PNEUMATIC & HYDRAULIC SYSTEMS

INTRODUCTION

Dr. Ahmad Al-Mahasneh

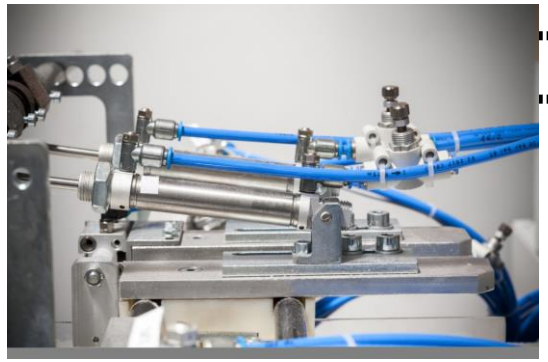
outline

- Introduction to fluid power
- Examples of fluid power applications
- Advantages of fluid power
- Hydraulics vs Pneumatics
- Problems with fluid power
- Adv/dis of hydraulics
- Adv/dis of pneumatics
- Examples

INTRODUCTION TO FLUID POWER

What is fluid power?

- Fluid power is a technology that deals with the generation, control, and transmission of power using pressurized fluids (either liquids or gases).
- This power is used to provide **force** and **motion** to mechanisms.



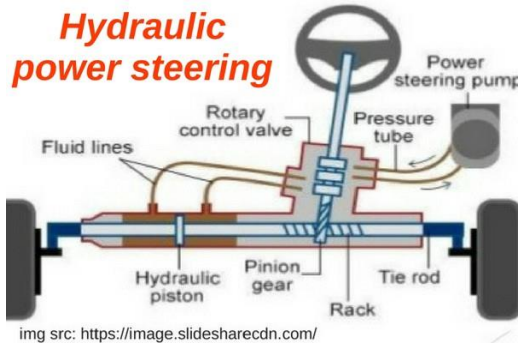
INTRODUCTION TO FLUID POWER

What is fluid power?

- **Fluid power is the muscle that moves the industry this is because** the fluid power maybe used in pushing, pulling, rotating, regulating, or driving modern industrial machines.
- Fluid power includes hydraulics, which involves liquids, and pneumatics, which involves gases.

Examples of fluid power Applications

- Streeting and brakes of automobile
- Spacecraft launching
- Harvesting machines
- Mining machines
- Airplanes
- Food processing
- Teeth drilling.



ADVANTAGES OF FLUID POWER

- They eliminate the need for complicated systems of gears, cams, and levers.
- Motion can be transmitted without the slack (loose) inherent in the use of solid machine parts.
- The fluids used are not subject to breakage as are mechanical parts, and the mechanisms are not subjected to great wear.

ADVANTAGES OF FLUID POWER

- The different parts of a fluid power system can be conveniently located at widely separated points, since the forces generated are rapidly transmitted over considerable distances with small loss.
- These forces can be conveyed up and down or around corners with small loss in efficiency and without complicated mechanisms.
- Very large forces can be controlled by much smaller ones and can be transmitted through comparatively small lines and orifices.

ADVANTAGES OF FLUID POWER

- If the system is well adapted to the work it is required to perform, and if it is not misused, it can provide smooth, flexible, uniform action without vibration, and is unaffected by variation of load.

- In case of an overload, an automatic release of pressure can be guaranteed, so that the system is protected against breakdown or strain.

- Fluid power systems can provide widely variable motions in both rotary and straight-line transmission of power.

- The need for control by hand can be minimized. In addition, fluid power systems are economical to operate.

Hydraulics vs. pneumatics

Why hydraulics is used in some applications and pneumatics in others.

- Many factors are considered by the user and/or the manufacturer when determining which type of system to use in a specific application.
- There are no hard and fast rules to follow; however, previous experience has provided some sound ideas that are usually considered when such decisions are made.
- If the application requires speed, a medium amount of pressure, and only fairly accurate control, a pneumatic system may be used.
- If the application requires only a medium amount of pressure and a more accurate control, a combination of hydraulics and pneumatics may be used.
- If the application requires a great amount of pressure and/or extremely accurate control, a hydraulic system should be used.

