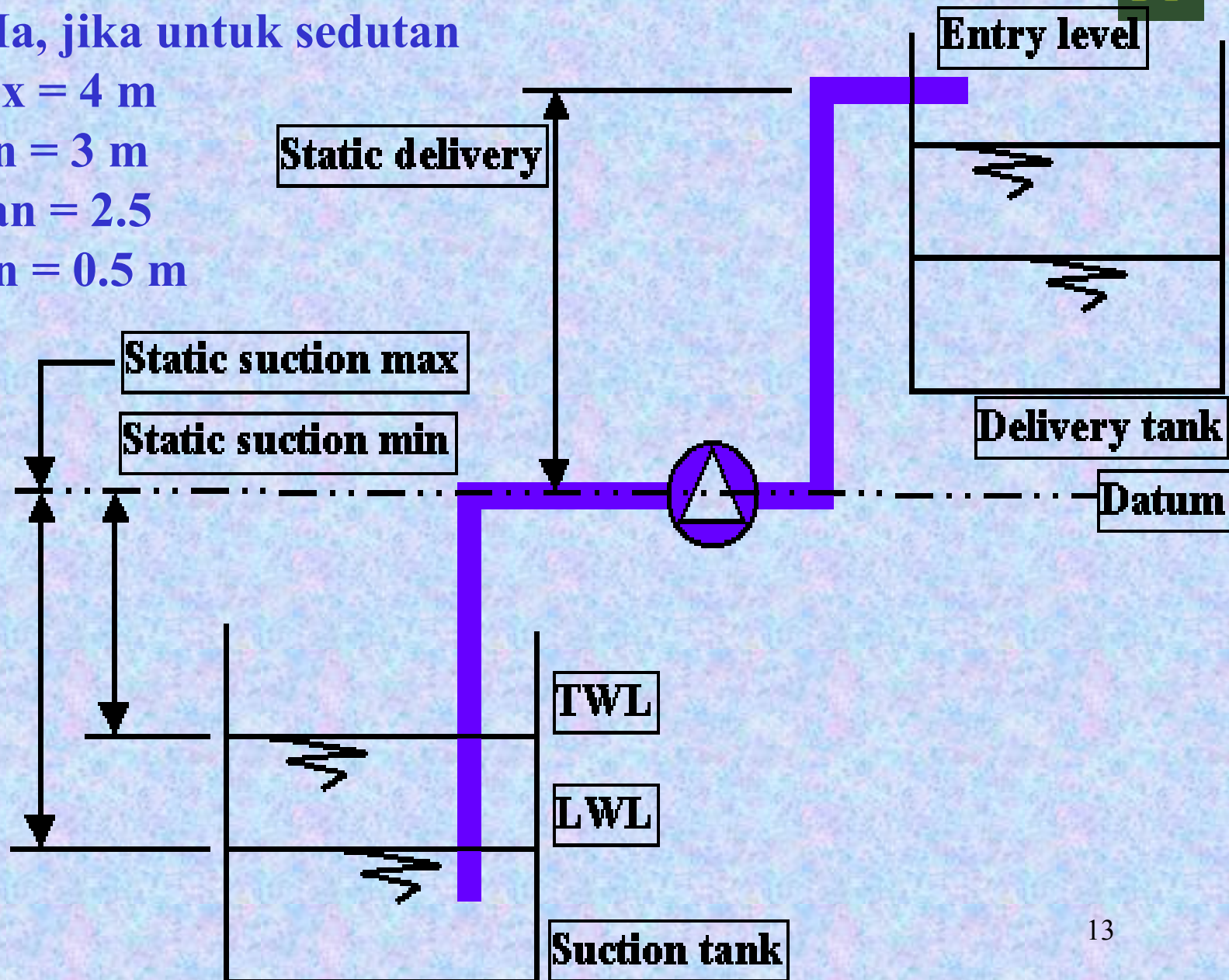
# SISTEM PAM

## CIRI PAM



Kira NPSHa, jika untuk sedutan

- Statik max = 4 m
- Statik min = 3 m
- K2 sedutan = 2.5
- Rintangan = 0.5 m





# **APAKAH BEZANYA NPSH<sub>a</sub> DAN NPSH<sub>r</sub> ?**

**NPSH<sub>a</sub>** – kelebihan tekanan atmosfera dan statik  
dalam sistem

**NPSH<sub>r</sub>** – kelebihan tekanan atmosfera dan statik  
diperlukan oleh pam

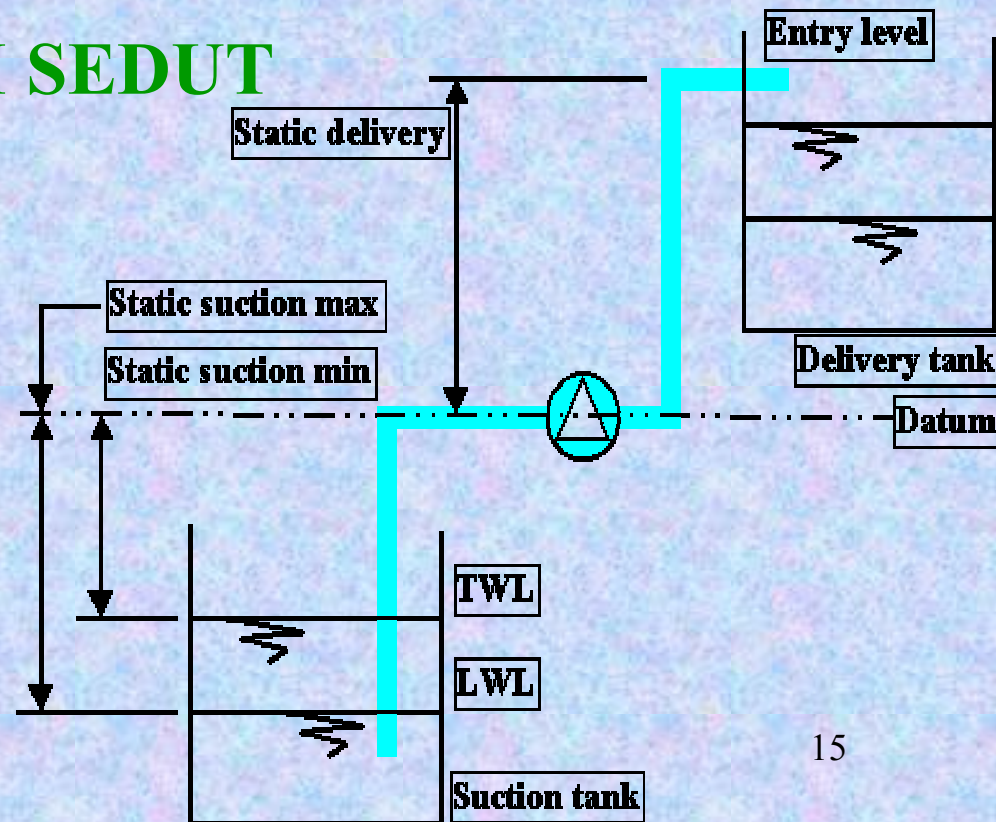


## CIRI PAM

$$NPSH_a > NPSH_r$$

Bagaimana jika tidak diperoleh ?

