



# Principles of Mechatronic Systems

## مبانی سیستم های مکاترونیکی (جلسه نهم)

By: Reza Tikani

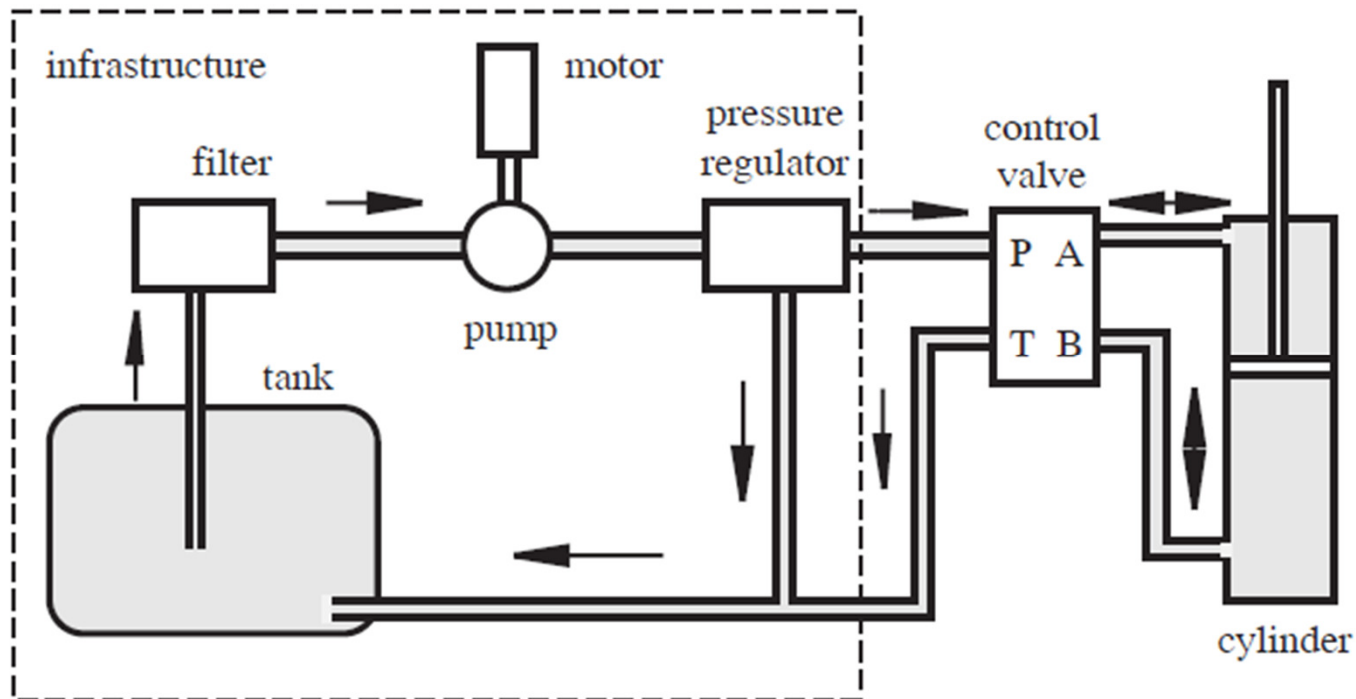
Mechanical Engineering Department

Isfahan University of Technology



# سیستم های هیدرولیک

سیستم هیدرولیک:

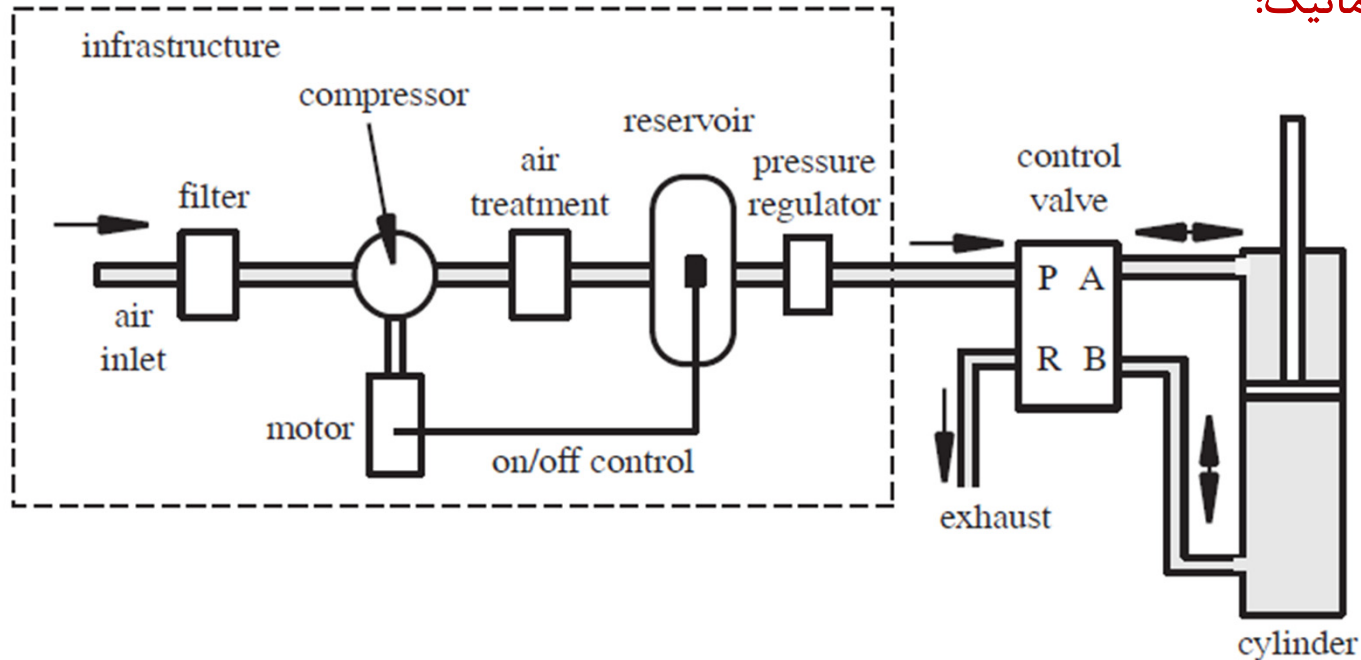


Hydraulic systems are designed to move large loads by controlling a high-pressure fluid in distribution lines and pistons with mechanical or electromechanical valves.



