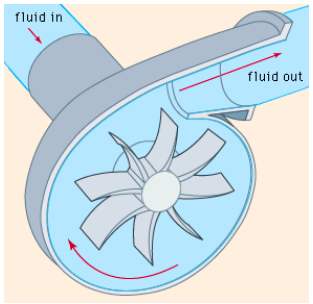
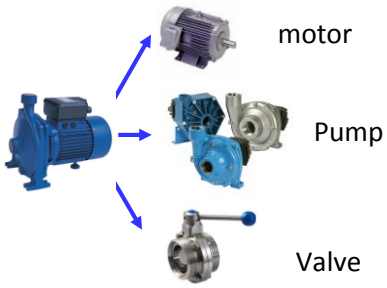
Inverter for water pump systems

Centrifugal pumps are often used in the industrial pumping systems. Structure of a centrifugal pump includes:

- Motor
- Pump
- Flow control valve



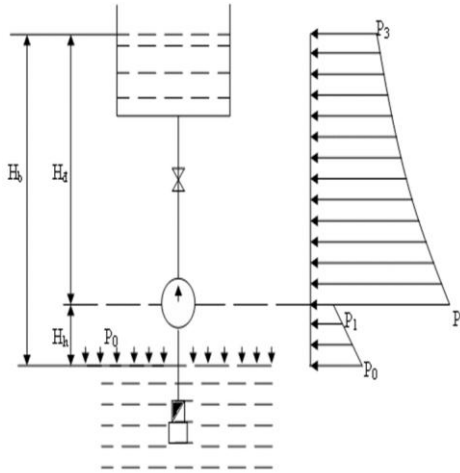


Pump classification:

- Positive displacement pump: low flow rate, high pressure (Piston, Gear, Screw, and Rotor)
- Vane pump: high flow rate, low pressure (Centrifugal, Axial-flow).

Characteristics and applications

- Basic parameters:



$$P = \frac{d.Q.H}{102.h}$$

H - Cột áp (r Head (m)

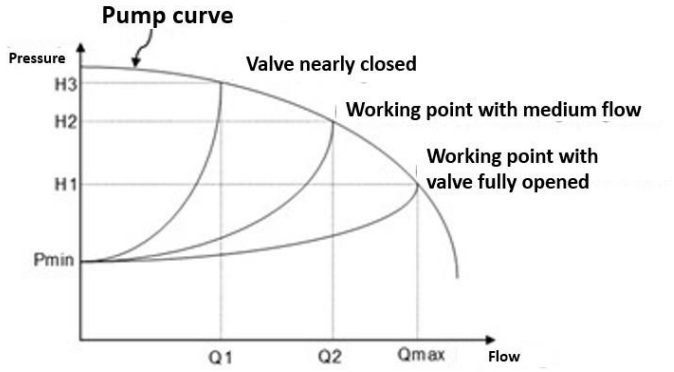
Q - Lưu lượi Flow (m3/s

N - Công suấ Capacity (kW)

d - Khối lượ Net weight (kg/m3)

h: Hiệu suất Pump efficiency (0.7- 0.85)

Determining pump operating point:

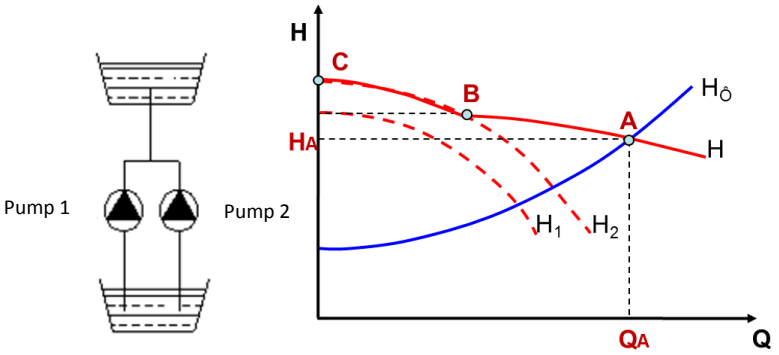


- Pumping affinity law

$$Q_2 = Q_1\left(\frac{N_2}{N_1}\right) P_2 = P_1\left(\frac{N_2}{N_1}\right)^3$$