- RENDAHKAN PAM
- TINGGIKAN TANGKI SEDUT
- BESARKAN PAIP
- PENDEKAN PAIP
- GUNA PRE-BOOST

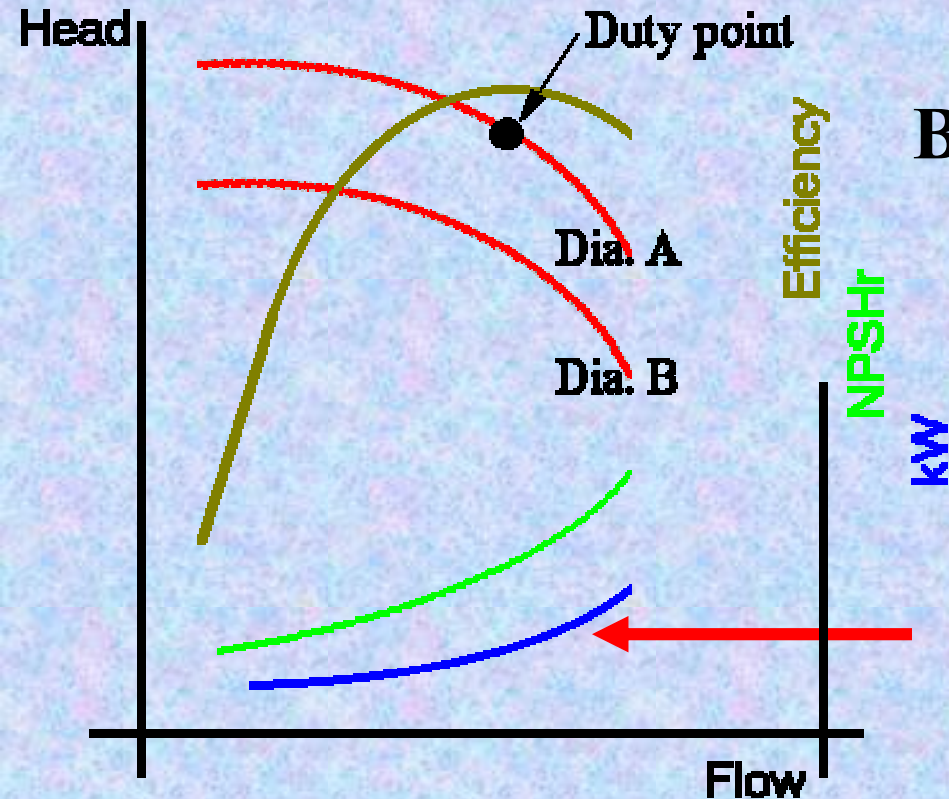


# SISTEM PAM

## CIRI PAM



Pump Characteristic Curves



**BAGAIMANA kW DIKIRA?**

**POWER CURVE**

-dijana oleh pam

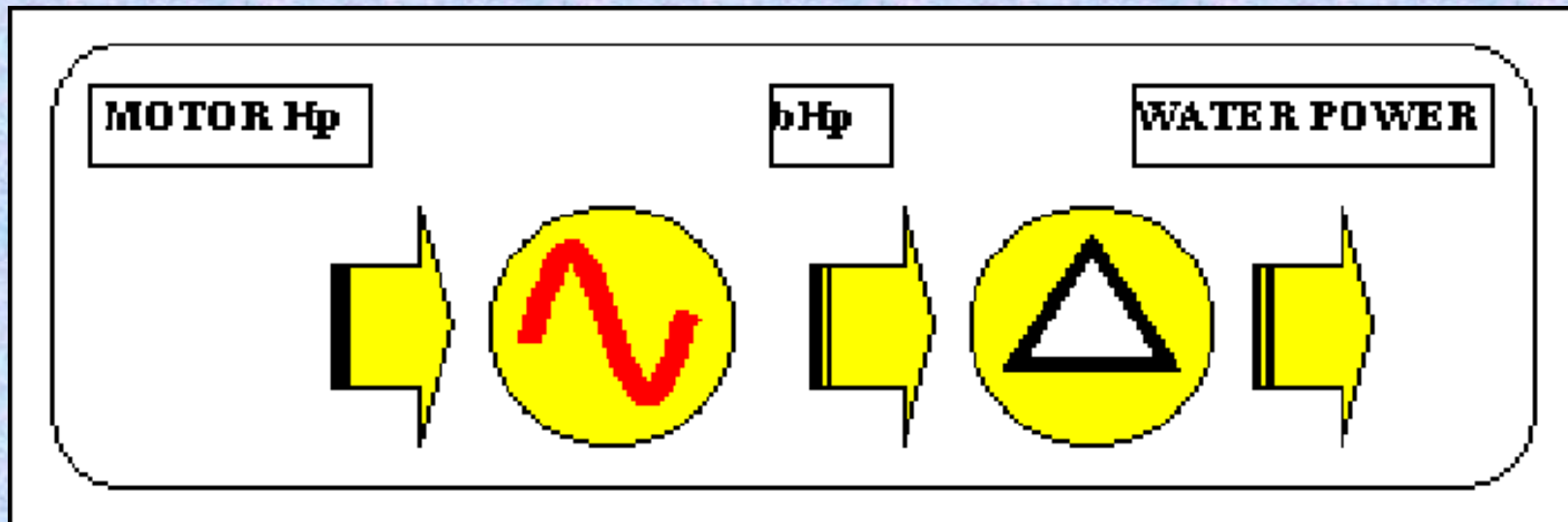
-penting untuk pemilihan motor / injin



$$\text{KUASA, hp} = \frac{\text{igpm} \times \text{ft}}{3300}$$

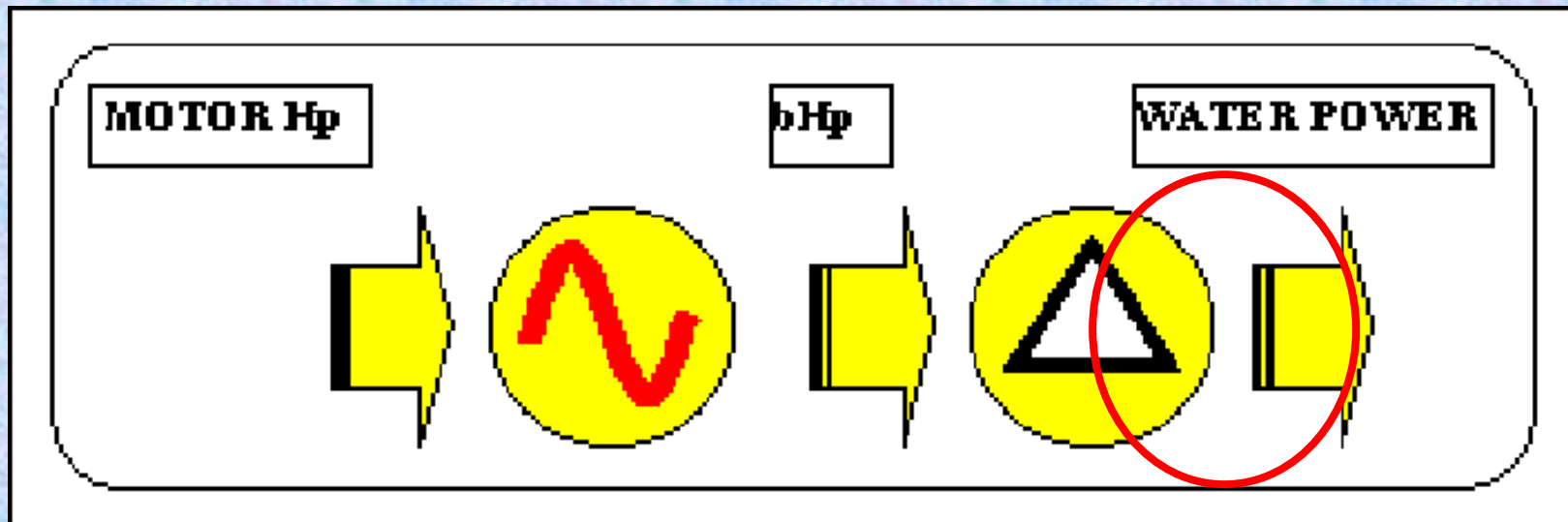
APAKAH DIMAKSUDKAN KUASA INI ?

