Notes on Fluidic Systems  
(mainly based on “Fluid Power with Applications”, 7th edition, Anthony Esposito)  

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Fluidic systems are called hydraulic systems when a liquid is used; or pneumatic when a gas is used. Thus fluid power is the generic term used for both hydraulic and pneumatic systems.

Hydraulic systems can either use mineral oil (petroleum oil); synthetic oil; or water. The first hydraulic systems employed water as the liquid, because water was readily available. However, water suffers from the following disadvantages:

- It freezes more readily.
- It can cause the equipment to rust.
- It is not good as lubricant.

Oil however suffers from the main disadvantages of being environmentally unfriendly.

There are two different types of fluid systems: fluid transport and fluid power.

1. Fluid transport systems have as their sole objective the delivery of fluid from one location to another to accomplish some useful purpose. Examples are: pump water to homes; cross country gas lines; and chemical processes that take place when fluids are brought together.

2. Fluid power systems are designed specifically to perform work. The work is accomplished by a pressurized fluid bearing directly on an operating fluid cylinder or fluid motor. The cylinder provides force and achieves linear motion; the motor provides torque and achieves rotary motion. Control components are needed in order to achieve the work smoothly, accurately, safely and efficiently (e.g., valves).

Fluid power technology started in 1650 with the discovery of Pascal’s law. Pascal’s law or the principle of transmission of fluid-pressure is a principle in fluid mechanics which states that a pressure change occurring anywhere in a confined incompressible fluid is transmitted throughout the fluid such as that the same change occurs everywhere.

(in other words, it is an effective medium for transmitting pressure).
But fluid power systems only flourished during the first half of the 20th century in naval and military systems between the two world wars.

Areas of application:
1. Automobiles (hydraulic brakes; transmission; power steering; power brakes; air conditioning; lubrication; water coolant; petrol pumping systems).
2. Tractors
3. Airplanes
4. Missiles
5. Boats
6. Robots
7. Machine tools

When designing power systems, there are three choices: electrical, mechanical and fluidic.

Fluidic power systems can transmit power over longer distances compared to mechanical systems, but shorter distance that electrical systems.

Advantages of fluid power systems:

1. Ease and accuracy of control. (Resolution of 1/1000 of an inch!)
2. Multiplication of Force. Without the use of gears and pulleys can multiply forces simply and efficiently.
3. Constant force of torque. Fluid power system can provide constant force or torque regardless of speed changes. Speeds can vary from a few inches per hour to several hundred inches per minutes; or few revolutions per minute.
4. Simplicity, safety and economy. They have fewer moving parts compared to electrical or mechanical systems. This maximizes safety, compactness and reliability.
5. Compactness: they offer the highest power-per-weight ratio of any power source.

Disadvantages:

1. Leakage of Oil: Must be properly designed to prevent leakage of oil into the surroundings.
2. Bursting due to excessive pressure: Hydraulic pipelines can burst due to excessive pressure. In pneumatic systems, the components must be correctly selected and designed to ensure that it can withstand the maximum possible pressure.
3. Noise: The level of noise (from pumps, compressors and pipelines) must be controlled in the vicinity of the system.

Components of a hydraulic system:

1. Tank (reservoir) to hold the hydraulic oil.
2. A pump to force the oil through the system.
3. An electric motor or other power source to drive the pump.
4. Valves to control the oil direction, pressure and flow rate.
5. An actuator to convert the pressure of the oil into a mechanical force or torque to do useful work. Actuators can either be cylinders or hydraulic motors.
6. Piping to carry the oil from one location to another.