## سیستم های هیدرولیک

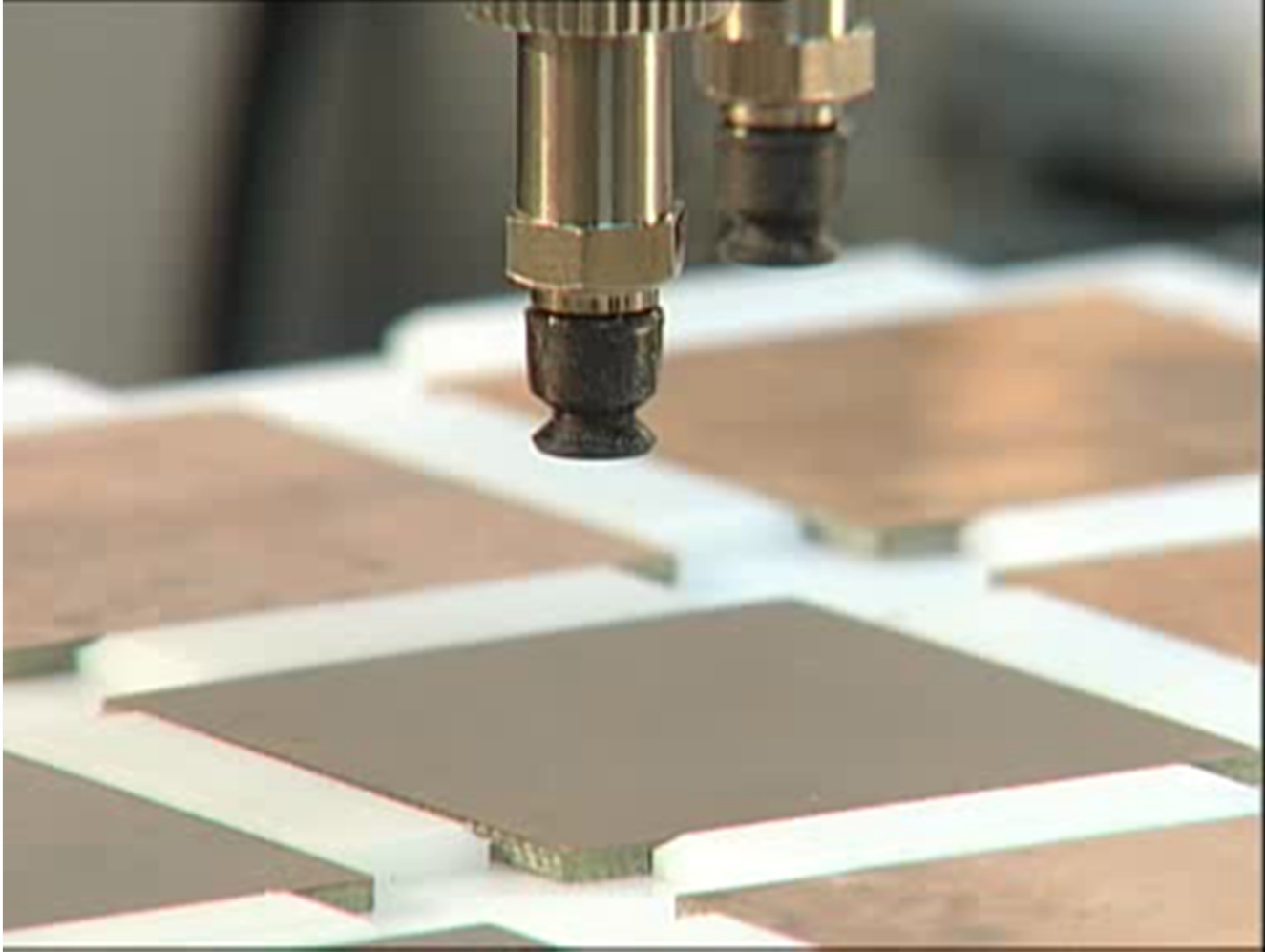
سیستم نیوماتیک:



Pneumatic systems are similar to hydraulic systems, but they use compressed air as the working fluid rather than hydraulic liquid. The components in a pneumatic system are illustrated in the figure. A compressor is used to provide pressurized air, usually on the order of 70 to 150 psi (482 kPa to 1.03 MPa), which is much lower than hydraulic system pressures. As a result of the lower operating pressures, pneumatic actuators generate much lower forces than hydraulic actuators.



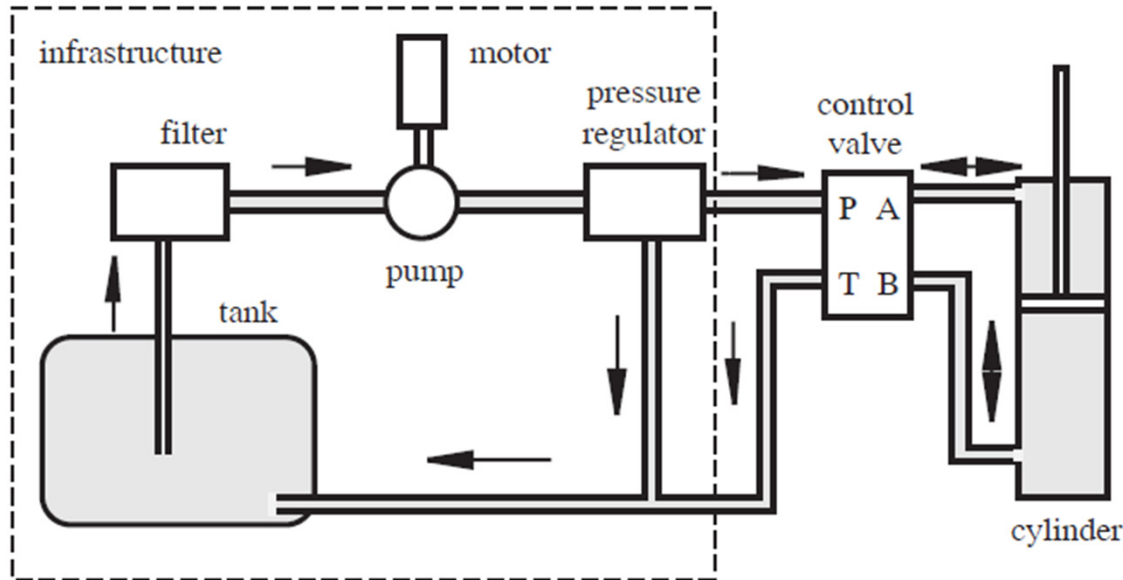
## سیستم های نیوماتیک





# سیستم های هیدرولیک

سیستم هیدرولیک:



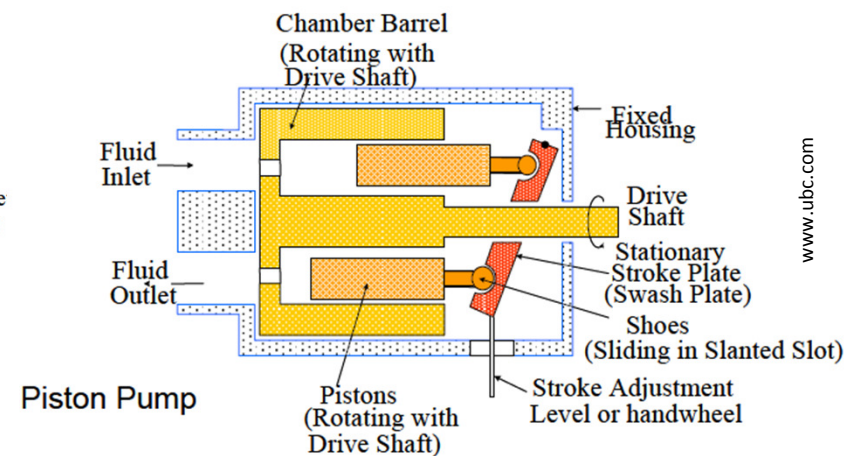
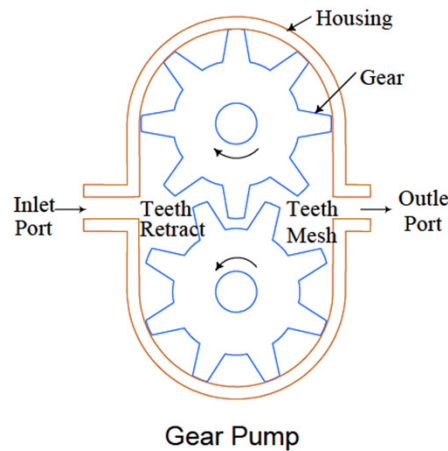
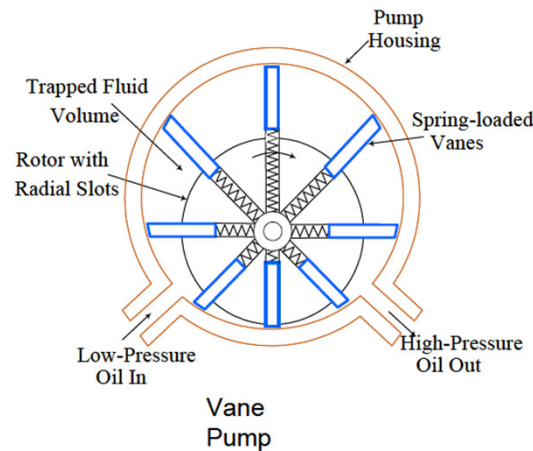
- A pump to deliver high pressure Fluid
- A pressure regulator to limit the pressure in the system
- Valves to control flow rates and pressures



# سیستم های هیدرولیک

پمپها:

A hydraulic pump is usually driven by an electric motor (e.g., a large AC induction motor) or an internal combustion engine. Typical fluid pressures generated by pumps used in heavy equipment (e.g., construction equipment and large industrial machines) are in the 1000 psi (6.89 MPa) to 3000 psi (20.7 MPa) range.