APAKAH KUASA LAIN BERKAITAN PAM ?





$$\text{hp} = \frac{\text{igpm} \times \text{ft, water power}}{3300}$$



$$\text{Bhp} = \text{hp} / (\text{kecekapan pam})$$

$$\text{Motor hp} = \text{Bhp} / (\text{kecekapan motor})$$

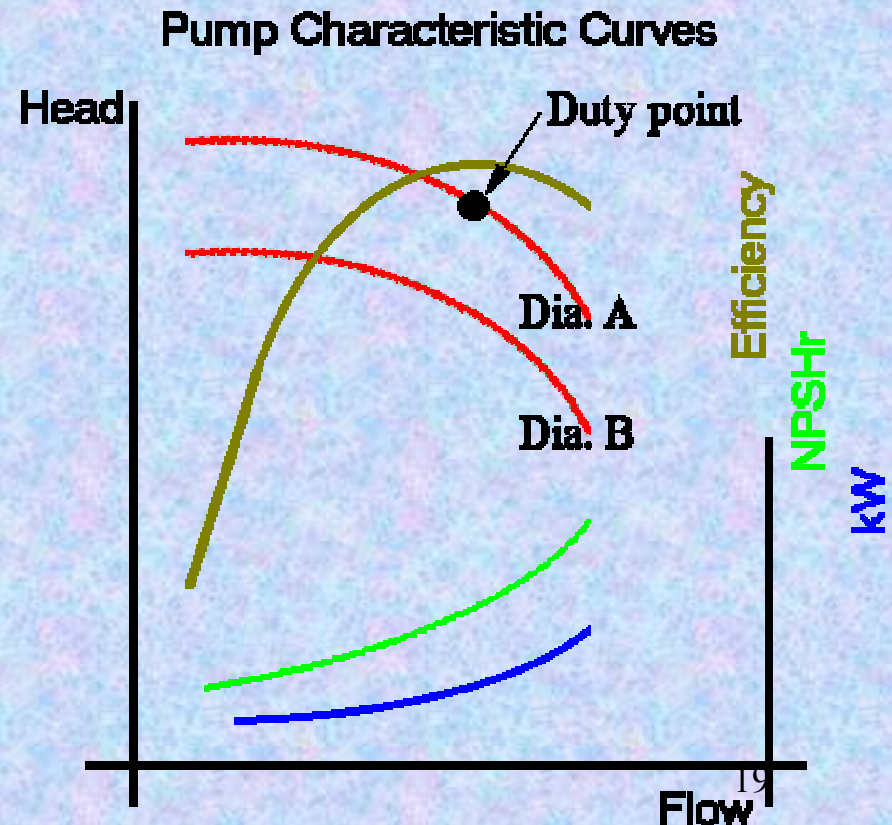


## PENGENALAN SISTEM PAM

### MEMPERKENALKAN SISTEM PAM

- KOMPONEN SISTEM
- KOMPONEN PAM
- CIRI PAM & SISTEM
- ASAS REKABENTUK

Q & A



# SISTEM PAM

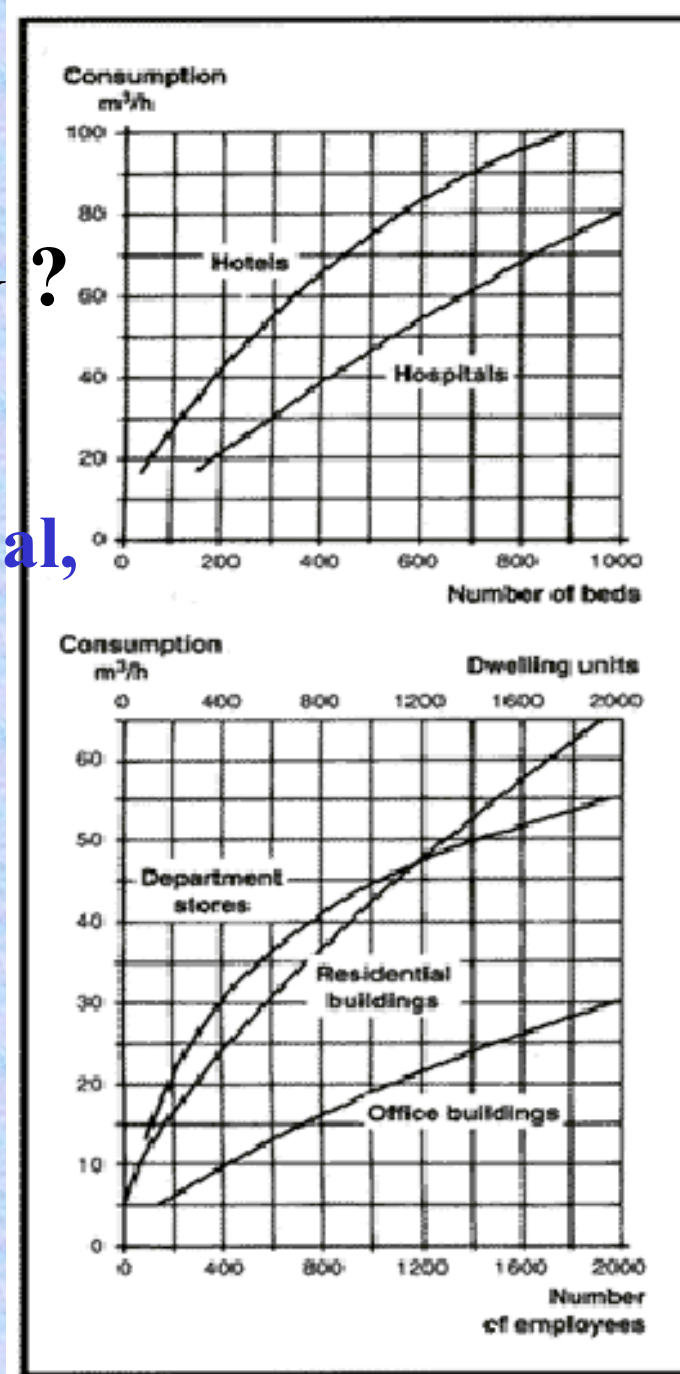
## ASAS REKABENTUK

### APAKAH FAKTOR PENTING ?

1.KAPASITI - siasatan tapak, jadual, katalog, piawaian

2.LOKASI - menentukan jenis & OPERASI pam

Diberikan, kapasiti tangki,  $V$  dan tempoh,  $t$  mengepam. Bagaimana kapasiti pam,  $Q$  dikira ?



# SISTEM PAM

## ASAS REKABENTUK



**TEKANAN** - pihak berkuasa (BOMBA, JBA ...)

e.g 500 mbar, 70 ft ... ?

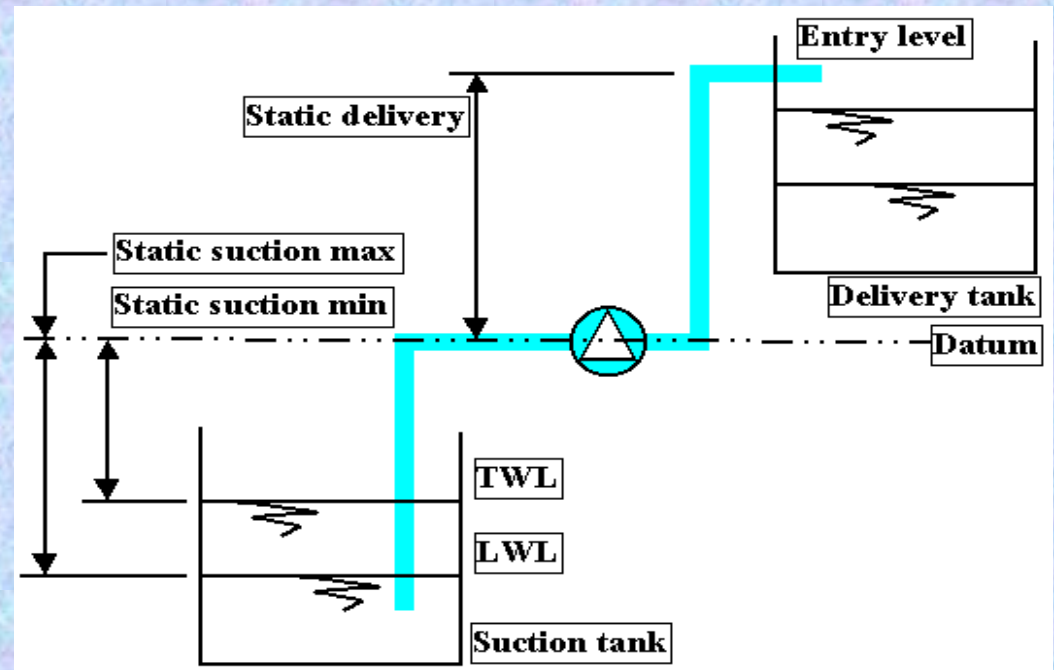
- katalog (FLUSH VALVE, ALAT KHUSUS ...)

