Maintenance & Troubleshooting of Hydraulic Systems

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We will introduce many aspects of troubleshooting hydraulic systems and will share information that will help you to better understand and enhance the operation of your hydraulic equipment.
Agenda

- Before you Begin
- General Guidelines
- System Faults
- Pump Troubleshooting
- Valve Troubleshooting
- Actuator Troubleshooting
- Accumulator Troubleshooting
- Where to get Help
Before You Begin

Obtain Documentation

You cannot have too much information!

- Obtain all Hydraulic and Electrical Schematics pertaining to the equipment

- Manuals of the machine’s operation

- Determine your starting point based on the symptoms
Before You Begin

Have a Plan!
SAFETY FIRST

- Use Safety Equipment
- Lockout / Tag-out
- Work with a partner
- Be cautious of multiple power sources (i.e. hydraulic accumulators)
- Have Complete Documentation
Before you begin

Don’t think... Know!

- Don’t assume the information you were given is correct
- Collect your own data
- Verify your findings
Observe and Record

- Understand the machine sequence and operation
- What is the machine doing or not doing?
- Intermittent or continuous?
- Machine running slow or fast?
- Pressure low or high?
- Shock, banging, vibration?
- Smell, touch, listen, and see
General Guidelines

Be prepared to UNDO

- Take pictures
- Make measurements
- Mark orientation of components
- Count rotations on set points
- Keep notes
Isolating Portions of the System

- Be Methodical

- Select a specific aspect of the system that is suspect

- Isolate that item from the rest of the system so that it can be investigated without outside interference

- Note findings and move on to the next item
General Guidelines

Predictability
Expect a result – Be predictive

- Every time an adjustment is made predict what should happen
- Every time you shift a valve predict what will happen
- If your predication is correct continue troubleshooting
- If your predication **IS NOT** correct, **STOP**, determine course of action
- **NEVER MAKE A CHANGE JUST TO SEE WHAT WILL HAPPEN**
- You must make a predication **especially when working with a partner!**
**General Guidelines**

**What did you change?**

Always ask if any maintenance or event triggered the current failure.
Troubleshooting Hydraulic Systems
## Isolating Hydraulic Systems

Isolating portions of the circuit is a good way to identify the area of concern.

<table>
<thead>
<tr>
<th>Lacking flow?</th>
<th>Lacking pressure?</th>
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<tbody>
<tr>
<td>The flow is taking the path of least resistance. Isolate portions of the circuit, check all ball valves/safety valves, listen to relief valves, feel for heat, etc.</td>
<td>Try to isolate the hydraulic system from the rest of the system by blocking the pressure source. Close a ball valve, disconnect a line and plug, etc.</td>
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Symptom: No pressure!
Reasons and possible solutions:

- Unit not running or **pump turning in reverse** direction
- **Low oil** level or **no oil** in reservoir
- **Suction line** of pump **obstructed** or disconnected
- **Drive** coupling is damaged or **disconnected**
- Full pump volume by-passing through a **faulty valve or actuator**
- A manual valve may be shifted **diverting volume** to tank or a solenoid valve may be unintentionally energized/shifted or not shifted due to an electrical problem. - Check all possible electrically-operated valves with a volt meter or manual over-ride if available.

- **Note:** Don’t blindly pin the blame on the hydraulics; often the cause of the problem may be mechanical or electrical.
Hydraulic or Electrical?

Often an electrical issue will affect the hydraulic operation. Don’t get focused on a hydraulic problem until you have also reviewed electrical issues such as:

- No or low voltage at a solenoid valve due to a defective limit switch, misadjusted limit switch, PLC output, power supply, transformer or no control power.

- What has changed?

- A change to the PLC program, a limit switch or other electrical component recently replaced?
System Overheating?
Determine the source – What is hot?
Symptom: Over heating of system
What is the maximum temperature for a hydraulic system?