Problems with fluid power

The extreme flexibility of fluid power elements presents a number of problems:

- Since fluids have no shape of their own, they must be positively confined throughout the entire system.
- Special consideration must be given to the structural integrity of the parts of a fluid power system.
- Strong pipes and containers must be provided.
- Leaks must be prevented. This is a serious problem with the high pressure obtained in many fluid power installations.

Problems with fluid power

- The operation of the system involves constant movement of the fluid within the lines and components. This movement causes friction within the fluid itself and against the containing surfaces which, if excessive, can lead to serious losses in efficiency.
- Foreign matter must not be allowed to accumulate in the system, where it will clog small passages or score closely fitted parts.
- Chemical action may cause corrosion. Anyone working with fluid power systems must know how a fluid power system and its components operate, both in terms of the general principles common to all physical mechanisms and of the peculiarities of the particular arrangement at hand.

Advantages of hydraulic systems

- Very high power to weight ratio.
- Very high peak torque (or forces).
- Very short time lags enabling fast response.
- Smooth operation even at low speeds.
- Large holding forces when stationary.
- High power efficiency.
- Rugged (durable or robust).
- Self lubricating and cooling.
- Linear and rotary motions available.

A direct results of operating at high pressure (up to 5000 psi, 34 MPa)

Disadvantages of hydraulic systems

- Clumsiness of connections.
- Mess from oil leaks.
- Danger from large oil leaks (high pressure, toxicity, and flammability).
- Oil properties change with temperature.
- Inertia of oil can degrade system performance.
- Expensive when power supply is included in cost.
- Fluid must be kept clean and gas free.
- Severe nonlinearities may necessitate special treatment.

Advantages of pneumatic systems

- Relatively cheap.
- Pressurized air is often available, so that no special supply is then required.
- Safe in potentially explosive atmosphere.
- No mess or danger from leakage.
- Can exhaust to atmosphere.

disadvantages of pneumatic systems

- Power to weight ratio is lower than with hydraulics (due to the lower operating pressure).
- Relatively inefficient.
- Undesirable behaviour due to compressibility of air. For this reason pneumatics drives tend to be used mainly in on-off (bang-bang) applications.

comparison

If we compare pneumatic drives with other types of drives, we can see that pneumatics is able to cover a very large area of applications. If high actuating forces are required, hydraulics offers advantages, while electrical drives are a better choice for very slow motions. This can be seen in Fig. 3.

