MODULE 1

INTRODUCTION TO FLUID POWER AND APPLICATION IN MECHATRONICS SYSTEM

EET 411
PNEUMATICS AND ELECTROPNEUMATICS CONTROL

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I. Topic

1.1 Introduction to fluid power

1.2 Fluid power system

1.3 System characteristics

1.4 Advantages and disadvantages of fluid power system

II. Time Frame: 12 hrs.

III. Introduction

Fluid power is a term which was created to include the generation, control, and application of smooth, effective power of pumped or compressed fluids (either liquids or gases) when this power is used to provide force and motion to mechanisms. This force and motion maybe in the form of pushing, pulling, rotating, regulating, or driving.

Fluid power includes:

a. hydraulics, which involves liquids, and
b. pneumatics, which involves gases.

Liquids and gases are similar in many respects. The differences are pointed out in the appropriate areas of this manual.

This manual presents many of the fundamental concepts in the fields of hydraulics and pneumatics. It is intended as a basic reference for all students taking the course and require them to have a knowledge of the fundamentals of fluid power. Consequently, emphasis is placed primarily on the theory of operation of typical fluid power systems and components that have applications in industry. Many applications of fluid power are presented in this manual to illustrate the functions and operation of different systems and components. However, these are only representative of the many applications of fluid power in the industrial settings.

IV. Objectives

After completing the module, you will be able to:

1. Understand hydraulic and pneumatic fluid power system and discuss the advantages application and characteristics of such system.
2. Apply the concept of energy, power and efficiency to fluid power system.
3. Define the terms fluid power, hydraulic system, and pneumatic system.
4. Explain the extent of fluid power use in current society and provide several specific examples.
5. List the advantages and disadvantages of fluid power systems.

V. Pre-test

VI. Learning Activities

Introduction to Fluid Power

The extensive use of hydraulics and pneumatics to transmit power is due to the fact that properly constructed fluid power systems possess a number of favorable characteristics. They eliminate the need for complicated systems of gears, cams, and levers. Motion can be transmitted without the slack 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

The purpose of fluid power system is to perform work that cannot be accomplish by an unaided human or to perform a task quicker or efficiently with respect of time. It comes in two notable forms. Fluid power system using liquid are hydraulic system while fluid power system using gas are pneumatic system.

Hydraulic	**Pneumatics**
Liquid, incompressible	Gas, compressible
Oil	Gas
Costing, P, $, £ etc…	Free
Self-lubricating	Must be condition
Medium/heavy	Light/medium
Smooth and firm, holding	Inconsistent and spongy
Reservoir-Filtered, conditioned and contained	Exhausted
Dirty, flammable, hazardous	Clean

The basis of fluid power is pressurized fluids. These fluids may be either liquids or gases. The fluids are incorporated into physical hardware systems that generate, transmit, and control power in a wide variety of consumer and industrial applications. Today, it would be difficult to identify a product that has not been affected by fluid power at some point along the route from raw material to final installation. Fluid power systems are versatile contributors to industry. Applications range from brute force needed in heavy industry to the sensitive positioning of parts in precision machining operations, Figure 1-1 and 1-2. The systems are generally grouped under the two broad classifications of pneumatic and hydraulic. Pneumatic systems use gas, usually air, while hydraulic systems use liquids, usually oil. Other fluids are often used in special applications. Fluid power is one of the three types of power transfer systems commonly used today. The other systems are mechanical and electrical. Each of the systems transfers power from a prime mover (source) to an actuator that completes the task (work) required of the system.

Figure 1.1 Equipment used in construction and street maintenance is an example of a fluid power application commonly encountered in daily life. This backhoe is capable of producing the brute force needed to break and move concrete.

Figure 1.2 Robotics application in car manufacturing using Pneumatics and Electropneumatics

Fluid Power System

Fluid power is a highly versatile power transmission system, as illustrated by the range of applications. No system, however, is entirely suitable for all applications. All power-transmission systems have characteristics that are desirable in one

application, but turn into disadvantages in other situations. A system cannot have every desired advantage without
disadvantages. Understanding system characteristics as well as what is needed for a particular result will help in producing an effective and efficient application. The range of applications that use fluid power makes the development of a simple list of advantages
and disadvantages difficult, since examples that do not "fit" can easily be found. This problem is further complicated by the inherent differences of the two major divisions of the fluid power field: hydraulics and pneumatics.

System Characteristics

Although hydraulic and pneumatic systems share the characteristics of energy transfer by means of fluid pressure and flow, differences affect how and where they are applied. These differences include:

- Accuracy of actuator movement
- Operating pressure
- Actuator speed
- Component weight
- Cost

Accuracy of movement

Fluid compressibility is the inherent characteristic that produces the difference between hydraulic and pneumatic systems. A gas is compressible, while a liquid can be compressed only slightly. Hydraulic systems, therefore, can produce more accurate, easily controlled movement of cylinders and motors than pneumatic systems. Compressibility produces a more "spongy" operation in pneumatic systems that is not suitable where highly accurate movement is required.

Operating pressure

Hydraulic systems can operate at much higher pressures than pneumatic systems. Hydraulic system operating pressure ranges from a few hundred pounds per square inch (psi) to several thousand psi. Pressures of more than 10,000 psi are used in special situations. Pneumatic systems, in contrast, normally operate between 80 to 120 psi. Extremely high–pressure pneumatic systems normally are not used.