- kiraan

**TEKANAN = Jumlah Statik + Jumlah Rintangan**

**Jumlah Statik =  
Statik sedutan +  
Statik hantaran**

**Bagaimana apabila  
aras air berubah ?**





**Jumlah Rintangan = Rintangan sedutan +  
Rintangan hantaran**

**FRICITION LOSS FORMULA :**

$$H_F = L \times p \times f$$

Where ;

L = Pipe length (m)

p = Pressure loss (m) /(m) length of pipe

f = Pipe specials, minor and other losses

**Formula di atas antara yang digunakan dalam  
perkiraan rintangan**

# SISTEM PAM

**ATAU** Gunakan carta

Jika  $Q = 200$  Usgpm

Saiz paip = 4"

Berapa nilai rintangan?

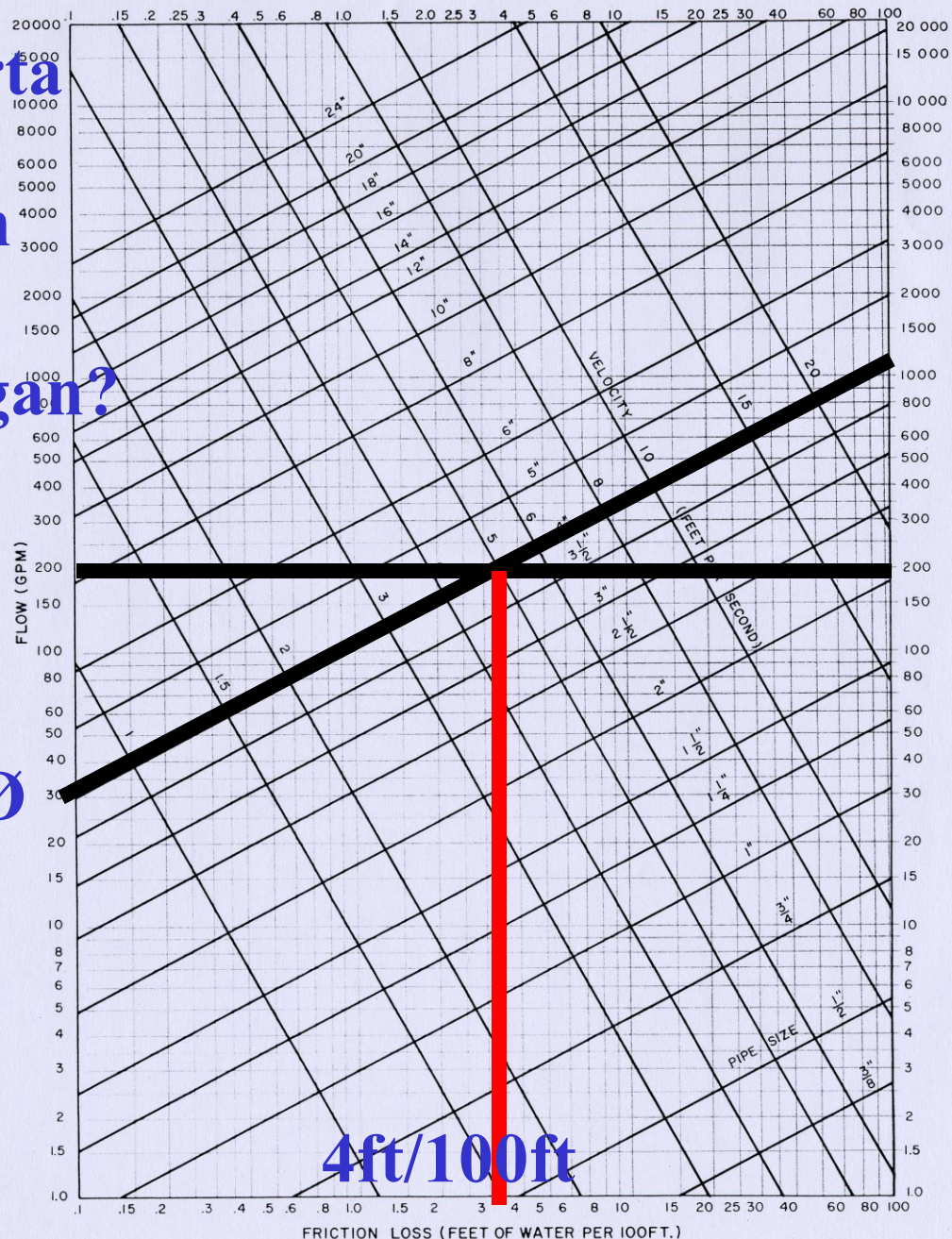
$Q = 200$

4" Ø

Apa kesan  $Q$   
meningkat ?