For safety, efficiency, and oil quality, temperatures above 140°F are not recommended for industrial hydraulic equipment using petroleum-based hydraulic oil.

Oil that is too hot will degrade rapidly, drop in viscosity and can lead to accelerated component wear and poor system performance. A broken hose or leak in a line may result in serious burns to nearby personnel.
Symptom: Over heating of system

Causes of overheating systems (1 of 2)

- Contamination causing wear of components thus creating internal leakage of the component and higher operating temperatures.
- Relief valves and/or compensators misadjusted.
- Compensator on pump may be set higher than the Safety relief valve
- Flow control valves may be set improperly for a given application
- Water supply feeding heat exchanger may be shut-off or has insufficient flow or temperature for cooling.
Symptom: Over heating of system

Causes of overheating systems (2 of 2)

- Heat exchanger may be clogged or water modulating valve may have failed.

- If an air to oil heat exchanger is in the system the cooling fins may need to be cleaned or electric motor or starter may have failed.

- Ambient air temperature may have increased and can no longer supply sufficient cooling media. Inadequate ventilation or area of room size may have changed.

- Incorrect fluid used in hydraulic system

- Defective pump (reference noisy pump information)
Symptom: Slow or Erratic Travel Rate

Possible Reasons:

- Low fluid level
- Viscosity of the fluid is too high or temperature is too low
- Contamination
  - Dirt/debris stuck and holding a valve partially open
- Internal leakage through a valve or actuator
- Low flow rate
  - Worn/Inefficient pump
  - Pump drive speed too low
  - Faulty or dirty flow control or other feed related valve
- Mechanical Issue - Misalignment, sticky, warped, or binding ways, bent bracket or other mechanical failures
Symptoms: Slow or Erratic Travel Rate

Actions:

- Check level, color, quality and cleanliness of fluid and act accordingly.

- Take temperature readings at the pump, pump case, and various valves to identify a noticeable temperature rise (possible internal leakage).

- Put your hand on valve to feel or listen for leakage.

- If the valve discharges to tank, disconnect the tank line and connect a hose from the valve, feeding into a bucket. Start system and measure the leakage. Act accordingly to repair or replace the valve.
Pumps not Functioning?

- Flow and Pressure
- Internal Leakage
- Excessive Noise
Flow and Pressure

- Hydraulic pumps create flow not pressure
- Resistance to flow creates pressure
- Flow determines actuator travel speed
- Pressure determines actuator applied force
- Fluid will always take the path of least resistance
- When fluid moves from an area of high pressure to an area of low pressure (pressure drop) without performing work, heat is generated
Pumps

Pump Internal Leakage

- Do not confuse with external leakage
- Good indicator of pump condition
- Will result in **loss of flow**
- Will **generate heat**
Symptom: Noisy Pump
Possible Cause: Cavitation

VIDEO – “The Beer Bottle Trick”
Symptom: Noisy Pump
Possible Cause: Cavitation

- **Suction line issues**
  - Clogged inlet strainer
  - Inlet pipe obstructed
  - Loose connections
  - O-Rings, Seals damaged or missing

- **Reservoir issues causing air infiltration**
  - No baffles / insufficient baffles
  - Reservoir too shallow or oil level too low thus causing a vortex
  - Plugged or dirty filter breather
  - Return lines above the oil level.

- **Fluid viscosity too high**
  - Wrong fluid for application
  - Operating temperatures are too low

- **Other Issues**
  - Excessive drive speed
  - Worn or damaged shaft seal on pump; check shaft for misalignment.
  - Contamination or high heat. Monitor ISO cleanliness codes and temperature
Pumps

Symptom: Noisy Pump
Possible Cause: **Pump worn or damaged**

Many kinds of pumps, many moving parts
- Worn or sticking vanes
- Worn ring
- Worn or damaged gears
- Worn or damaged rotary group
- Worn or faulty bearings

How to measure leakage
- If your pump has a case drain line a quick check for inefficiency is to remove the case drain line and drop it into a bucket.
- While the pump is in compensation, monitor how much fluid is coming from the case drain line. It should be within the catalog characteristics.
- If more than 10% of the pump’s maximum output is going out the case drain line, this would indicate that the pump requires rebuild or replacement.
- Internal leakage will show signs of high heat. Temperature readings at the pump during a morning start-up will help to identify the source of the heat.
Valves Not Functioning?