Actuator speed

Pneumatic systems are commonly used when high-speed movement is required in an application. Rotation speeds of over 20,000 revolutions per minute (rpm) are possible. Rapid-response cylinder operation is also possible with pneumatic systems. These designs are generally found in situations involving lighter loads and lower accuracy

Component weight

System operating pressure affects the structure of components. Hydraulic systems operate at higher pressures, requiring the use of stronger materials and more-massive designs to withstand the pressure. Pneumatic systems operate at much lower pressures and, therefore, can be manufactured using lightweight materials and designs that minimize the amount of material. Hydraulic applications tend to involve equipment that handles heavier weights, requiring both higher system operating pressure and physical strength of machine parts. Pneumatic systems tend to involve applications where ease of handling and lightweight are critical for effective operation of the tool or system.

Cost

The cost of fluid power systems ranges widely. A variety of situations exist and a number of solutions are available for each one. The solution selected to solve the problem directly affects the cost. Understanding system advancements, basic characteristics of hydraulic and pneumatic systems, and knowing which standard components are available are necessary to produce a system that does the best job at the lowest cost. The cost of system operation is a factor that must be considered. Generally, pneumatic systems are more expensive to operate than hydraulic systems. This cost can be directly associated with the compression, conditioning, and distribution of air. Careful maintenance to eliminate leakage can greatly reduce operating cost.

Advantages and Disadvantages of Fluid Power Systems

Fluid power systems have several advantages and disadvantages when compared with mechanical and electrical power transfer systems.

Advantages

The following list of advantages applies to both hydraulic and pneumatic systems, except as noted.

- An easy means of multiplying and controlling force and torque.
- Infinitely variable speed control for both linear and rotary motion.
- Overloading the system simply stalls the actuator without damage to the components.
- Provides an easy means of accurately controlling the speed of machines and/or machine parts.
- Provides the ability to instantly stop and reverse linear and rotary actuators with minimal shock to the system.
- Systems easily adapt to accommodate a range of machine sizes and designs.

- Systems readily adapt to external control methods, including mechanical, pneumatic, electrical, and electronic systems.
- Systems can easily provide component lubrication.
- Large volumes of compressed air may be easily stored in pneumatic systems to provide energy for intermittent, heavy system demand.
- Pneumatic systems provide clean operation with minimal fire hazard.

Disadvantages

The following list of disadvantages applies to both hydraulic and pneumatic systems, except as noted.

- Higher safety factors associated with high-pressure oil and compressed air.
- Susceptibility to dirty environments, which can cause extreme component wear without careful filtration.
- Fluid leakage and spills cause a slippery, messy work environment around hydraulic equipment.
- Fire hazard with hydraulic systems using combustible oils.
- Special handling and disposal procedures for hydraulic oil required by environmental regulations.
- High cost of compressing and conditioning air for use in pneumatic systems.
- Reduced accuracy in actuator speed control in pneumatic systems caused by compressibility of air.
- Noise level of pneumatic systems when air is directly exhausted to the atmosphere from components.

VII. Self-evaluation

Written Examination

Answer the following question:

1. Fluid power system using liquid are _____ system.
2. Fluid power system using gas are _____ system.
3. _____ is the inherent characteristic that produces the difference between hydraulic and pneumatic systems.
4. Hydraulic systems operate at _____ pressures, requiring the use of stronger materials and more-massive designs to withstand the pressure.
5. Pneumatic systems operate at much lower pressures and, therefore, can be manufactured using _____ materials and designs that minimize the amount of material.
6. The three power transfer systems commonly used today are _____ , _____ , and _____ .
7. The basis of fluid power is pressurized fluids. These fluids may be either _____ or _____.

8. Clean operation with minimum fire hazards are characteristics of which fluid power system(s)?
9. What fluid power system is compressible?
10. What fluid power system is incompressible?

VIII. Review of Concepts

Fluid power includes:

a. hydraulics, which involves liquids, and
b. pneumatics, which involves gases.

The purpose of fluid power system is to perform work that cannot be accomplish by an unaided human or to perform a task quicker or efficiently with respect of time. It comes in two notable forms. Fluid power system using liquid are hydraulic system while fluid power system using gas are pneumatic system.

Characteristics of the two types of fluid power:

Hydraulic	**Pneumatics**
Liquid, incompressible	Gas, compressible
Oil	Gas
Costing, P, $, £ etc…	Free
Self-lubricating	Must be condition
Medium/heavy	Light/medium
Smooth and firm, holding	Inconsistent and spongy
Reservoir-Filtered, conditioned and contained	Exhausted
Dirty, flammable, hazardous	Clean

IX. Post-test

X. References:

Beasley, Albert Jr. Fluid Power, Naval Education Training and Command 1990 Edition, July1990 Training Manual

Internet Resources:

www.ideafi nder.com/history/inventors/watt.htm
The Great Idea Finder
Provides information on James Watt and other inventors who made major contributions to industrial development during the Industrial Revolution.

www.island-of-freedom.com/pascal.htm
Island of Freedom
Provides details of the contributions of Blaise Pascal and others to science, mathematics, and philosophy.

www.nfpa.com
National Fluid Power Association
A good overall review of the basic aspects of fluid power systems. Go to the Our Industry section of the site.

http://library.thinkquest.org/3044
Oracle Education Foundation Provides insight into Leonardo da Vinci as an artist and inventor.

www.en.wikipedia.org/wiki/hydraulic
www.en.wikipedia.org/wiki/pneumatic