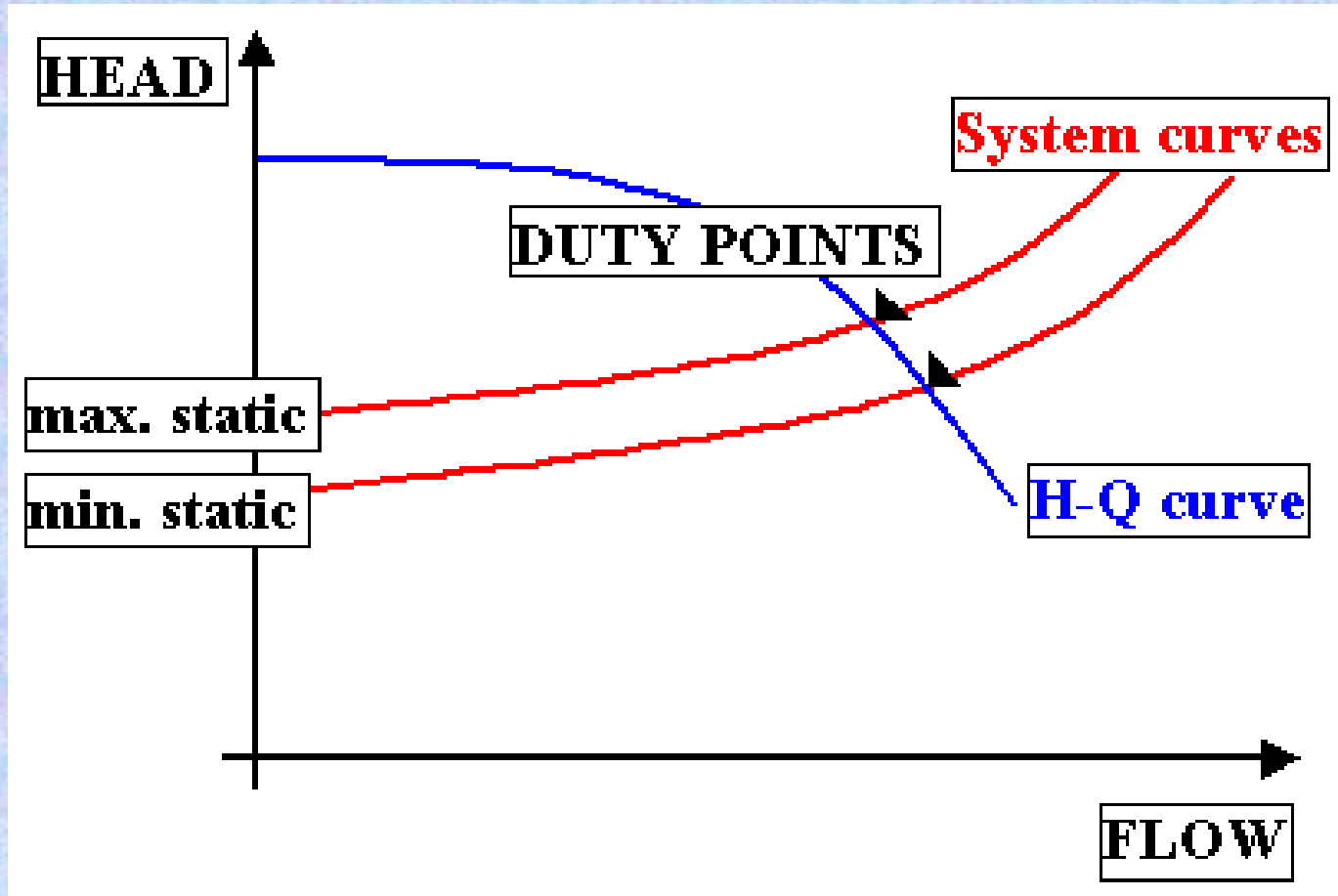
CHART 4—FRICTION LOSS FOR OPEN PIPING SYSTEMS

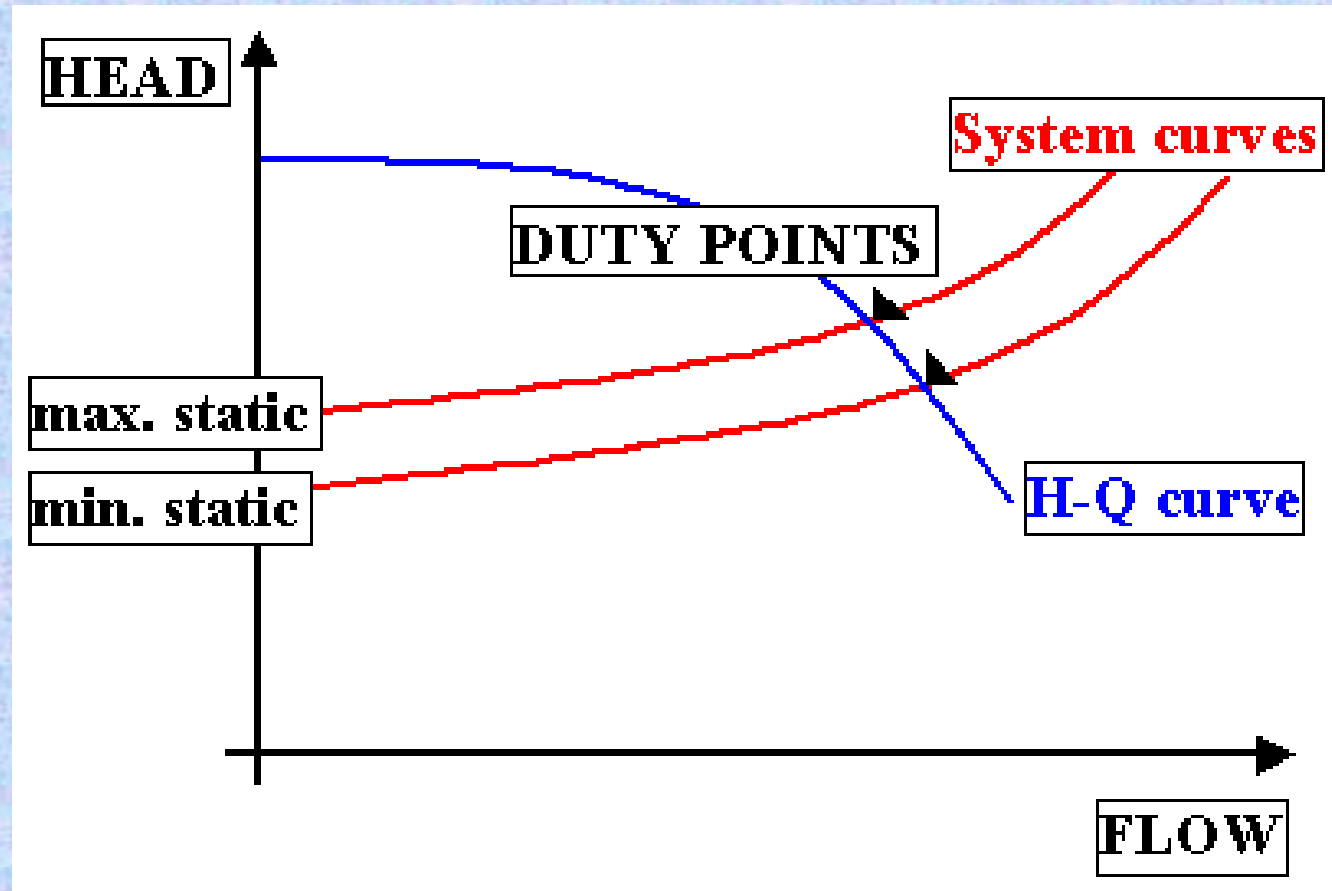
Schedule 40 Pipe





‘**SYSTEM CURVE**’ boleh disediakan dengan mengubah nilai  $Q$ , e.g 50, 100, 150, 200 Usgpm etc