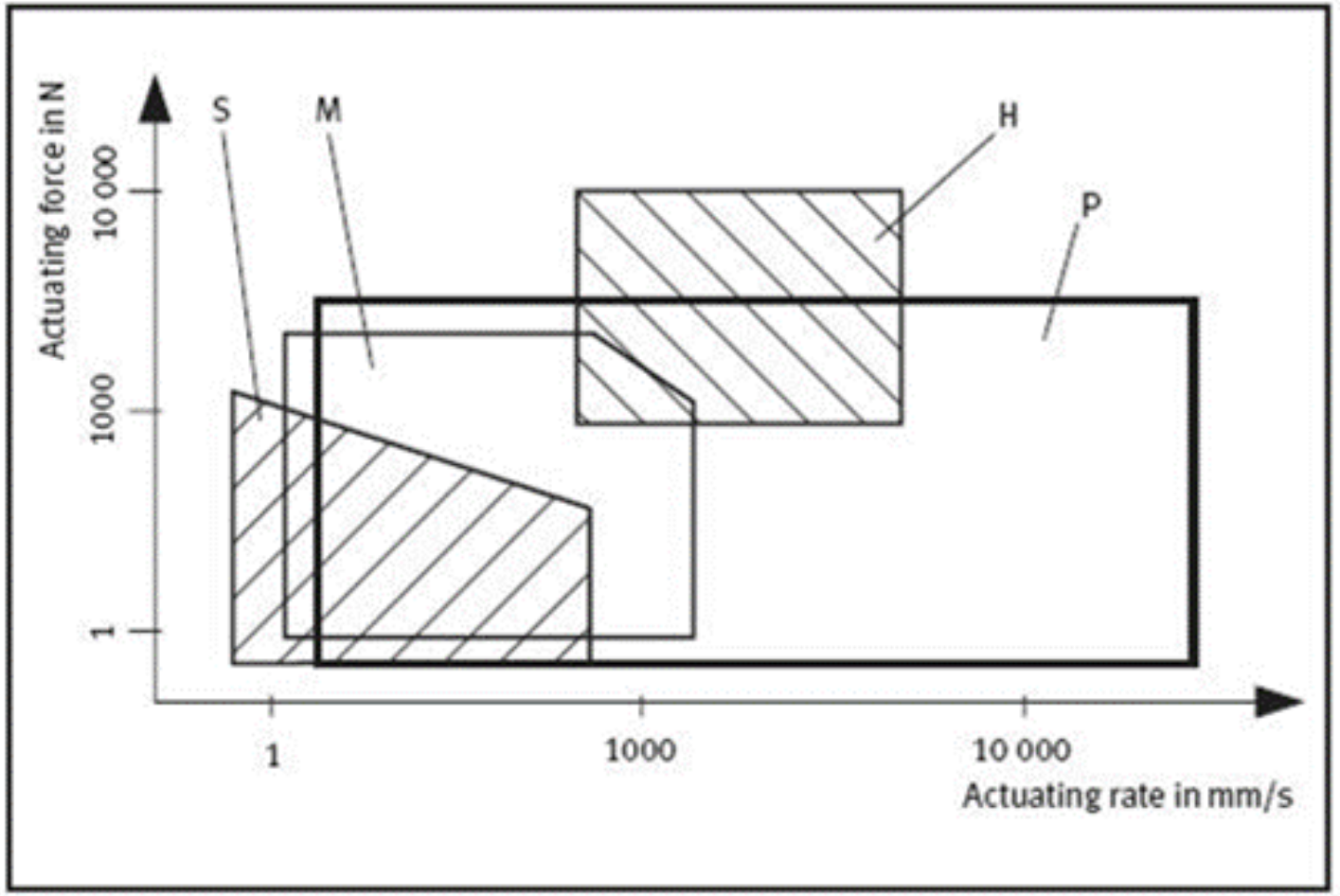


Fig. 3:
Areas of applications of pneumatic drives

H Hydraulics (100 to 10,000 N, 100 to 10,000 mm/s)
M Spindle-motor combination (0.5 to 2,000 N)
P Pneumatics (0.1 to 5,000 N, 10 to 15,000 mm/s)
S Stepper motor