N, Q, P are the speed, volume and capacity of the pump, respectively

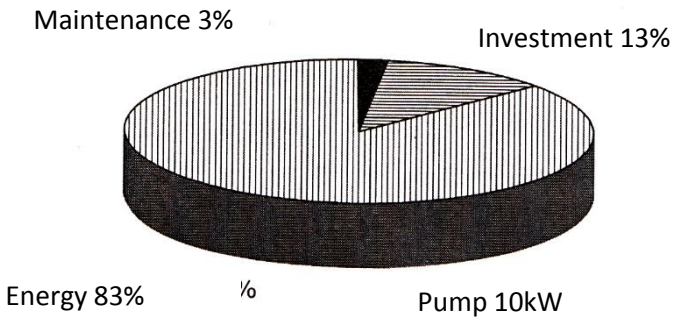
Parallel pump system



- The static head of the system is equal to the static head of each pump
- The flow of the system is equal to the total flow rate of the pumps

Pump cost chart

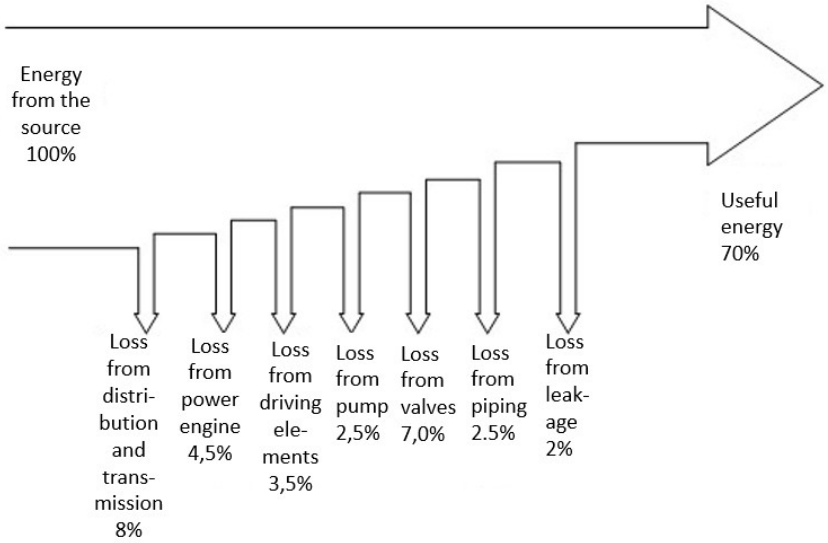
Pump operating and investment costs are shown in the following graph:



Pumping operating and investment costs

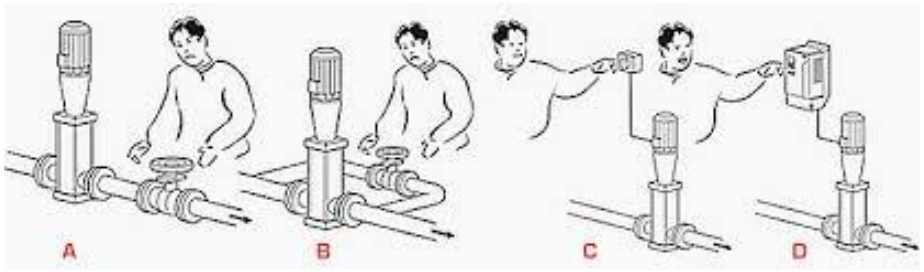
As such, energy costs account for more than 83% of the total pump service life costs. Therefore, optimizing pump usage may significantly reduce operating costs.

