

Reference Material:

Mobil Hydraulics Manual by Vickers. Can be ordered online from <http://www.hydraulicsliteraturestore.com/mohyma.html>

Learning Objectives:

1. Hydraulic Theory, use and maintenance of hydraulic fluids

A. Hydraulic Theory

1. Pascal's Law
2. Fluid flow
 - a. Effects of an orifice on flow
 - b. Effects of changes in pressure on flow
3. Pressure and flow
 - a. Measurement names
 1. Bar
 - b. PSIG vs PSIA
 - c. Charge pressure
 - d. Metric conversion
 - e. Hydrodynamics
 - f. Back flow/ back pressure
 - g. Operating pressure
4. Definition of fluid flow
5. Effects on fluid by ambient pressure
6. Causes & Effects of cavitation and aeration
7. Horsepower ratings
 - a. foot pound formula
8. Purpose of fluid
9. Laminar flow
10. Types of energy in hydraulic system
11. Calculating area and force of actuators
12. Measuring force

B. Hydraulic fluid

1. Viscosity
2. Filtration
 - a. Types of elements & compatibility
 - b. Efficiency measurement
 1. Smallest particle observable
 - c. Location in system
 - d. Coalescing filters
3. Additives
4. Types
 - a. Synthetic
 - b. Hydrocarbon
 - c. ATF
 - d. Biodegradable
5. Fluid Features
 - a. Characteristics of fluid
 1. Flash point
 - b. Weight of oil vs water
 - c. Water based
6. Contamination
 - a. ISO 4406-1999
 - b. Required Cleanliness Levels
 - c. Oxidation catalysts
 - d. New fluids
 - e. Free air - air in fluid
 - f. Microbial growths

2. Understand Hydraulic system components and their functions

A. PTO's and Drives

1. Types of engagement
2. Horsepower requirements
3. Drive line requirements

B. Hydraulic Pumps

1. Piston
 - a. Fixed displacement
 1. swash plate
 - b. Variable displacement
 1. Inline
 2. Axial
 3. Compensator
 - c. Pressure/flow compensating
2. Balanced/Unbalanced vane
 - a. Displacement
3. Gear
4. Cause of aeration and cavitation

C. Reservoir

1. Capacity Requirements
2. Design
3. Location
4. Function

D. Plumbing

1. Hosing type, size & construction
2. Tubing vs. Pipe
3. How hydraulic steel tubing size is measured
4. Proper Sealing Methods
5. Restriction to flow
6. Fittings
 - a. Quick disconnect couplings

E. Valves

1. Directional Valve
 - a. Rotary
 - b. Spool
 1. Deadband
 - c. Pilot Operated
 - d. Shuttle
 1. Inlets/outlets
2. Cartridge Valve
 - a. Relief valves
 - b. Flow control valves
 1. Non-Compensated
 2. Compensated
 - c. Sequencing Valve
 - d. Slip-in and screw-in cartridges
 1. Pressure range
 2. Modulating orifice cartridges
 - e. Manifold blocks
 1. Cavities
 - f. Unloading valve
3. Hysteresis
 - a. Causes
4. Solenoid Valves
 - a. Pulse width modulation
 - b. Electronics controls
 1. Force motor
 2. Torque motor
 3. Servo & Proportional Valves
 - c. Valve actuation
5. Pressure control valves
 - a. Relief valve
 - b. Pressure Reducing valve
 - c. Balance piston relief valve

1. Vent connection

- d. Remote
6. Counterbalance valves
7. Unloading valves
8. Auxiliary valves
 - a. Flow divider

F. Actuators

1. Linear (cylinder)
 - a. Single Acting
 - b. Double Acting (differential)
 - c. Telescoping
 - d. Components of cylinders
 1. Seal construction
 2. Cylinder cushion
 3. Thermal relief valve
 - e. Double acting double rod
 - f. Welded construction
2. Rotary (Motor)
3. Torque and Speed
 - a. Output horsepower

G. Heat Exchangers - BTU/HR

H. Accumulators

1. Maintaining pressure

I. Gauges and Meters

1. Pressure Transmitter
2. Pressure Transducer

J. Filter media

3. Understand and identify hydraulic circuits & symbols

A. Types

1. Parallel
2. Series
3. Regenerative
4. Open Circuit
5. Closed Circuit
6. Hydrostatic Transmission
 - a. Peak Torque
 - b. Charge Pump
7. Open Center & Open Loop
8. Closed Center & Closed Loop
9. Load Sensing

B. Schematics & Symbols

1. Variable Motor
2. Accumulator
3. Fixed motor
4. Variable pump
5. Fixed pump
6. Filter, Strainer
7. Cooler
8. Types of Cylinder
9. Heater
10. Temperature Controller
11. Counterbalance
12. Slip in cartridge
13. Direction of flow

14. Flowmeter

15. Pressure gauge
16. Liquid level gauge
17. Pressurized reservoir

C. Control

1. Digital
2. Analog
3. Electro-Hydraulic
4. Conductor
 - a. Fluid Velocity
5. Resistance

4. Troubleshooting, Tools and Equipment

A. Troubleshooting

1. Circuits
 - a. Speed Control
 - b. Flow Control
2. Components
 - a. Pumps
 1. Cavitation causes
 2. Failure analysis
 - b. Valves
 1. Counter balance
 2. Shuttle valve
 3. Load sensing
 - c. Actuators
 1. Cylinders
 - (i) Pressure intensification
 2. Hydraulic Motors
 - (i) Shaft Failure Causes
 - 1) torsional failures
 - 2) bending shear failures
 - d. Tubes, hoses, fittings
 - e. Filters
3. Overheating
4. Fluid contamination

B. Tools and Equipment

1. Flow meters
2. Pressure gauge sets
3. Tube fabrication
 - a. Tube benders
 - b. Flaring tools
 - c. Proof pressure

5. Definitions

- A. Unload
- B. Closed Circuit
- C. Reciprocation
- D. Circuit
- E. Demulsibility
- F. Bar
- G. Deadband
- H. Wiper ring
- I. Thermocouple
- J. Solenoid
- K. Hysteresis
- L. Watt
- M. Counterbalance Valve
- N. Nominal Rating
- O. Filter
- P. Strainer
- Q. Elastohydrodynamic Lubrication
- R. Absolute rating
- S. Abrasion
- T. Lubricity
- U. Pour Point
- V. Cracking Pressure
- W. Hydrokinetics

X. Drain

Y. Viscosity

Z. Actuator

AA. Specific gravity

AB. Durometer

AC. Silt

AD. Delivery

AE. Back pressure

AF. Exhaust

AG. Bleed off

AH. Bypass

AI. Full flow

AJ. Rated flow

AK. Pressure compensator

AL. Positive displacement

AM. Throttle

AN. Reversing valve