**H-Q CURVE DITINDIH DI ATAS SYSTEM CURVE**

- TENTUKAN PAM SESUAI UTK DUTY PT.**
- GAMBARAN APA TERJADI SEKIRANYA ADA PERUBAHAN TEKANAN**



# SISTEM PAM

## ASAS REKABENTUK

### JENIS AIR / OPERASI

- kesesuaian pam
- boleh juga ditentukan dari jadual pembuat

| PERASI<br>m<br>entukan<br>buat | PUMP TYPE             |                              |                                  |                            |                                   |                           |             |                    |                |                          |                           |                             |                      |                                 |                                |                                       |                            |                        |                       |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
|--------------------------------|-----------------------|------------------------------|----------------------------------|----------------------------|-----------------------------------|---------------------------|-------------|--------------------|----------------|--------------------------|---------------------------|-----------------------------|----------------------|---------------------------------|--------------------------------|---------------------------------------|----------------------------|------------------------|-----------------------|-----------------|-------------------------|-------------------------------|------------------------|---------------------------------|-----------------------------|--------------------------------|--------------------------------------|-----------------------------------|---|
|                                | LC - END SUCTION, CCP | LF - END SUCTION, FRAME MTD. | LUE - ENGINE DRIVEN CENTRIFUGALS | ASC - END SUCTION, SS, CCP | ASP - END SUCTION, SS, FRAME MTD. | PIC - IN-LINE CIRCULATORS | VL IN-LINES | LN, GLN - LOW NPSH | OL - TWO STAGE | VM - VERTICAL MULTISTAGE | KP, KPH, KPV - SPLIT CASE | C, F - REGENERATIVE TURBINE | NC - COLUMN NON-CLOG | NSC/TP - SUBMERSIBLE FIXED PIPE | QDN/QDF/QDC - SUBM. GUIDE RAIL | NCH, NCP, NCF, NCV - DRY PIT NON-CLOG | NGDP - DRY PIT SUBMERSIBLE | SL - COLUMN SUMP PUMPS | SM - SUBMERSIBLE SUMP | DW - DEWATERING | GR - GROUND CONDENSATES | GC, BC - OVERHEAD CONDENSATES | VT - VERTICAL TURBINES | PF9000ES - END SUCTION BOOSTERS | PF9000VL - IN-LINE BOOSTERS | PF9000VM - MULTISTAGE BOOSTERS | PF9000VT - VERTICAL TURBINE BOOSTERS | PF9000VS - VARIABLE SPEED SYSTEMS |   |
| APPLICATIONS                   |                       |                              |                                  |                            |                                   |                           |             |                    |                |                          |                           |                             |                      |                                 |                                |                                       |                            |                        |                       |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
| WASTEWATER                     |                       |                              |                                  |                            |                                   |                           |             |                    |                |                          |                           |                             |                      |                                 |                                |                                       |                            |                        |                       |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
| LIFT STATIONS                  |                       |                              |                                  |                            |                                   |                           |             |                    |                |                          |                           |                             | *                    |                                 |                                |                                       |                            |                        | *                     |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
| INFLUENT STATIONS              |                       |                              |                                  |                            |                                   |                           |             |                    |                |                          |                           |                             | *                    |                                 |                                |                                       |                            | *                      |                       |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
| DIVERSION PUMPS                |                       |                              |                                  |                            |                                   |                           |             |                    |                |                          |                           |                             | *                    |                                 |                                |                                       |                            | *                      |                       |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
| GAS SCRUBBER CIRC.             |                       |                              |                                  | *                          | *                                 |                           |             |                    |                |                          |                           |                             |                      |                                 |                                |                                       |                            |                        |                       |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
| RECYCLE STATION                | *                     | *                            |                                  |                            |                                   |                           |             |                    |                |                          | *                         |                             |                      |                                 |                                |                                       |                            |                        |                       |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
| TRICKLING FILTER               |                       |                              |                                  |                            |                                   |                           |             |                    |                |                          |                           |                             |                      |                                 |                                |                                       |                            |                        |                       |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
| PRIMARY RECIRC.                |                       |                              |                                  |                            |                                   |                           |             |                    |                |                          |                           |                             |                      | *                               | *                              | *                                     | *                          | *                      |                       |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
| PRIMARY EFFLUENT               |                       |                              |                                  |                            |                                   |                           |             |                    |                |                          |                           |                             |                      | *                               | *                              | *                                     | *                          | *                      |                       |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
| RAS                            |                       |                              |                                  |                            |                                   |                           |             |                    |                |                          | *                         |                             |                      | *                               | *                              | *                                     | *                          | *                      |                       |                 |                         | *                             |                        |                                 |                             |                                |                                      |                                   |   |
| SECONDARY SLUDGE               |                       |                              |                                  |                            |                                   |                           |             |                    |                |                          |                           |                             | *                    | *                               | *                              | *                                     | *                          | *                      |                       |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
| TRICKING FILTER EFF.           |                       |                              |                                  |                            |                                   |                           |             |                    |                |                          |                           |                             | *                    | *                               | *                              | *                                     | *                          | *                      |                       |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
| REUSE TREATMENT                | *                     | *                            |                                  |                            |                                   |                           |             |                    |                |                          | *                         |                             |                      |                                 |                                |                                       |                            |                        |                       |                 |                         | *                             |                        |                                 |                             |                                |                                      |                                   |   |
| EFFLUENT                       | *                     | *                            | *                                |                            |                                   |                           | *           | *                  |                |                          |                           |                             |                      | *                               | *                              | *                                     | *                          | *                      |                       |                 |                         | *                             | *                      | *                               | *                           | *                              | *                                    | *                                 | * |
| PLANT WASHDOWN                 | *                     | *                            |                                  |                            |                                   |                           |             |                    | *              | *                        | *                         | *                           | *                    | *                               | *                              | *                                     | *                          | *                      |                       |                 |                         | *                             | *                      | *                               | *                           | *                              | *                                    | *                                 | * |
| PLANT IRRIGATION               | *                     | *                            | *                                |                            |                                   |                           | *           | *                  | *              | *                        | *                         | *                           | *                    | *                               | *                              | *                                     | *                          | *                      |                       |                 |                         | *                             | *                      | *                               | *                           | *                              | *                                    | *                                 | * |
| PRIMARY SLUDGE                 |                       |                              |                                  |                            |                                   |                           |             |                    |                |                          |                           |                             |                      |                                 |                                |                                       |                            |                        |                       |                 |                         |                               |                        |                                 |                             |                                |                                      |                                   |   |
| SAMPLING                       | *                     | *                            |                                  | *                          | *                                 |                           |             |                    |                |                          |                           | *                           | *                    | *                               | *                              | *                                     | *                          | *                      |                       |                 |                         | *                             | *                      | *                               | *                           | *                              | *                                    | *                                 | * |
| INJECTION                      | *                     | *                            |                                  | *                          | *                                 |                           |             |                    | *              | *                        | *                         | *                           | *                    | *                               | *                              | *                                     | *                          | *                      |                       |                 |                         | *                             | *                      | *                               | *                           | *                              | *                                    | *                                 | * |
| HVAC                           |                       | *                            | *                                | *                          | *                                 | *                         | *           | *                  | *              | *                        | *                         | *                           | *                    | *                               | *                              | *                                     | *                          | *                      |                       |                 | *                       | *                             | *                      | *                               | *                           | *                              | *                                    | *                                 | * |
| PLUMBING                       |                       |                              |                                  |                            |                                   |                           |             | *                  | *              | *                        | *                         | *                           | *                    | *                               | *                              | *                                     | *                          | *                      |                       |                 | *                       | *                             | *                      | *                               | *                           | *                              | *                                    | *                                 | * |
| POTABLE H <sub>2</sub> O       | *                     | *                            |                                  | *                          | *                                 | *                         | *           | *                  | *              | *                        | *                         | *                           | *                    | *                               | *                              | *                                     | *                          | *                      |                       | *               | *                       | *                             | *                      | *                               | *                           | *                              | *                                    | *                                 | * |
| BELT PRESS. BOOST.             | *                     | *                            |                                  | *                          | *                                 | *                         | *           | *                  | *              | *                        | *                         | *                           | *                    | *                               | *                              | *                                     | *                          | *                      |                       | *               | *                       | *                             | *                      | *                               | *                           | *                              | *                                    | *                                 | * |
| WAS                            |                       |                              |                                  |                            |                                   |                           |             |                    |                | *                        | *                         | *                           | *                    | *                               | *                              | *                                     | *                          | *                      |                       |                 |                         | *                             | *                      | *                               | *                           | *                              | *                                    | *                                 | * |



## SISTEM PAM SELARI / SISTEM PAM BERSIRI ?

- operasi dua / lebih pam SERENTAK

## SISTEM PAM SELARI - untuk apa ?

- kadar aliran tinggi
- kadar aliran yang berubah2
- jamin sebahagian aliran dapat dibekal

## SISTEM PAM BERSIRI - untuk apa ?

- tekanan tinggi
- serupa dengan pam 'multi-stage'



**AFFINITY LAWS:**

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2} , \quad \frac{H_1}{H_2} = \frac{(N_1)^2}{(N_2)^2} , \quad \frac{P_1}{P_2} = \frac{(N_1)^3}{(N_2)^3}$$

Where ;

Q == Flow (cu.m/s)  
N == Pump speed (rpm)  
H == Total head (m)

**D = Unchanged**

**APAKAH GUNA NYA ‘AFFINITY LAWS’ INI ?**  
**- MENILAI PERUBAHAN Q BILA N, H, P BERUBAH**  
**TETAPI D KEKAL**



### AFFINITY LAWS:

$$\frac{Q_1}{Q_2} = \frac{D_1}{D_2}, \quad \frac{H_1}{H_2} = \frac{(D_1)^2}{(D_2)^2}, \quad \frac{P_1}{P_2} = \frac{(D_1)^3}{(D_2)^3}$$

Where ;

Q == Flow (cu.m/s)

D == Diameter (m)

H == Total head (m)

Speed N, unchanged

**GUNA NYA 'AFFINITY LAWS' YANG INI PULA ?**

**- MENILAI PERUBAHAN Q, H, P BILA D BERUBAH  
TETAPI N KEKAL**



## CONTOH :

**N1 = 1750 RPM**

**N2 = 2000 RPM**

**Jika pada kelajuan 1750 rpm;**

**Q = 300 gpm, H = 160 ft dan kuasa = 15 hp**

**Kirakan nilai baru Q, H dan Hp untuk 2000 rpm.**

**Dimensi impeller tidak berubah.**

### AFFINITY LAWS:

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2}, \quad \frac{H_1}{H_2} = \frac{(N_1)^2}{(N_2)^2}, \quad \frac{P_1}{P_2} = \frac{(N_1)^3}{(N_2)^3}$$

Where ;

|   |   |                  |
|---|---|------------------|
| Q | ≡ | Flow (cu.m/s)    |
| N | ≡ | Pump speed (rpm) |
| H | ≡ | Total head (m)   |