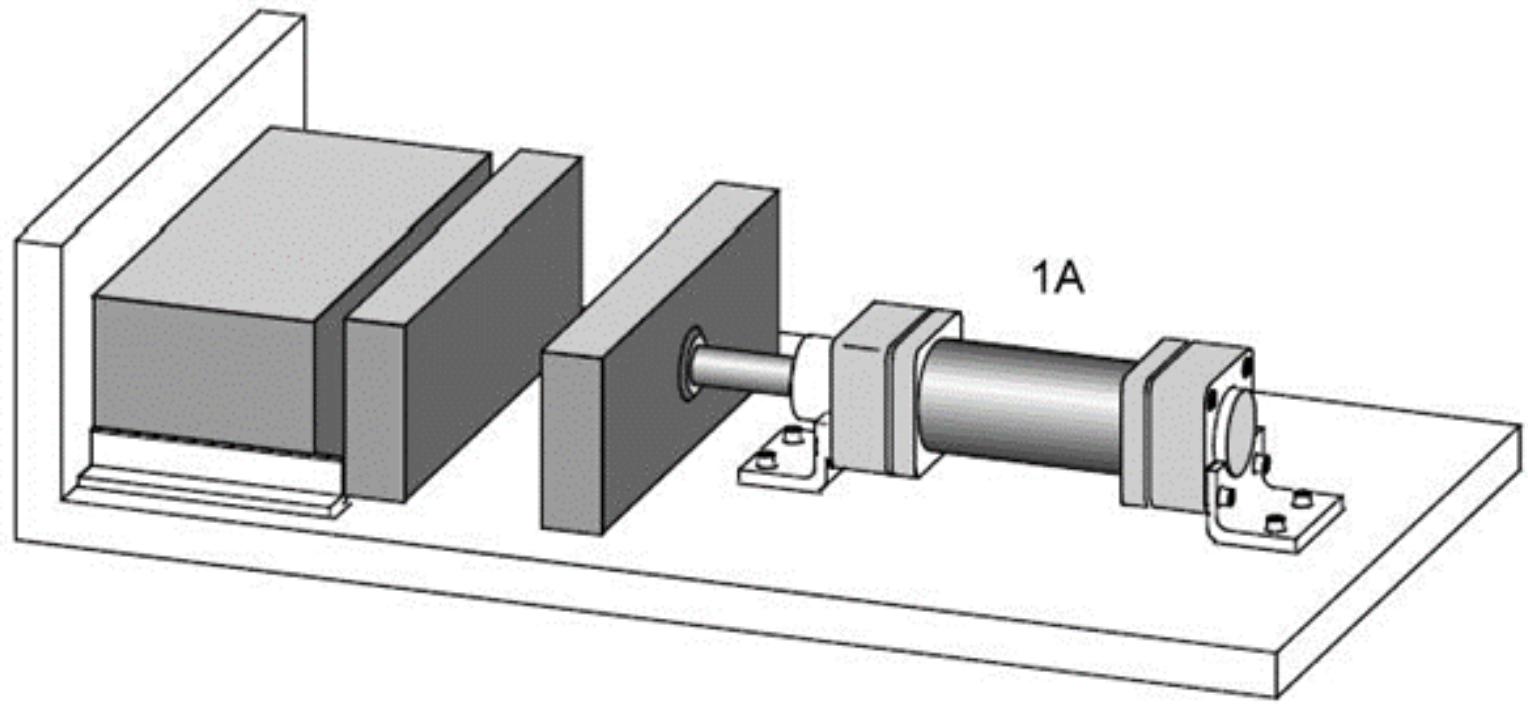
comparison

	Pneumatics	Electrics	Hydraulics
Energy storage	By means of air tanks and compressed air bottles	With batteries, although only in small quantities	With the help of gases
Energy transmission	Easily up to 1.000 m (pressure drop possible)	Unlimited, but voltage drop	Up to 100 m (pressure drop)
Leakage	No disadvantages *(minimal energy loss)*	Danger of exposed *cables*	Contamination
Environmental conditions	Explosion-proof, temperature insensitive, ice hazard with undried compressed air in winter	Explosion hazard in certain areas, temperature insensitive, heating required for outdoor use	Sensitive to temperature fluctuations, fire risk in the event of leakage
Handling	Simple	Only with specialised technical knowledge	More difficult than with pneumatics, return piping is necessary
Generation of linear movements	Simple with excellent adjustability of speed	Associated with major expenditure, gear units	Simple with cylinder, good ajustability
Forces	Overload-proof, no energy consumption for retention forces	Not overload-proof, impaired efficiency as a result of downstream mechanical elements	Overload-proof, permanent energy consumption for retention forces

