Fluid Power Training Institute™
2170 South 3140 West
Salt Lake City, UTAH 84119
United States of America

Troubleshooting Hydraulic Systems and Components Workshop for Mobile and Industrial Systems

Troubleshooting Hydraulic Systems and Components Workshop – 40 hours

The Troubleshooting Hydraulic Systems and Components Workshop for Mobile and Industrial Hydraulics covers the following topics:

1. How to Troubleshoot the Inlet Side of a Hydraulic Pump
2. How to Flow Test Hydraulic Pumps
3. How to Test Pressure Control Valves
4. How to Test Directional Control Valves
5. How to Test Check Valves
6. How to Test Hydraulic Cylinders
7. How to test Closed-Loop (Hydrostatic) Transmissions
8. How to Execute a Case Pressure Test on an External Drain Pump and Motor
9. How to Troubleshoot Hydraulic Motors

Troubleshooting Hydraulic Systems and Components Workshop
Course Syllabus

Upon completion of the Troubleshooting Hydraulics Training Workshop a person will be able to explain, describe, and/or perform the following:

1 – How to Troubleshoot the Inlet Side of a Hydraulic Pump

(approximately 4-hours)

1) Explain how the inlet side of a hydraulic pump works.

2) Explain how excessive restriction effects the operation at the inlet side of a hydraulic pump.

3) Explain what "cavitation" is.

4) Explain where the air comes from when hydraulic oil is subjected to a vacuum.

5) Explain what "pseudo-cavitation" is.

6) Describe at least four symptoms associated with high inlet restriction.

7) Explain what happens when air is permitted to enter the inlet side of a hydraulic pump.

8) Describe at least two symptoms associated with low inlet restriction.

9) Describe how prime mover over-speeding affects the inlet side of a hydraulic pump.

10) Skill Drill – Install a vacuum gauge at the correct location in relationship to a pump's inlet port and properly record inlet restriction.

11) Recite the maximum inlet restriction, relative to rules-of-thumb for piston, vane, and gear pumps.

12) Describe what diagnostic instruments are required to analyze the inlet side of a hydraulic pump, and describe how to use them.

2 – How to Troubleshoot Hydraulic Pumps (flow test)

(approximately 4-hours)

1) Explain why a hydraulic pump leaks.

2) Explain the difference between theoretical flow and actual flow as it applies to a hydraulic pump.

3) Describe the three variable that affect leakage across the clearances in a hydraulic pump.

4) Give four symptoms associated with a worn pump.

5) Explain why the wear rate of a hydraulic pump typically exceeds the wear rate of any other hydraulic component.

6) Explain why it is not possible to analyze hydraulic pump leakage when the pressure against the pump clearances is low.

7) Explain the meaning of pump "volumetric efficiency."

8) Give the volumetric efficiencies, by rule-of-thumb, of the following pumps types:

   a) Piston

   b) Gear

   c) Vane

9) Explain why it is important to monitor pump speed when flow testing a hydraulic pump.

10) Explain why it is necessary to monitor pump inlet restriction when flow testing a hydraulic pump.

11) Explain, according to rule-of-thumb, when a hydraulic pump should be removed from service.

12) Describe the difference between a direct access pump flow test, and an in-circuit pump flow test.

13) Describe what diagnostic equipment is required to safely and effectively perform a direct-access pump flow test.

14) Describe what critical safety step must be used when executing a direct-access pump flow test.

15) Explain what condition must exist to perform an in-circuit pump flow test in a circuit which has a hydraulic motor.

16) Explain why a pump case flow test is unreliable.

17) Give two reasons why a pump pressure line flow test is more effective than a case drain flow test.

18) Explain what critical safety steps must be taken before performing a test on any hydraulic component.

19) Name the diagnostic instruments required to flow test a hydraulic pump.

20) Describe how to safely and effectively use the following diagnostics instruments:

a) Flow meter

b) Load cell

c) Pressure gauge

d) Vacuum gauge

e) Temperature gauge

f) Tachometer.

3 – How to Troubleshoot Pressure Control Valves (leakage test)

(approximately 4-hours)

1) Explain what is meant by the term “normally closed.”

2) Describe what the most effective and safest test for a normally closed (normally non-passing) pressure control valve is.

3) Explain why if a pressure control valve can be set at its specified setting, it in no manner indicates that there is not leakage across the seat of the valve.

4) Explain why setting a pressure control valve with a porta-power can lead to severe injury, death, or substantial property damage.

5. Give the two most common cause of pressure control valve seat leakage.

6. Give at least three symptoms of excessive wear across the seat of a pressure relief valve.

7. Give at least one symptom of excessive wear across the seat of a sequence valve.

8. Give a least one symptom of excessive wear across the seat of an unloading valve.

9. Give a least one symptom of wear across the seat of a counterbalance valve.

4 – How to Troubleshoot Directional Control Valves (leakage test)

(approximately 4-hours)

1) Explain the meaning of "leaker" as it applies to a directional control valve.