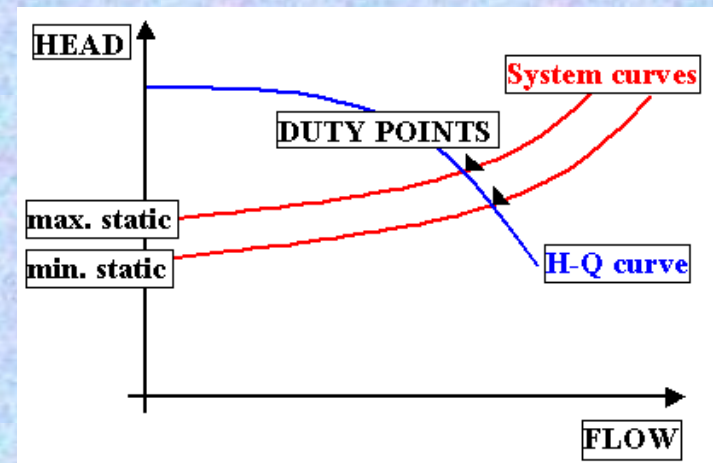
**D = Unchanged**



## PENGENALAN SISTEM PAM

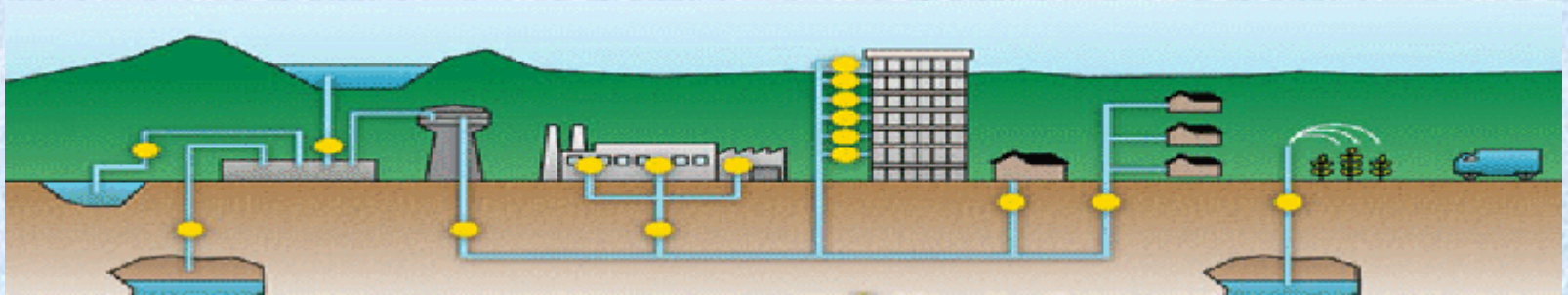
### MEMPERKENALKAN SISTEM PAM

- KOMPONEN SISTEM
- KOMPONEN PAM
- CIRI PAM & SISTEM
- ASAS REKABENTUK





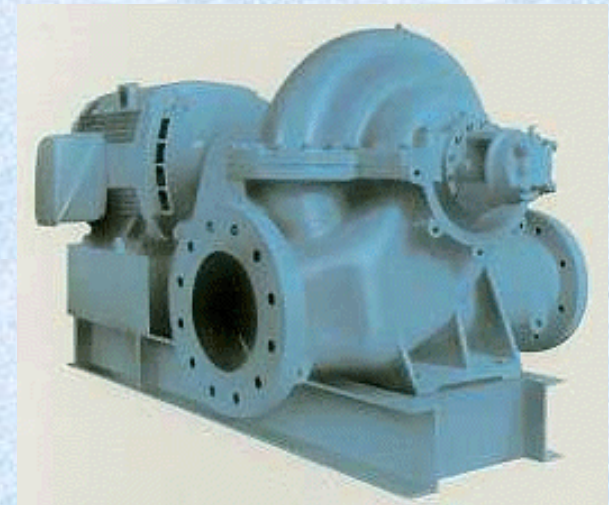
## PENGENALAN SISTEM PAM





## MEMPERKENALKAN SISTEM PAM

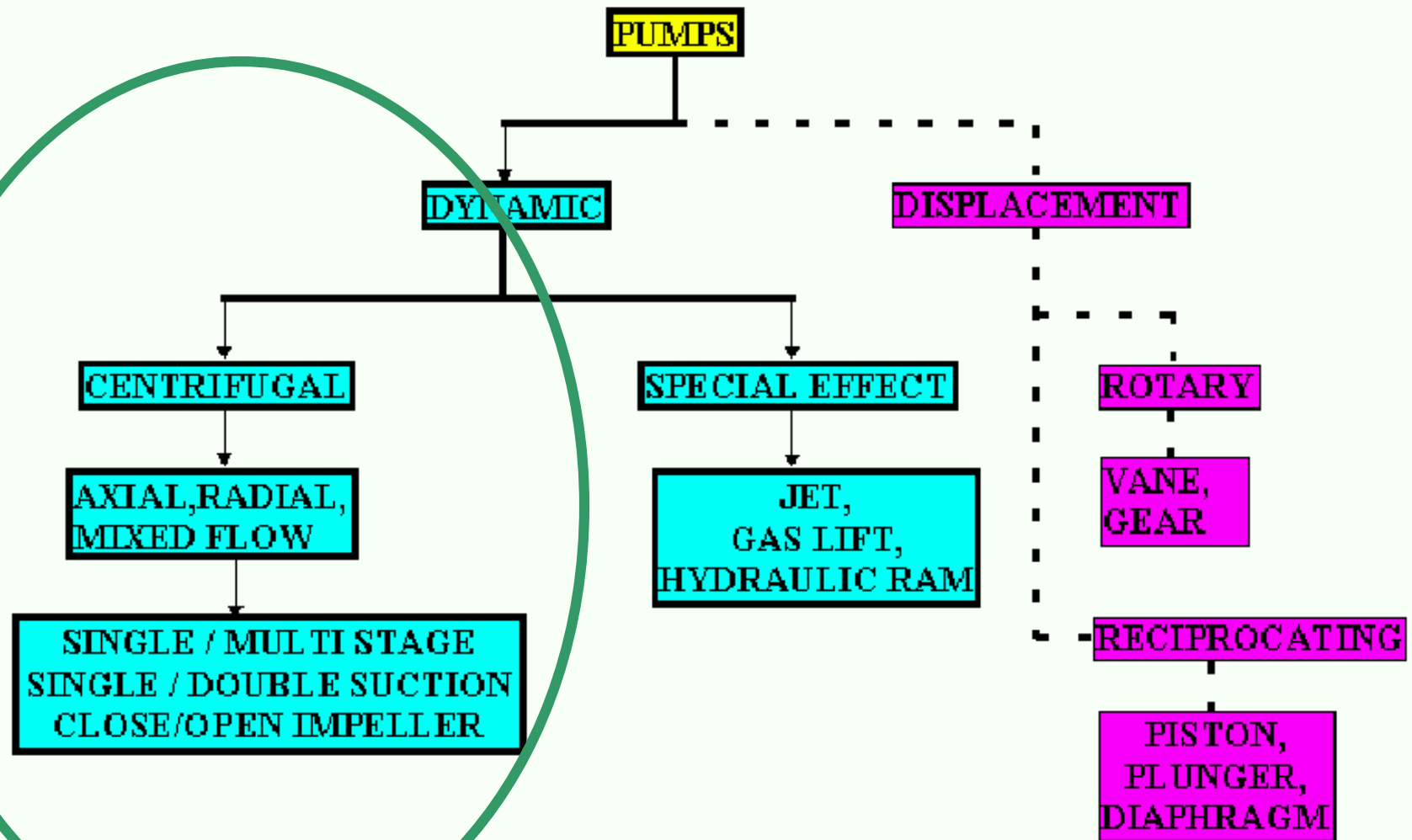
- **KOMPONEN SISTEM**
- **JENIS & KOMPONEN PAM**
- **CIRI PAM & SISTEM**
- **ASAS REKABENTUK**





