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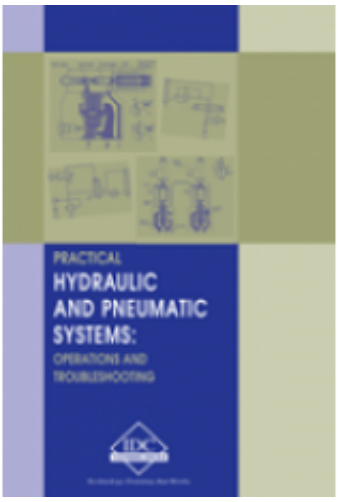
HY-E - Practical Hydraulic & Pneumatic Systems Operations and Troubleshooting



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Short Description

This information packed practical manual focusing on hydraulics and pneumatics will enhance your knowledge of the fundamentals, improve your maintenance programs and help you become an excellent troubleshooter of the problems in this area. No matter what hydraulics or pneumatics applications you are working on, and what the level of your knowledge, this manual will be highly beneficial to you.

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The practical hydraulics and pneumatics manual is comprehensive and highly practical. You will focus on the construction of hydraulic and pneumatic systems, design-applications, and learn operations, maintenance and management issues. You will be provided with the most up-to-date information and best practice in dealing with the subject.

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First Chapter
Practical Hydraulic & Pneumatic Systems: Operations and Troubleshooting

1 Introduction to Fluid Power

In this chapter, we summarize how the term “hydraulics” was derived, the history of hydraulics along with the researchers who have contributed to its advancement.

A brief comparison of advantages of hydraulics over electrical devices and pneumatics is made. The inherent characteristics and the energy transfer in the field of hydraulics is discussed.

A brief summary of ensuing chapters sketches the basic principles involved, various hydraulic component functions and applications, mathematical calculations for sizing components, explanatory figures, hydraulic circuits and symbols, practical examples and many more.

1.1 Introduction

The term fluid power generally refers to the power generated by fluid substances like liquids and gases. The power generated by the pump is controlled at various stages with the help of valves. Finally, the power generated is applied to the end user to obtain force or motion in the form of an operating mechanism.

In our explanation in ensuing chapters, we emphasize that power from liquids (mainly hydraulic oil) will invariably become the operating medium in power transmission. Power from gases, means the transfer of power by air, that has been compressed to a pressure higher than atmospheric air that is put to work in operating mechanisms.

To summarize, the use of hydraulic oil, mainly because of its incompressibility characteristic, in energy transfer leads to the term “HYDRAULICS”. The use of atmospheric air’s compressibility characteristic in energy transfer is called

“PNEUMATICS.” Both these categories are used in “FLUID POWER SYSTEMS.” Up to Chapter 16 we will be explaining the functionality of hydraulic systems and controls. Chapters 17 to 21, with the common Chapter 2, will deal with pneumatics.

1.2 History of hydraulics

The science behind modern hydraulics dates back 2000 years, when water was the only liquid medium available for experimentation. There were many scientists and, mathematicians whose inventions led to the stage-by-stage development of modern hydraulics.

Aristotle	384–322 bc	Theory of motion of liquid
Archimedes	287–212 bc	Theory of floating body and displacement
Leonardo da Vinci	1452–1519	Jet, waves, eddies, continuity and velocity of flow
Simon Stevin	1548–1620	Hydrostatic paradox
Galelio	1564–1642	Gravitational acceleration
Castelli	1577–1644	Principles of continuity
Torricelli	1608–1647	Vacuum theory
Edme Mariotte	1620–1684	Wind and water pressure and elasticity of air
Robert Boyle	1627–1691	Gas laws
Blaise Pascal	1623–1662	Principles of hydrostatics
Isaac Newton	1642–1727	Inertia, principles of momentum
Johann Benoulli	1667–1748	Kinetic theory of liquid and gases
Hendri de pitot	1695–1771	Pitot tube and rotating arm
Osborne Reynolds	1842–1912	Theory of laminar and turbulent flow

Joseph Bramah 1748–1814 Hydraulic press

1.3 Advantages over electrical devices

- Hydraulic actuators provide high force transmission at low speeds, whereas electrical motors or devices transmit low force or torque at low speeds.

Even though high torque electrical motors are available, they require high current, but the speed is drastically reduced.

- Hydraulic actuators can be located in harsh environments.
- Hydraulics can operate in explosive atmospheres; whereas electrical devices can generate sparks can cause serious accidents.
- Constant holding force or torque in hydraulics can be easily achieved, even when the power system is not running, whereas electrical motors draw large current to maintain the torque even when stopped.
- Most electric motors overheat and burnout easily when overloaded.
- Hydraulic power transmission is practically noiseless, whereas electrical transmissions are noisy.
- Many hydraulic components are self-lubricating.
- Hydraulic maintenance and troubleshooting activities do not need licensed electrical personnel.

1.4 Advantages over pneumatics

- Hydraulics are high pressure systems (may be up to 70MPa); whereas pneumatics have low maximum working pressures (0.7 to 1. MPa).
- A hydraulic system is practically noiseless, its actuators operate smoothly, whereas in pneumatics, the system is noisy when compressed air exhausted.
- Incompressibility characteristics of hydraulic fluid allow the transmission of high force at low speeds, whereas with air’s compressibility the force out of actuators is limited.
- When precision control is required, in most cases only hydraulics can satisfy the requirement.

1.5 The energy transfer in a hydraulics field

- Phase-1 Electrical energy is obtained from an electric motor or diesel engines (rotary motion).
- Phase-2 Mechanical energy is transferred by a coupling, v-pulleys or gear

drive (rotary motion).
- Phase-3 Hydraulic energy is generated by hydraulic pumps. Then it is directed by valves with spools having a rotary or reciprocating motion.
- Phase-4 Mechanical energy is available from actuators (cylinders or hydraulic motors). They provide reciprocating or rotary motion in the form of pushing, pulling or twisting.

Although, various fields like industrial, mobile, marine and aerospace utilize hydraulic systems and controls; consequently, emphasis in this book is placed primarily on the theory, functions, characteristics, applications, and maintenance aspects of industrial hydraulics systems.

Many applications presented in this manual are representative in nature to explain the function and operating characteristics of different hydraulic systems and components that commonly exist in this field. It does not promote a particular model or maker.

A summary of this book’s contents follows next.