2) Describe the most effective and safest test for a directional control valve.

3) Give at least four symptoms of excessive leakage across a directional control valve spool.

4) Describe at what point the leakage across a directional control valve spool is excessive using a pressure leak test.

5) Explain at least two causes of excessive leakage across a directional control valve spool.

6) Explain how to pin-point leakage across a circuit module when there are two or more suspects in the stack.

7) Explain how to determine where the leakage source is in a mobile directional control valve when there is a cylinder port relief valve or an anti-cavitation valve in the same body as the spool.

8) Give at least one symptom of a defective load check valve.

9) Explain what condition will cause an O-ring to collapse into the port in a sub-plate mounted valve application.

10) Explain how to test a directional control valve from the "P" port across to the "A" or "B" ports when the spool is in the activated position.

11) Explain what is meant by "cut-off pressure" as it applies to testing a directional control valve.

5 – How to Troubleshoot Check Valves (leakage test)

(approximately 4-hours)

1) Explain the meaning of "zero-leaker" as it applies to a check valve.

2) Describe the most effective and safest test for a check valve.

3) Describe the procedure for testing a check valve using a pressure/leak test.

4) Give at least four symptoms associated with leakage across a check valve.

5) Give at least three reasons why a pilot-to-open check valve will leak.

6) Explain how to test a pilot-to-open check valve when it is integrated in, or attached directly to, a cylinder housing.

7) Explain what condition will cause a cylinder to drift when the cylinder seals and the pilot-to-open check valve are in good working condition.

6 – Troubleshoot Hydraulic Cylinders (leakage test)

(approximately 4-hours)

1) Explain the meaning of "zero-leaker" as it applies to a hydraulic cylinder.

2) Describe the most effective and safest test for a hydraulic cylinder.

3) Give at least four symptoms of excessive leakage across the seals in a cylinder.

4) Explain how to execute a "through-stroke" cylinder bore condition test.

5) Explain why it is important to dead-head a cylinder rod in the opposite. direction to which it is drifting, when executing a cylinder seal leakage test.

6) Explain why a flow meter is unsuitable for checking leakage across the seals in a cylinder.

7) Describe a quick method of determining if there is leakage across cylinder piston seals especially if the machine is equipped with dual cylinders.

7 – How to Troubleshoot Closed-Loop Systems

(approximately 4-hours)

1) Give at least four symptoms of excessive leakage in a closed-loop system.

2) Describe what action to take if a closed-loop propelled vehicle experiences an unexpected “freewheel” condition.

3) Explain why it is unwise to tow a vehicle which is equipped with a closed- loop system.

4) Give at least two symptoms of low charge pressure in a closed-loop system.

5) Describe how to set charge pressure in a closed-loop system.

6) Explain why manufacturers of closed-loop systems state very clearly that the “inherent braking of a closed-loop system should not be construed as the braking system on a machine.”

7) Give at least two reasons why neutral is difficult or impossible to find in a closed-loop pump.

8) Give at least four reasons why a closed-loop system will overheat.

9) Give at least four reasons why a closed-loop system will operate in one direction only

10) Give at least four reasons why the response will be sluggish in a closed-loop system.

Give at least four reasons why a closed loop system will fail to operate in either direction.

11) Explain why a case flow test does not detect internal leakage in a closed-loop system.

12) Explain how to test charge pump condition in a closed-loop system.

13) Describe what will happen if a closed-loop system operates without charge pressure.

8 – How to Case Pressure Test an External Drain Pump and Motor

(approximately 4-hours)

1) Give at least three symptoms of excessive case pressure in an external drain pump or motor.

2) Give at least three causes of excessive pressure in an external drain pump or motor case.

3) Explain why installing a pressure gauge in the case drain line does not show if there is excessive pressure in an external drain pump or motor case.

4) Explain why it is advisable to install two pressure gauges – one in the case, and one in the case drain line, when testing case pressure in a pump or motor

5) Describe what the meaning of case pressure is as described by a pump or motor manufacture. For example: maximum pump/motor case pressure is 40-PSI when the oil temperature is approximately 135ºF.

6) Explain how to determine which pump shaft seal is leaking if there are three pumps on a gear box, and there is hydraulic oil discharging from the breather on the gearbox – without removing a pump from the gearbox.

7) Explain why it is unwise to connect case-drain lines in series.

8) Explain why it is important to terminate a case-drain line below the oil level in a reservoir.

9 – How to Troubleshoot Hydraulic Motors

(approximately 4-hours)

1) Give at least three symptoms of excessive leakage across a hydraulic motor.

2) Explain why it is dangerous to attempt to stall a motor output shaft to test a motor.

3) Explain why “loading” a motor by creating resistance on the outlet side with a needle valve, is ineffective when testing a motor for internal leakage.

4) Explain why testing an external drain motor by creating resistance at the motor outlet port with a needle valve, will make the internal leakage appear worse than it actually is.

5) Describe the safest and most effective leakage test for a hydraulic motor.