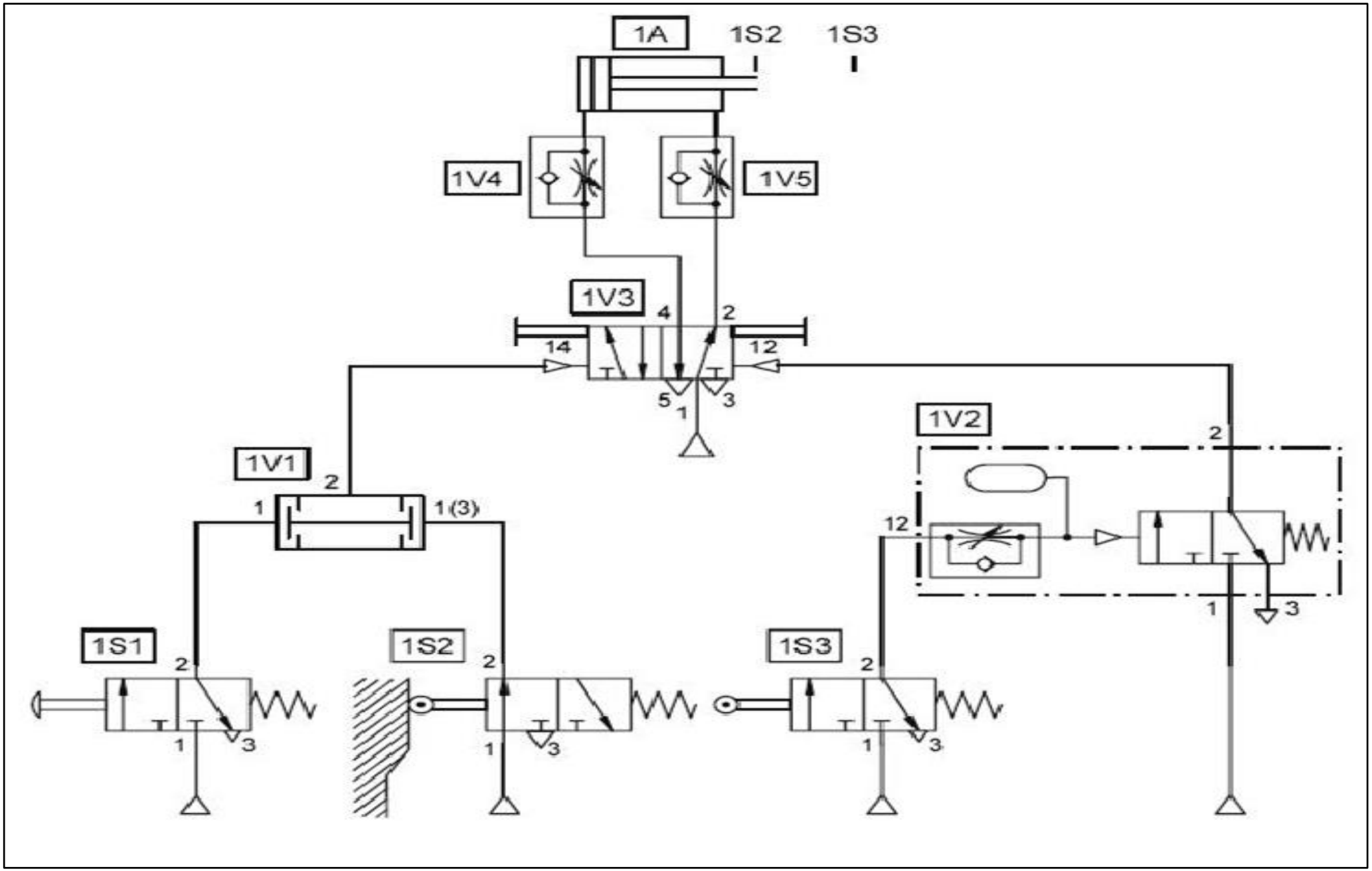
Example

A double-acting cylinder is used to press together glued components. Upon operation of a push button, the clamping cylinder extends.

Once the fully advanced position is reached, the cylinder is to remain for a time of T= 6 seconds and then immediately retract to the initial position. The cylinder retraction is to be adjustable. A new start cycle is only possible after the cylinder has fully retracted.



Example


1A
1S2
1S3
1V4
1V5
1V3
4
2
14
12
5
1
3
1V1
2
1
1(3)
1V2
2
12
1
3
1S1
2
1
3
1S2
2
1
3
1S3
2
1
3