Sankey diagram

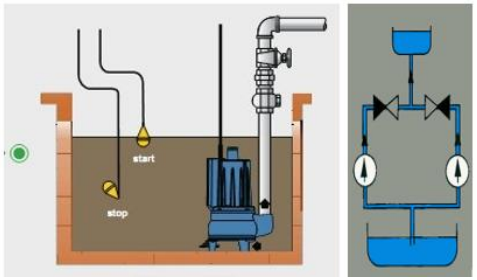


Useful energy supplied to the pump is only about 70% total energy, the rest is lost in many different forms mainly through valves, leaks, pipes, pump

Pump flow control

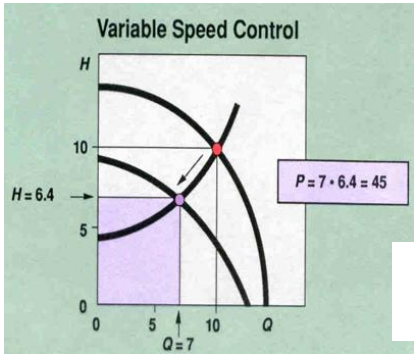


- Adjusting pipeline properties through valve (pump properties unchanged)
  - Butterfly cock: Reducing pressure in the system, changing system properties, and reducing pump efficiency
  - Circulation: this is an economical control option



- Adjusting pump properties (pipeline properties unchanged)

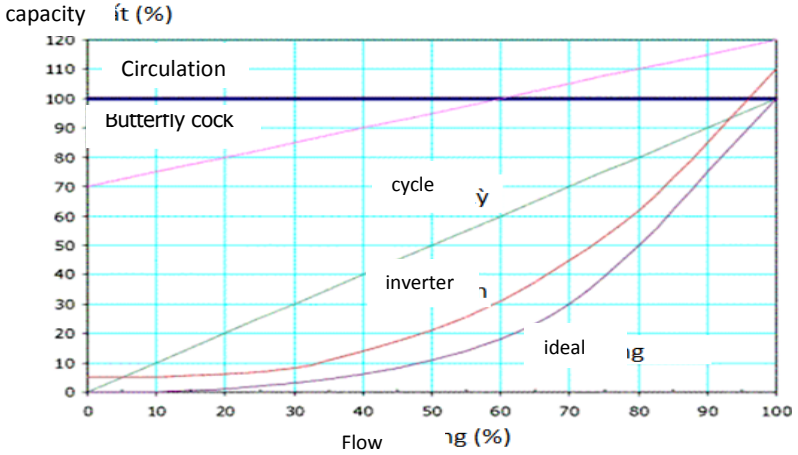
Using the inverter for the motor: changing flow and pressure flexibly, saving electricity.



$$\frac{P_1}{P_2} = (\frac{N_1}{N_2})^3$$

structures...	

- Pump capacity between flow regulation methods



From the above graph, we can see, with the same pumping flow, the inverter control method (red line) has a much lower percentage of power consumption compared to the valve control method.

Inverter for water pump systems

- Operating principle of the inverter in the pump system

+ The inverter system applies the principle of closed-loop control
+ Pressure signals from the water supply network are sent to the processor, and compared with the pressure signals setting as required. The deviation between these two values will be processed by a program installed specifically for the system to deliver the optimal control signals to the inverter.
+ The inverter is programmed to process that signal and give the appropriate frequency for the motor input electric current. The number of pump shaft revolutions varies and meets both the required flow and pressure on the pipeline network.

- Functions of the inverter

+ Automatically control the number of revolutions of the pump to meet the required flow

+ Alternate the working pump and backup pump

+ Avoid voltage drop of the current

+ Prevent overload, circuit break, and phase loss

- Advantages of installing inverters for water pump systems

- Improve motor service life thanks to the supply of constant voltage and current.
- Limit high starting current and save energy.
- Control the pumps flexibly and automatically stop when the set point is reached.
- Automatically accelerate, decelerate to avoid overload or over voltage when starting.
- Protect the motor in the event of short circuit, phase loss, phase out, overload, over current, and over temperature, etc.
- Compact size that does not occupy much area in the station.
- Easy to install, operate and start smoothly.
- Automatically control the number of pumps and pump rotation to provide enough flow, as required.
- Automatically change the working pumps and backup pumps alternately.

A textile factory in Long An province has installed an inverter for the secondary pump: reduce the secondary pump speed to save energy. After installation of the inverter, the pump operates at a frequency of 15.4 Hz.
Cost-benefit analysis table in below:

Parameter	Unit	Value
Nominal power	kW	18.5
Operating power	kW	8.9
Operating power after installing the inverter	kW	4.9
Annual electricity saving	kWh/year	33,354
Cost saving	VND million/year	55
Investment cost	VND million	57.5
Payback time	Year(s)	1.0