

Reference Material: **Mobil Hydraulics Manual** by Vickers. Can be ordered online from <https://hydraulicsliteraturestore.com/mobile-hydraulics-manual-3rd-edition/>

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

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

9) Load Control

- a. Pilot Operated
- b. Counter Balance

F. Actuators

1) Linear (cylinder)

- a. Single Acting
- b. Double Acting (differential)
 - (1) Seal Failure
 - (2) Pressure Intensification

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

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

- | | | |
|---|--|--|
| <ul style="list-style-type: none"> A. Types <ul style="list-style-type: none"> 1) Parallel 2) Series 3) Regenerative 4) Open Circuit 5) Closed Circuit 6) Hydrostatic Transmission <ul style="list-style-type: none"> a. Peak Torque b. Charge Pump 7) Open Center & Open Loop 8) Closed Center & Closed Loop 9) Load Sensing | <ul style="list-style-type: none"> B. Schematics & Symbols <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> 14) Flowmeter 15) Pressure gauge 16) Liquid level gauge 17) Pressurized reservoir 18) Relief valve 19) Sequence 20) Pressure reducing C. Control <ul style="list-style-type: none"> 1) Digital 2) Analog 3) Electro-Hydraulic 4) Conductor <ul style="list-style-type: none"> a. Fluid Velocity 5) Resistance |
|---|--|--|

4. Troubleshooting, Tools and Equipment

- | | |
|---|---|
| <ul style="list-style-type: none"> A. Troubleshooting <ul style="list-style-type: none"> 1) Circuits <ul style="list-style-type: none"> a. Speed Control b. Flow Control c. Closed Loop 2) Components <ul style="list-style-type: none"> a. Pumps <ul style="list-style-type: none"> (1) Cavitation causes (2) Failure analysis b. Valves <ul style="list-style-type: none"> (1) Counter balance (2) Shuttle valve (3) Load sensing c. Actuators <ul style="list-style-type: none"> (1) Cylinders <ul style="list-style-type: none"> (i) Pressure intensification (2) Hydraulic Motors <ul style="list-style-type: none"> (i) Shaft Failure Causes <ul style="list-style-type: none"> 1) torsional failures 2) bending shear failures | <ul style="list-style-type: none"> d. Tubes, hoses, fittings e. Filters 3) Overheating 4) Fluid <ul style="list-style-type: none"> a. Contamination b. Sampling techniques B. Tools and Equipment <ul style="list-style-type: none"> 1) Flow meters 2) Pressure gauge sets 3) Tube fabrication <ul style="list-style-type: none"> a. Proof pressure |
|---|---|

5. Definitions

- | | | |
|--|--|--|
| <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> 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 AO. Pressure transducer | <ul style="list-style-type: none"> AP. Pressure transmitter AQ. Scraper ring |
|--|--|--|

