HYDRAULIC AND PNEUM ATIC SYSTEM

Haug,E. J. and Kwak,B. M.,“ Contact Stress Minimization by Contour Design,” London: Butterworths,1999

Hydraulic System

There are only three basic methods of transmitting power：electrical，mechanical，and fluid power. Most applications actually use a combination of the three methods to obtain the most efficient overall system . To properly determine which principle method to use，it is important to know the salient features of each type. For example，fluid systems can transmit power more economically over greater distances than can mechanical types. However， fluid systems are restricted to shorter distances than are electrical systems.

Hydraulic power transmission system are concerned with the generation，modulation，and control of pressure and flow，and in general such system sin clued：

1. Pumps which convert available power from the prime mover to hydraulic power at the actuator.
2. Valves which control the direction of pump-flow，the level of power produced，and the amount of fluid-flow to the actuators. The power level is determined by controlling both the flow and pressure level.
3. Actuators which convert hydraulic power to usable mechanical power output at the point required.
4. The medium，which is a liquid，provides rigid transmission and control as well as lubrication of components，sealing in valves，and cooling of the system .
5. Connectors which link the various system components，provide power conductors for the fluid under pressure，and fluid flow return to tank（reservoir）.
6. Fluid storage and conditioning equipment which ensure sufficient quality and quantity as well as cooling of the fluid.

Hydraulic systems are used in industrial applications such as stamping presses，steells，and general manufacturing，agricultural machines，mining industry，aviation，spacehnology，deep-sea exploration，transportation，marine technology，and offshore gas and petroleum exploration. In short，very few people get through a day of their lives without somehow benefiting from the technology of hydraulics.

The secret of hydraulic system’s success and widespread use is its versatility and manability. Fluid power is not hindered by the geometry of the machine as is the case in mechanical systems. Also，power can be transmitted in almost limitless quantities because fluid systems are not so limited by the physical limitations of materials as are the electrical systems. For example，the performance of an electromagnet is limited by the saturation limit of steel. On the other hand，the power limit of fluid systems is limited only by the strength capacity of the material.

Industry is going to depend more and more on automation in order to increase productivity. This includes remote and direct control of production operations，manufacturing processes，and materials handling. Fluid power is the muscle of automation because of advantages in the following four major categories.

1. Ease and accuracy of control. By the use of simple levers and push buttons，the operator of a fluid power system can readily start，stop，speed up or slow down，and position forces which provide any desired horsepower with tolerances as precise as one ten-thousandth of an inch. Fig.13-1 shows a fluid power system which allows an aircraft pilot to raise and lower his landing gear. When the pilot-moves a small control valve in one direction，oil under pressure flows to one end of the cylinder to lower the landing gear. To retract the landing gear，the pilot moves the valve lever in the opposite direction，allowing oil to flow into the other end of the cylinder.
2. Multiplication of force. A fluid power system（ without using cumbersome gears，pulleys，and levers）can multiply forces simply and efficiently from a fraction of an ounce to several hundred tons of output.
3. Constant force or torque. Only fluid power systems are capable of providing constant force or torque regardless of speed changes. This is accomplished whether the work output moves a few inches per hour，several hundred inches per minute，a few revolutions per hour，or thousands of revolutions per minute.
4. Simplicity， safety， economy. In general，fluid power systems use fewer moving parts than comparable mechanical or electrical systems. Thus，they are simpler tomaintain and operate. This，in turn，maximizes safety，compactness，and reliability. For example，a new power steering control designed has made all other kinds of power systems obsolete

on many off-highway vehicles. The steering unit consists of a manually operated directional control valve and meter in a single body. Because the steering unit is fully fluid-linked，mechanical linkages，universal joints，bearings，reduction gears，etc. are eliminated. This provides a simple，compact system .In addition，very little input torque is required to produce the control needed for the toughest applications. This is important where limitations of control space require a small steering wheel and it becomes necessary to reduce operator fatigue.

Additional benefits of fluid power systems include instantly reversible motion，automatic protection against overloads，and infinitely variable speed control. Fluid power systems also have the highest horsepower per weight ratio of any known power source. In spite of all these highly desirable features of fluid power，it is not a panacea for all power transmission problems. Hydraulic systems also have some drawbacks. Hydraulic oils are messy，and leakage is impossible to completely eliminate. Also，most hydraulic oils can cause fires if an oil leak occurs in an area of hot equipment.

Pneumatic System

Pneumatic systems use pressurized gases to transmit and control power. As the name implies，pneumatic systems typically use air（rather than some other gas）as the fluid medium because air is a safe，low-cost，and readily available fluid. It is particularly safe in environments where an electrical spark could ignite leaks from system components.

In pneumatic systems，compressors are used to compress and supply the necessary quantities of air. Compressors are typically of the piston，vane or screw type. Basically a compressor increases the pressure of a gas by reducing its volume as described by the perfect gas laws. Pneumatic systems normally use a large centralized air compressor which is considered to be an infinite air source similar to an electrical system where you merely plug into an electrical outlet for electricity. In this way，pressurized air can be piped from one source to various locations throughout an entire industrial plant. The compressed air is piped to each circuit through an air filter to remove contaminants which might harm the closely fitting parts of pneumatic components such as valve and cylinders. The air then flows through après sure regulator which reduces the pressure to the desired level for the particular circuit application. Because air is not a good lubricant（contains about 20% oxygen），pneumatics systems required a lubricator to inject a very fine mist of oil into the air discharging from the pressure regulator. This prevents wear of the closely fitting moving parts of pneumatic components.

Free air from the atmosphere contains varying amounts of moisture. This moisture can be harmful in that it can wash away lubricants and thus cause excessive wear and corrosion. Hence，in some applications，air driers are needed to remove this undesirable moisture. Since pneumatic systems exhaust directly into the atmosphere，they are capable of generating excessive noise. Therefore，mufflers are mounted on exhaust ports of air valves and actuators to reduce noise and prevent operating personnel from possible injury resulting not only from exposure to noise but also from high-speed airborne particles.

There are several reasons for considering the use of pneumatic systems instead of hydraulic systems. Liquids exhibit greater inertia than do gases. Therefore，in hydraulic systems the weight of oil is a potential problem when accelerating and decelerating actuators and when suddenly opening and closing valves. Due to Newton's law of motion（force equals mass multiplied by acceleration），the force required to accelerate oil is many times greater than that required to accelerate an equal volume of air. Liquids also exhibit greater viscosity than do gases. This results in larger frictional pressure and power losses. Also，since hydraulic systems use a fluid foreign to the atmosphere，they require special reservoirs and no eak system designs. Pneumatic systems use air which is exhausted directly back into the surrounding environment. Generally speaking，pneumatic systems are less expensive than hydraulic systems.

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However，because of the compressibility of air，it is impossible to obtain precise controlled actuator velocities with pneumatic systems. Also，precise positioning control is not obtainable. While pneumatic pressures are quite low due to compressor design limitations（less than 250 psi），hydraulic pressures can be as high as10,000 psi. Thus，hydraulics can be high-power systems，whereas pneumatics are confined to low-power applications. Industrial applications of pneumatic systems are growing at a rapid pace. Typical examples include stamping，drilling，hoist，punching，clamping，assembling，riveting，materials handling，and logic controlling operations.