## JENIS-JENIS PAM

### PUMP CLASSIFICATION:





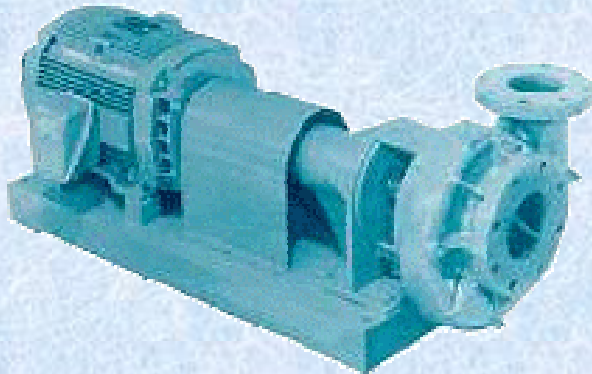
## JENIS-JENIS PAM

### PAM SEDUTAN HUJUNG

- PAM CEGAH KEBAKARAN
- PAM PENGALAK TANGKI BUMBUNG

### CIRI-CIRI

- AIR MASUK DARI HUJUNG
- PENDESAK TERGANTUNG
- 'SPACER' MEMUDAHKAN SELENGGARA





## JENIS-JENIS PAM

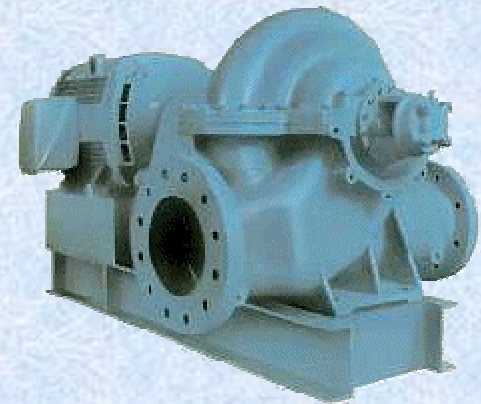
### PAM BINGKAI ASING

- SISTEM LEBIH BESAR
- OPERASI BERPANJANGAN
- CHILLER, TANGKI PENGGUNA



### CIRI-CIRI

- MUDAH DISELENGGARA
- KECEKAPAN TINGGI
- HARGA MUNGKIN TINGGI





## JENIS-JENIS PAM

**PAM 'BLOCK / CLOSE COUPLE / VERTICLE'**

- SISTEM KECIL
- RUANG TERHAD

**CIRI-CIRI**

- PEMASANGAN TEGAK
- TIADA MASALAH PELARASAN



# SISTEM PAM

## JENIS-JENIS PAM

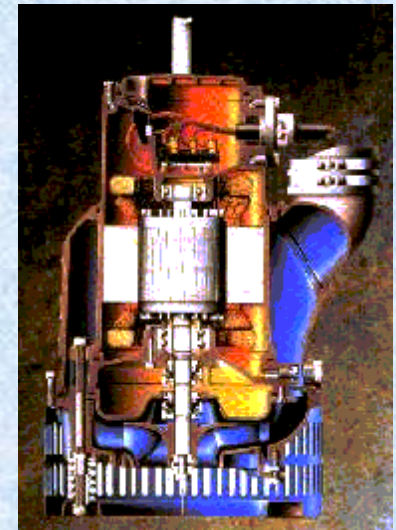
### PAM SELAM

- SISTEM KUMBAHAN
- AIR KOTOR



### CIRI-CIRI

- SELENGGARAAN MINIMUM
- KECEKAPAN RENDAH
- SENYAP
- SEAL GUNAKAN MINYAK UTK PELINCIRAN



# SISTEM PAM



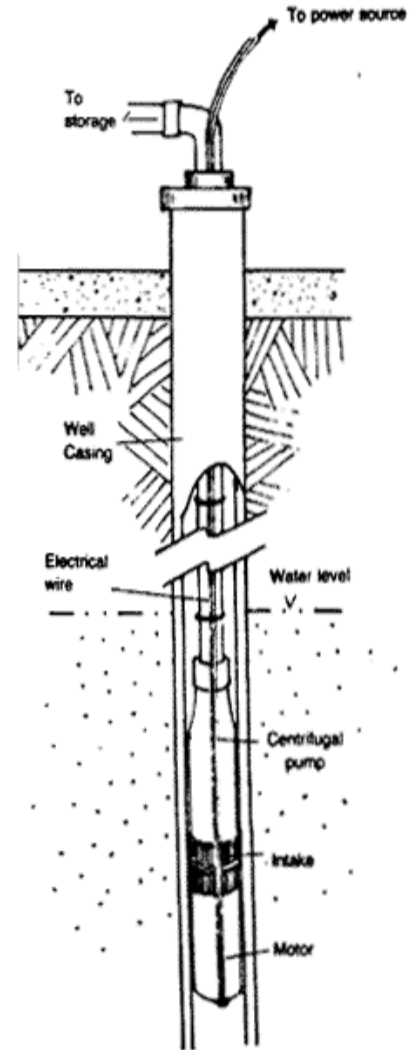
## JENIS-JENIS PAM

### PAM SELAM 'BOREHOLE'

- AIR BAWAH TANAH
- SISTEM SIRAMAN

### CIRI-CIRI

- SERUPA PAM SELAM BIASA
- BINGKAI, IMPELLER - S.S

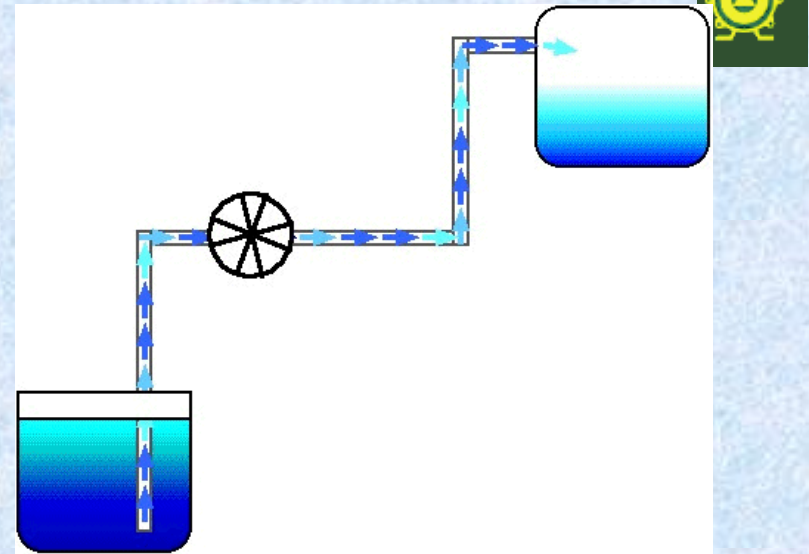


a. Submersible Pump

# SISTEM PAM

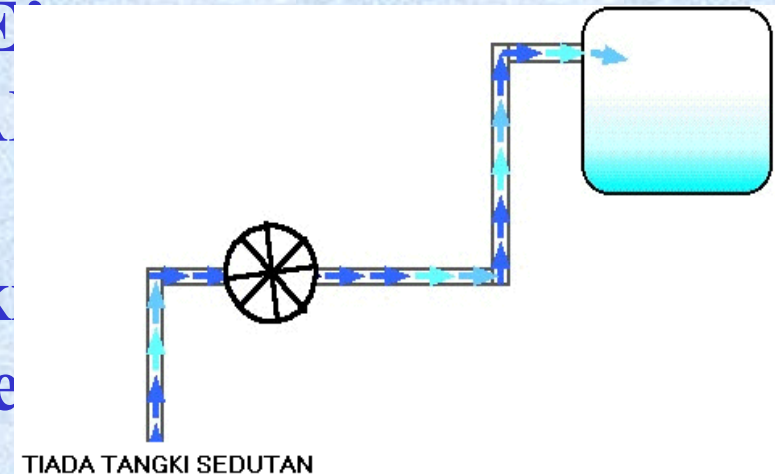
## SISTEM 'CONVENTIONAL'

- ADA TANGKI SEDUTAN
- BENEFITS : buffer supply, response time, chemical contact time



## SISTEM 'DIRECT IN-LINE'

- TIADA TANGKI SEDUTAN
- BENEFITS :  
jimat tapak tanah & tangk  
upstream residual pressure



**SISTEM TALIAN TERUS**



## OBJEKTIF SESI INI :

### MEMPERKENALKAN SISTEM PAM

- **KOMPONEN SISTEM**
- **JENIS & KOMPONEN PAM**
- **CIRI PAM & SISTEM**
- **ASAS REKABENTUK**





## ADA SOALAN ?



## REHAT SEBENTAR