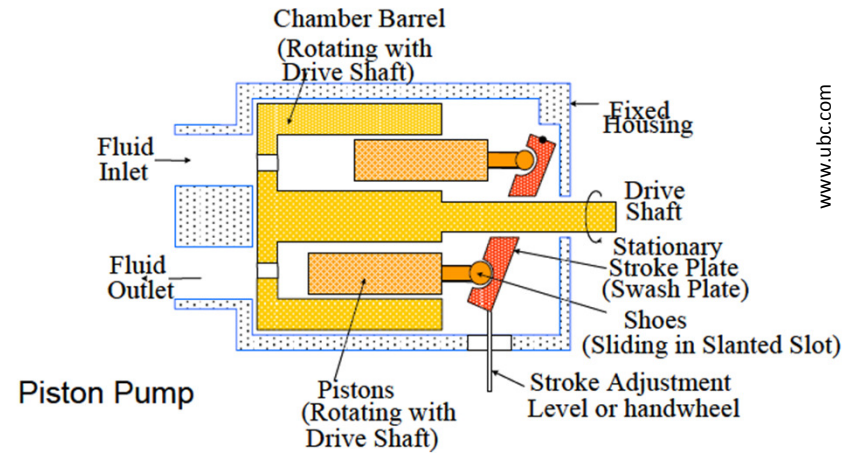
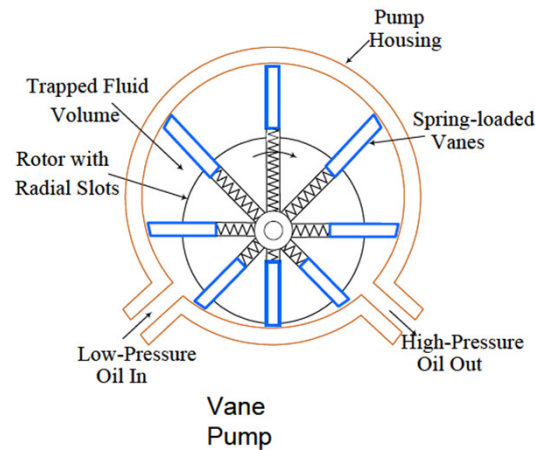
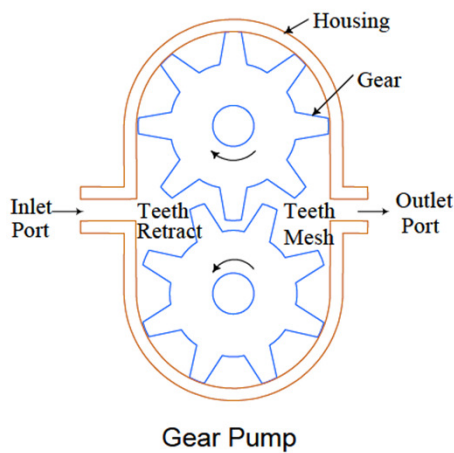


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# سیستم های هیدرولیک

پمپ ها به سه دسته دنده ای، پره ای و پیستونی تقسیم می شوند.



Pump type	Displacement	Typical pressure (psi)	Cost
Gear	Fixed	2000	Low
Vane	Variable	3000	Medium
Piston	Variable	6000	High

میزان جریان دهی پمپ (ثابت، قابل تنظیم)

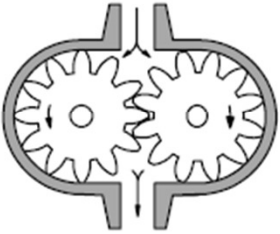

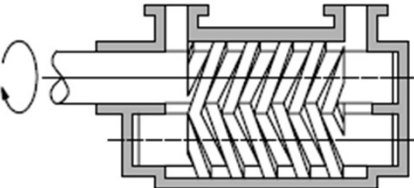
Pump Efficiency

$$\eta_p = \frac{PQ}{\omega T}$$



## سیستم های هیدرولیک

انتخاب یک پمپ هیدرولیک با توجه به دبی حجمی، حداکثر فشار مجار، سروصدا و راندمان پمپ تعیین می شود.

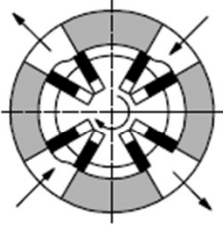
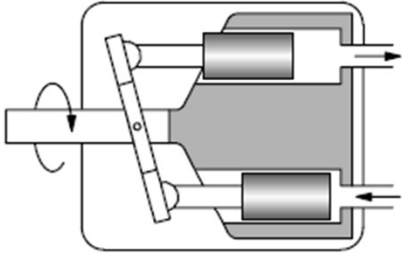
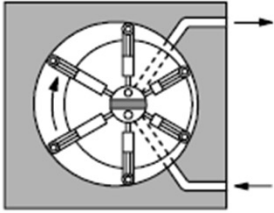
	Types of design	Speed range r.p.m.	Displacement volume (cm <sup>3</sup> )	Nominal pressure (bar)	Total efficiency
	Gear pump, externally toothed	500 – 3500	1.2 – 250	63 – 160	0.8 – 0.91
	Gear pump, internally toothed	500 – 3500	4 – 250	160 – 250	0.8 – 0.91
	Screw pump	500 – 4000	4 – 630	25 – 160	0.7 – 0.84





# سیستم های هیدرولیک

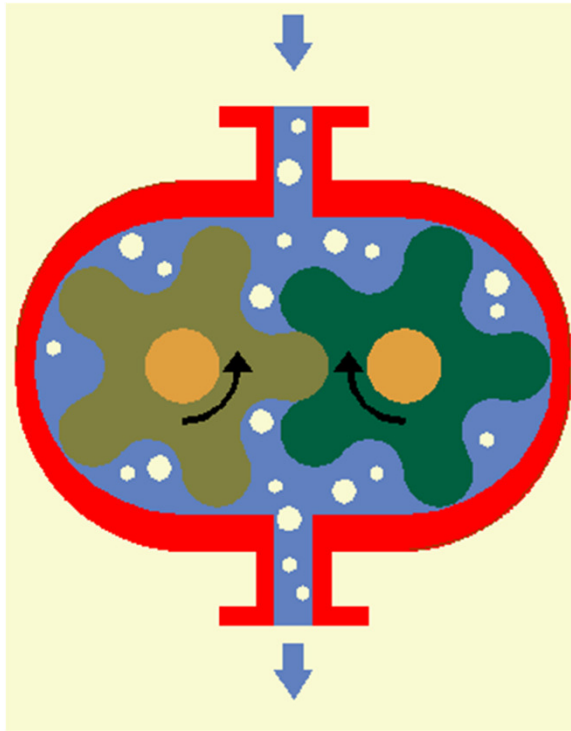
پمپها:

	Types of design	Speed range r.p.m.	Displacement volume (cm <sup>3</sup> )	Nominal pressure (bar)	Total efficiency
	Rotary vane pump	960 – 3000	5 – 160	100 – 160	0.8 – 0.93
	Axial piston pump	..... – 3000 750 – 3000 750 – 3000	100 25 – 800 25 – 800	200 160 – 250 160 – 320	0.8 – 0.92 0.82 – 0.92 0.8 – 0.92
	Radial piston pump	960 – 3000	5 – 160	160 – 320	0.90

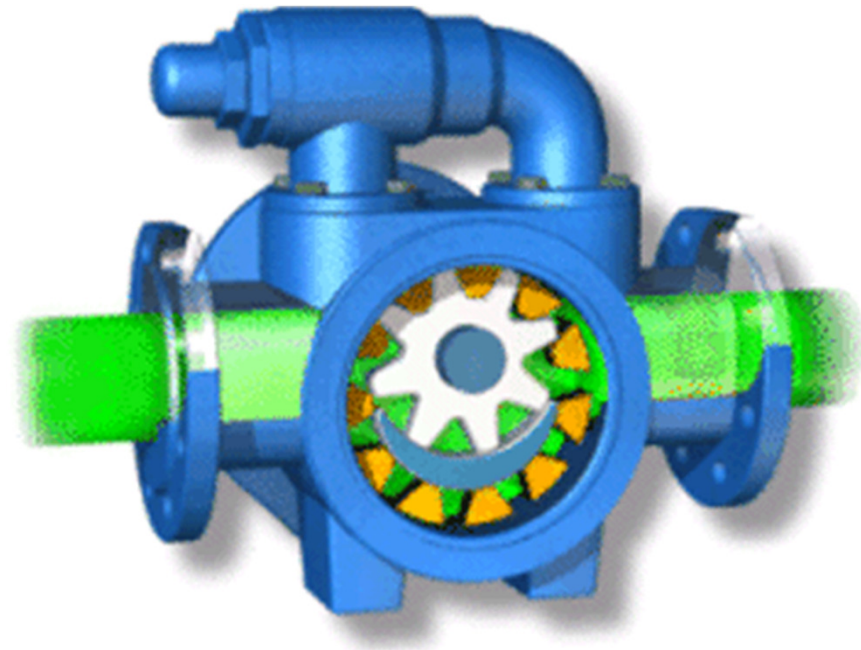


# سیستم های هیدرولیک

نحوه عملکرد پمپ:



پمپ دنده خارجی

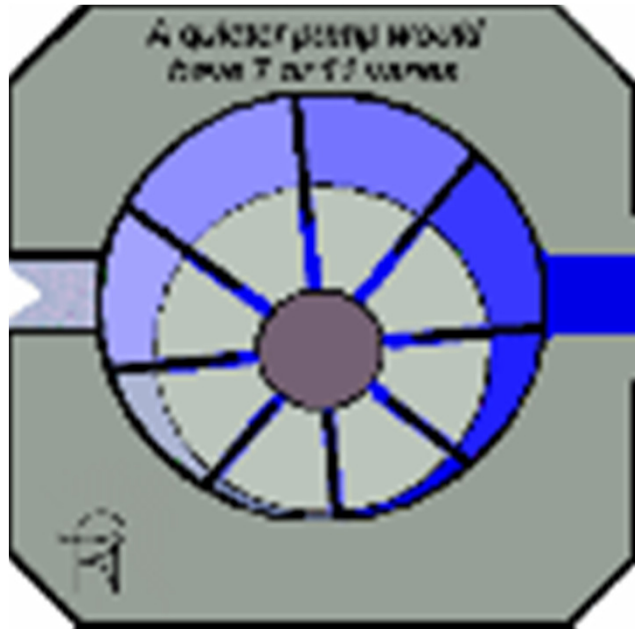


پمپ دنده داخلی

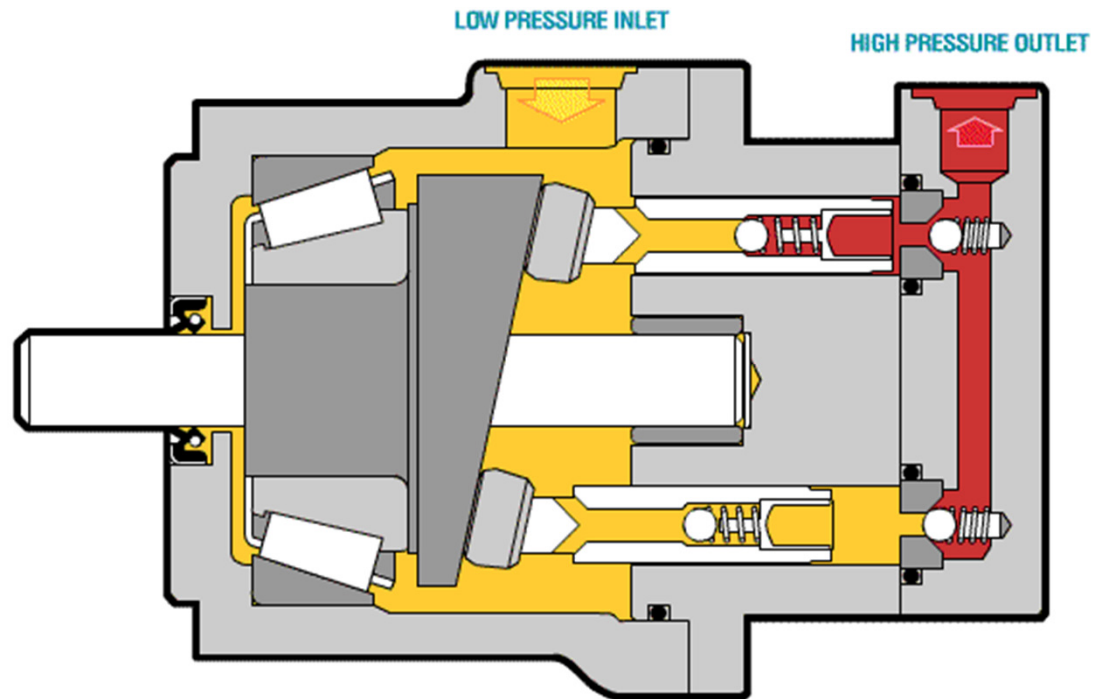


# سیستم های هیدرولیک

نحوه عملکرد پمپ:



پمپ پره ای

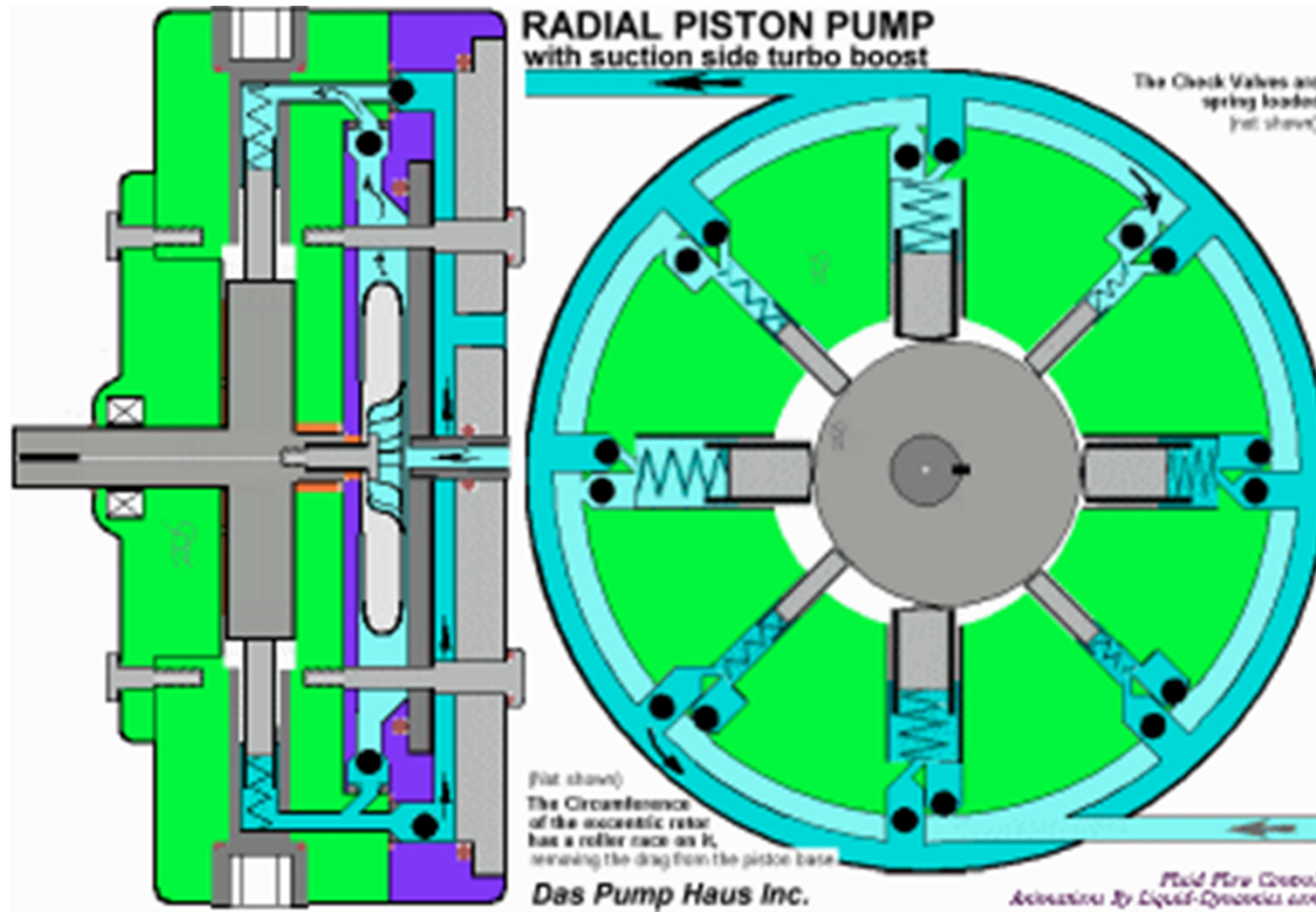


پمپ پیستونی محوری



# سیستم های هیدرولیک

نحوه عملکرد پمپ:

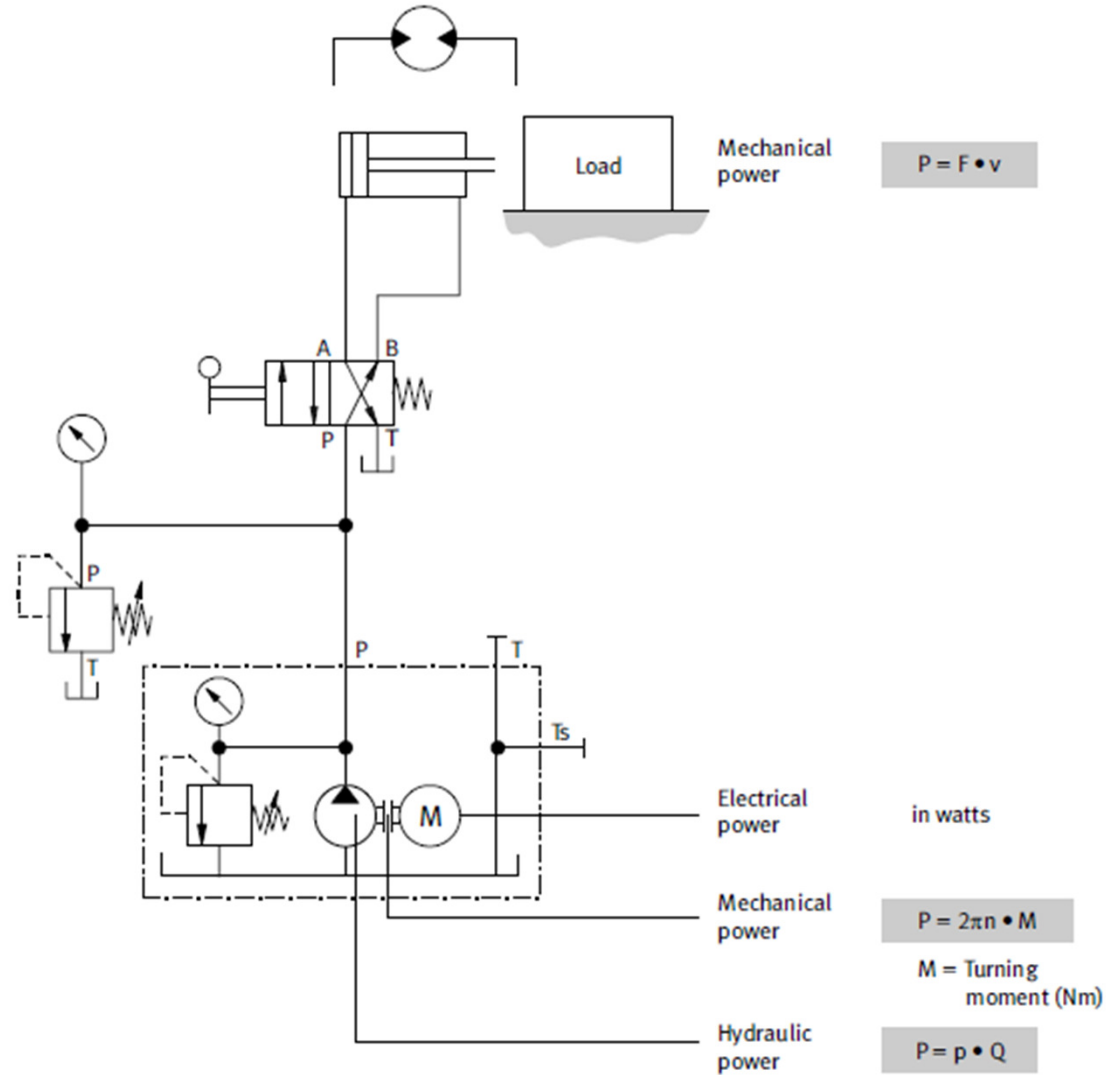


پمپ پیستونی شعاعی



# سیستم های هیدرولیک

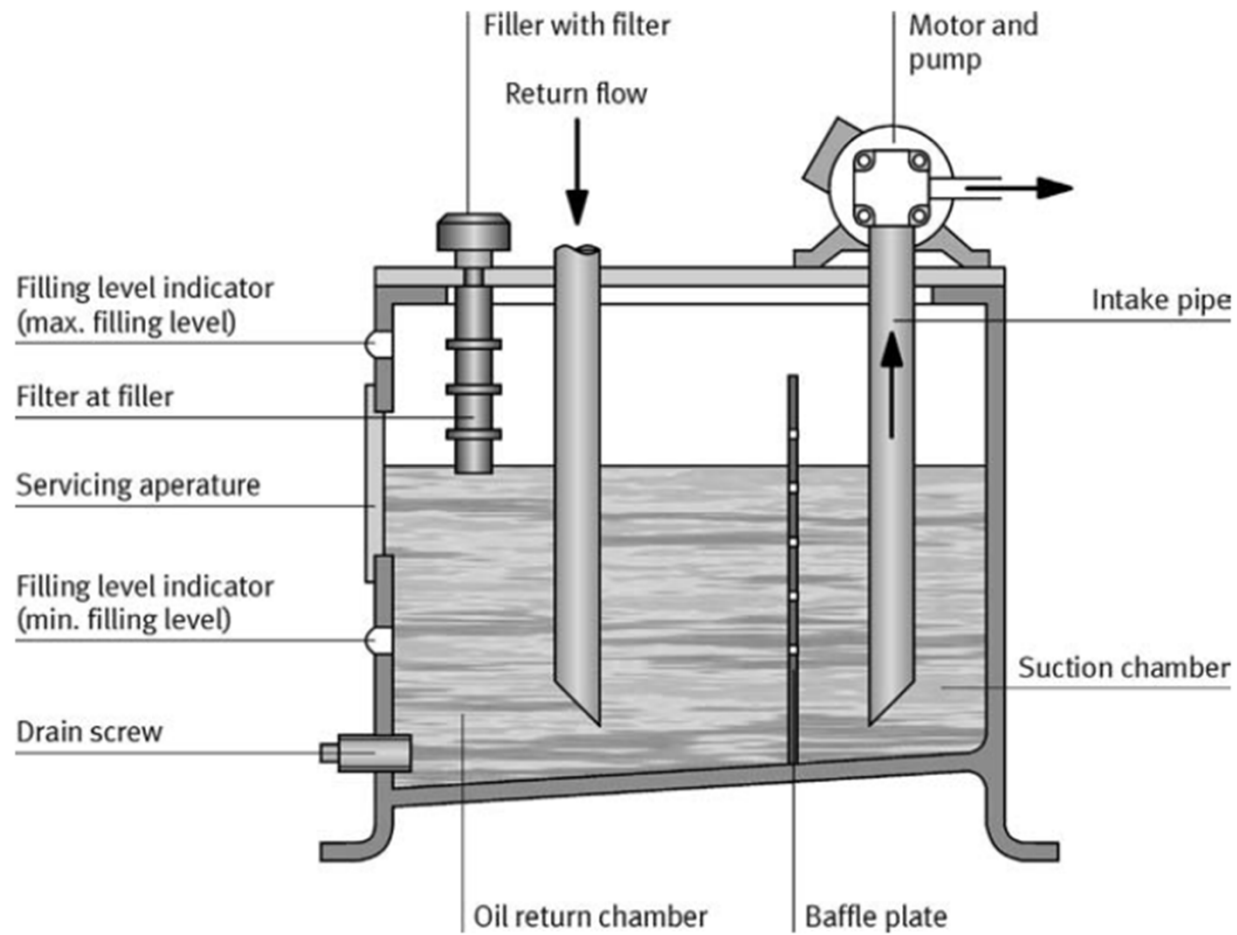
توان:





# سیستم های هیدرولیک

مخزن:



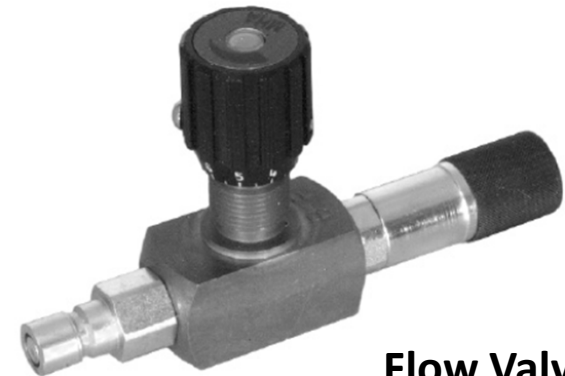


# سیستم های هیدرولیک

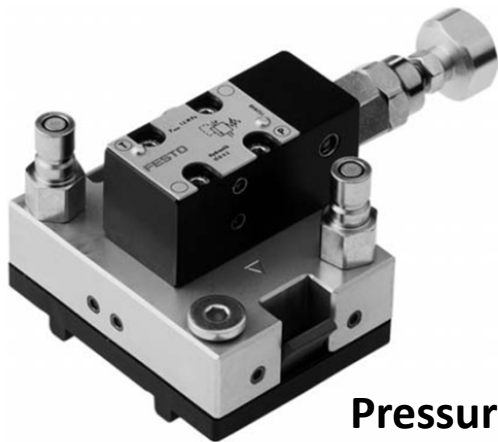
انواع مختلف شیرها (Valves):



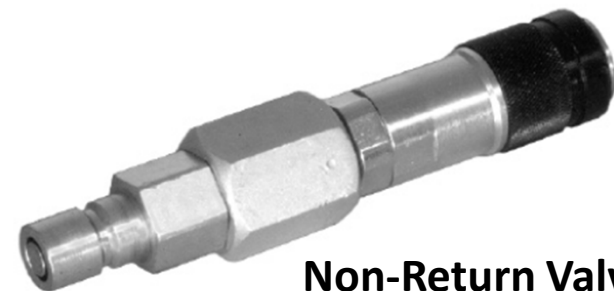
Directional Control Valve



Flow Valve



Pressure Valve



Non-Return Valve



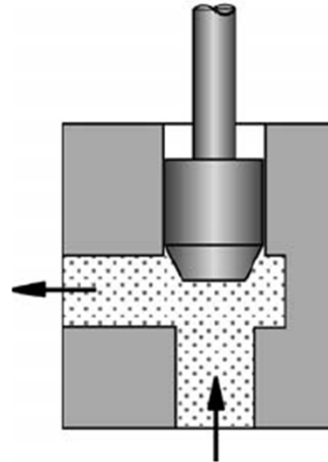
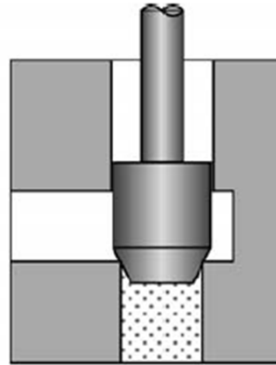


# سیستم های هیدرولیک

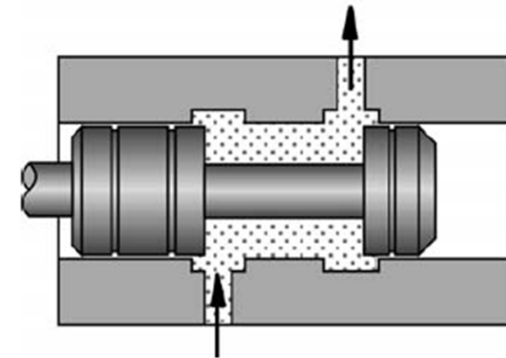
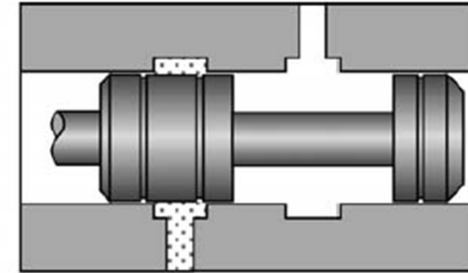
انواع مختلف شیرها (Valves):



Directional Control Valve



شیرهای سوپاپی (Poppet Valve)



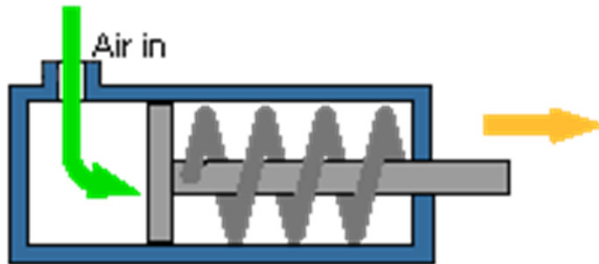
شیرهای کشویی (Spool Valve)



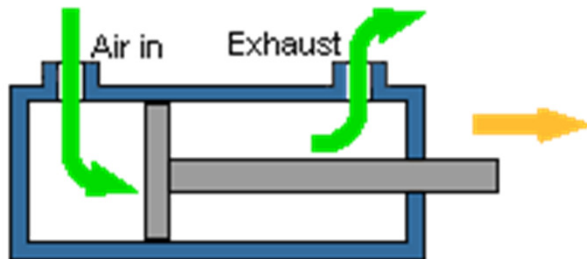


# سیستم های هیدرولیک

انواع مختلف سیلندرها:



Single Acting Cylinders



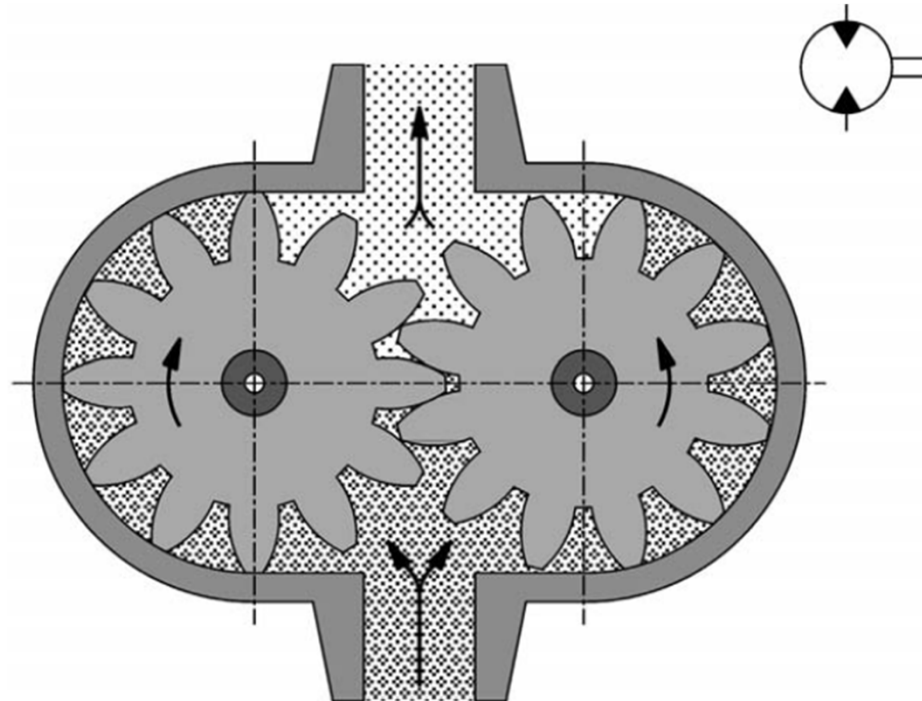
Double Acting Cylinders



# سیستم های هیدرولیک

موتور هیدرولیکی:

معادل هر پمپ هیدرولیکی، یک موتور هیدرولیکی وجود دارد.





# سیستم های هیدرولیک

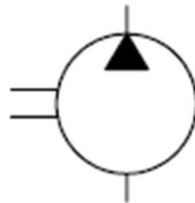
نمادهای گرافیکی:

موتورها و پمپها

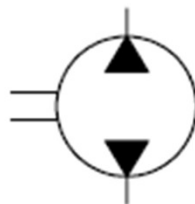
DIN ISO 1219

## Hydraulic pumps with fixed displacement

– with one flow direction

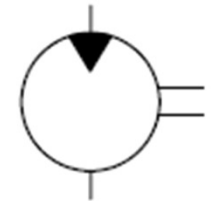


– with two flow directions

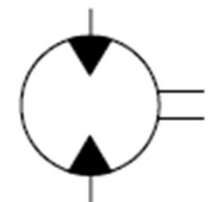


## Hydraulic motors with fixed displacement

– with single direction of rotation



– with two directions of rotation





# سیستم های هیدرولیک

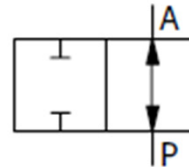
نمادهای گرافیکی:

شیرهای کنترل وضعیت

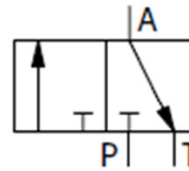
Number of ports

Number of switching positions

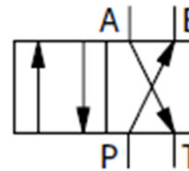
2/2 – way valve



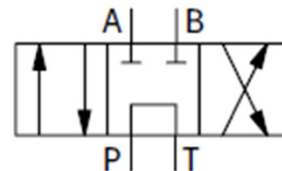
3/2 – way valve



4/2 – way valve



4/3 – way valve



Port designations

P pressure port  
 T return port  
 A } power ports  
 B }  
 L leakage oil

or:

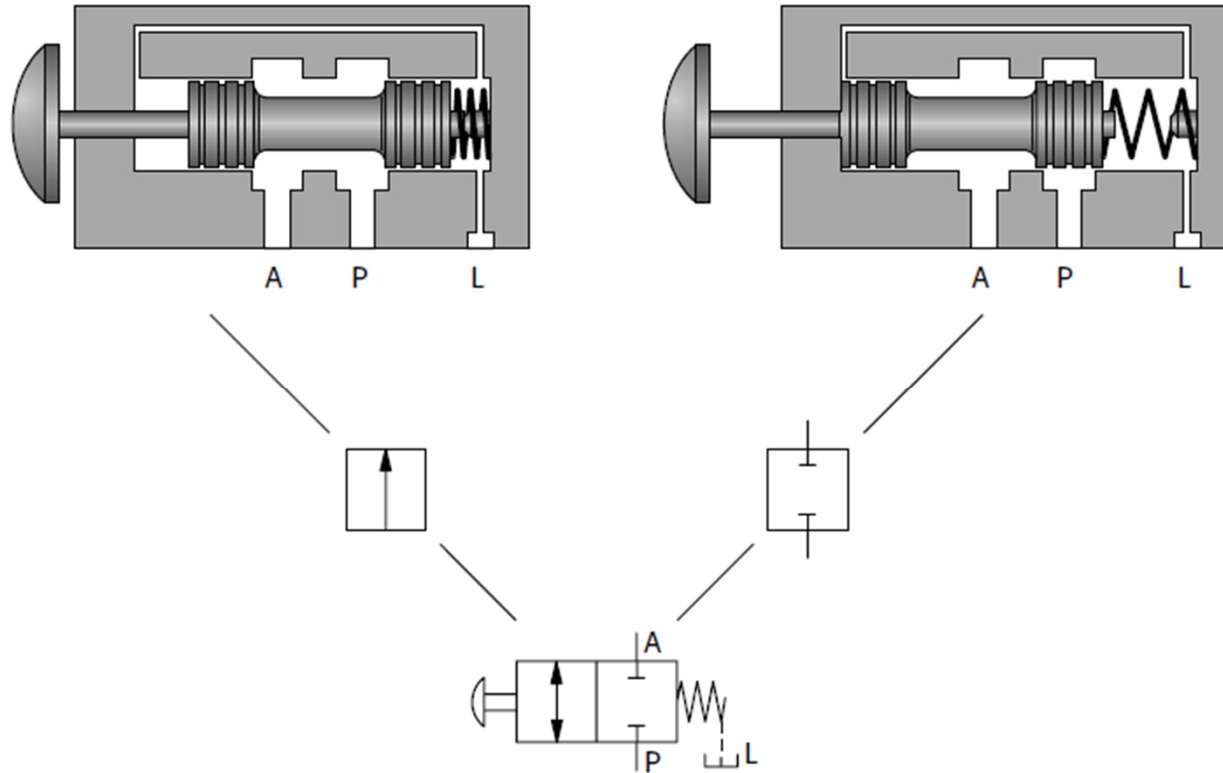
A pressure port  
 B return port  
 C } power ports  
 D }  
 L leakage oil



# سیستم های هیدرولیک

نمادهای گرافیکی:

شیرهای کنترل وضعیت

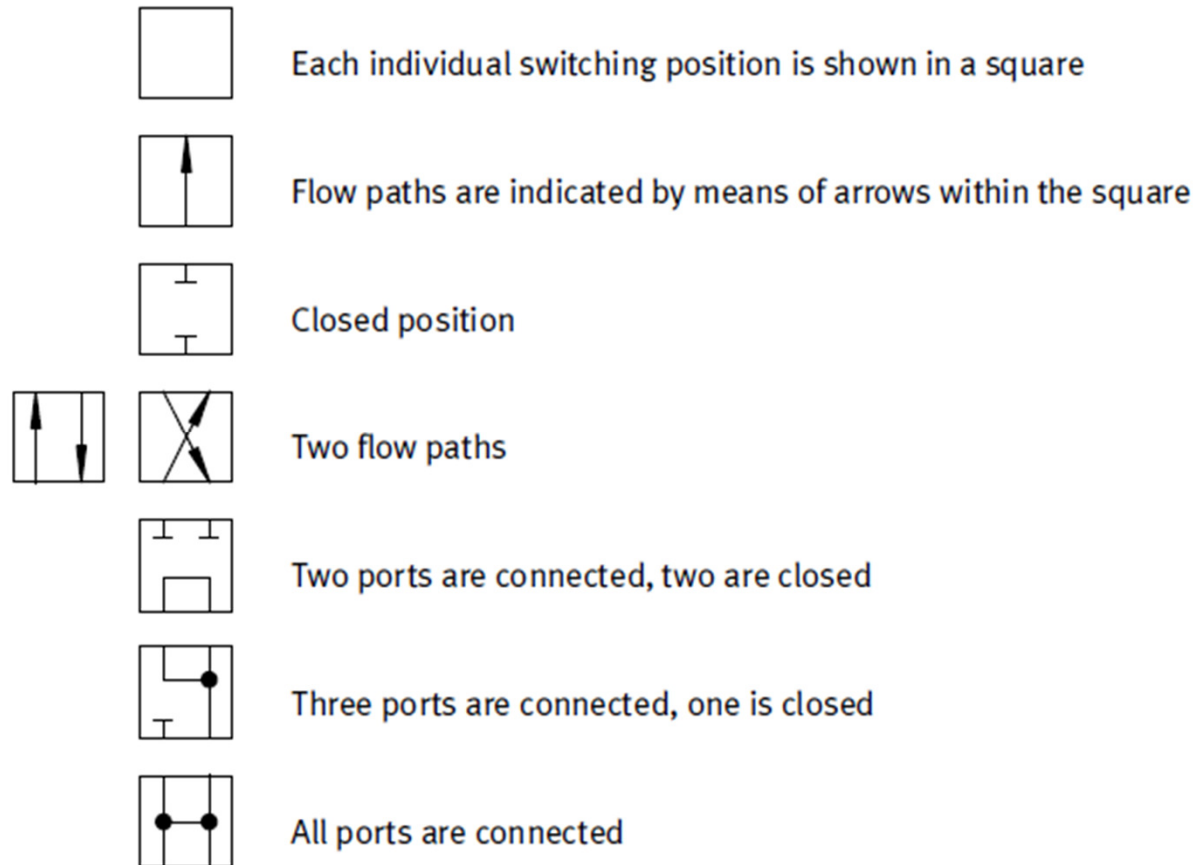




# سیستم های هیدرولیک

نمادهای گرافیکی:

شیرهای کنترل وضعیت





# سیستم های هیدرولیک

نمادهای گرافیکی:

شیرهای کنترل وضعیت

Directional control valve		
2/2-WV	Normal position "closed" (P, A)	
	Normal position "flow" (P → A)	
3/2-WV	Normal position "closed" (P, T → A)	
	Normal position "flow" (P → A, T)	



# سیستم های هیدرولیک

## شیرهای کنترل وضعیت

4/2-WV	Normal position "flow" ( $P \rightarrow B, A \rightarrow T$ )	
5/2-WV	Normal position "flow" ( $A \rightarrow R, P \rightarrow B, T$ )	
4/3-WV	Mid position "closed" ( $P, A, B, T$ )	
4/3-WV	Mid position "Pump re-circulating" ( $P \rightarrow T, A, B$ )	
4/3-WV	"H" mid position ( $P \rightarrow A \rightarrow B \rightarrow T$ )	



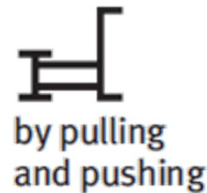


# سیستم های هیدرولیک

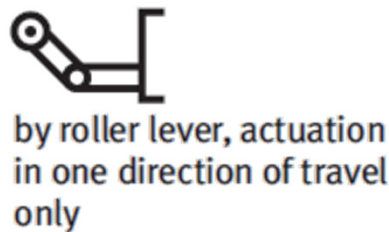
نمادهای گرافیکی:

نحوه فعالسازی شیرها

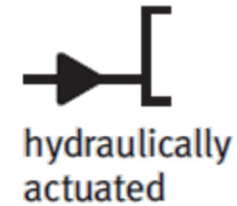
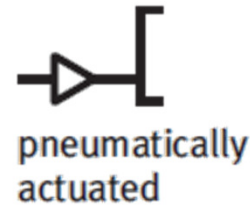
## Manual actuation



## Mechanical actuation



## Pressure actuation



## Electrical actuation





# سیستم های هیدرولیک

نمادهای گرافیکی:

نحوه فعالسازی شیرها

## Mechanical components



Detents are to be symmetrically matched with the mechanical connection.

With more than three detent positions the number of positions can be displayed above the detent element.



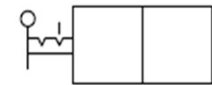
- by push button with spring return



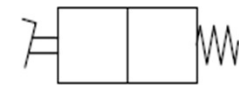
- by lever



- by lever with detent setting



- by pedal and spring return





# آشنایی با نحوه کار شیرهای کنترل وضعیت

FluidSIM-P (Demo-Version)

File Edit Execute Library Insert Didactics Project View Options Window ?

Hierarchical View - Component Library

Pneumatic

Supply Elements

Compressor Compressor Variable co... Air service ...

Air service ... Air pressure... Air pressure... Air filter

Manual drain... Automatic d... Manual drain Automatic d...

Lubricator Cooler Air Dryer

Actuators

Distance rule Single actin... Cylinder, Si... Double acti...

Cylinder wit... Cylinder wit... Multiple Pos... Air motor

Semi-rotary... Vacuum su... Sucker

C:\Program Files (x86)\Didactic\fsp4\_demo.en\ct\noname.ct

Simulation Mode (100% Real-time) 2:49.720



# آشنایی با نحوه کار شیرهای کنترل وضعیت

The screenshot displays the FluidSIM-P (Demo-Version) software interface. The main window shows a hydraulic circuit simulation with a cylinder and a 4-way valve. The valve is connected to a pressure source (pump) and a reservoir. The circuit is labeled with numbers 1, 2, 3, and 4. A large "Demo" watermark is overlaid on the simulation area.

The interface includes a menu bar (File, Edit, Execute, Library, Insert, Didactics, Project, View, Options, Window), a toolbar with various simulation controls, and a component library on the left. The component library is organized into sections: Valves, Configurable directional valves (2h Way V..., 3h Way V..., 4h Way V..., 5h Way V..., 6h-way dire..., 8h-way dire...), Frequently Used Way Valves, Mechanically Operated (3/2-way val..., 3/2-way roll..., 3/2-way idle..., Pneumatic ...), and Pneumatically Operated.

The status bar at the bottom indicates "Simulation Mode (100% Real-time)" and shows the time "0:38.200". The Windows taskbar at the very bottom shows the system tray with the date "۲۰۱۵/۰۲/۰۲" and time "۱۲:۳۰".