- Pressure Controls
- Directional Controls
- Flow Controls
Symptom: Low or Erratic Pressure

Reasons and possible solutions:

- Pressure control setting too low (relief, compensator, reducing valve, etc.)
- Worn or sticking relief valve.
- Dirt/debris stuck and holding a relief or other valve partially open.

Suggestions:

- Check cleanliness of fluid and act accordingly.
- Take temperature readings at the various valves to identify a noticeable temperature rise (possible internal leakage).
- Put your hand on valve to feel or listen for leakage.
- If the valve discharges to tank, disconnect the tank line and connect a hose from the valve, feeding into a bucket. Start system and measure the leakage rate. Act accordingly to repair or replace the valve.
Proportionally Controlled and Servo Controlled Valves and Drivers (1 of 3)
Valves

Proportionally Controlled and Servo Controlled Valves and Drivers (2 of 3)

- Valves may have separate or on-board electronic driver boards

- Proportional and servo valves are current driven using “Pulse Width Modulation”

- Before troubleshooting a proportional or servo valve obtain documentation for the valve and control amplifier

- **Shielded wire is required** for the valve to operate without interference (electrical noise).

- Proper grounding of signal wire critical for stable operation
Proportionally Controlled and Servo Controlled Valves and Drivers (3 of 3)

- Proportional and servo valves are controlled with either a current or voltage command to the valve electrical controller.

- Often the problem is not the valve but the amplifier, PLC, feedback device or broken wire.

- Fluctuating power supplied to the electrical amplifier will interfere with proper valve operation.

- What has changed? Ask Questions?
Actuators not functioning?

- **Cylinders**
  1. Speed
  2. No Movement
  3. Insufficient force
  4. Drifting

- **Hydraulic motors**
  1. Speed
  2. No Movement
  3. Insufficient torque
Actuators

Symptom: Actuator fails to move

Reasons and possible solutions:

Note: Often when an actuator doesn’t move the problem is not the actuator.

- Directional valve not shifting.
- Electrical failure: bad solenoid, limit switch, PLC, etc.
- Insufficient pilot pressure (if dual stage valve, check pilot and drain configuration, especially if valve has just been replaced).
- Look at any check valves or back pressure valves required to provide pilot pressure (often the case with proportionally controlled directional valves)
- System operating pressure too low (see low or erratic pressure)
- A valve elsewhere in the system is allowing flow to be diverted to the reservoir
- Interlock device not actuated
- Mechanical bind on machine or actuator (improper mounting of actuator).
- Faulty pump
- High heat – viscosity too low
- Previous contamination damage/high heat has caused component fatigue, wear and failure.
- Worn/damaged actuator (cylinder or hydraulic motor blow-by or internal leakage).
Suggestions:
If you think that it may be internal leakage:

- Take temperature readings on the system and on both sides of actuator. Actuator may be bypassing internally due to worn seals.

- Extend cylinder fully and disconnect rod end port connection. If fluid is continuing to flow from rod end port the cylinder has internal leakage and requires rebuild or replacement. If no leakage is present connect the line, retract the cylinder, and remove cap end connection to check for same on opposite end. *(Note: Only portion of cylinder stroke may be leaking)*

- Depending on the seal design it is possible for a cylinder to leak in one direction and not the other. A cylinder that leaks internally typically will drift in the extend direction because of the area differences on the piston even when mounted vertically rod up.

- If you experience this type of drifting the issue is probably the actuator and you should start your troubleshooting here.
Accumulators

Why is the accumulator in the system? Shock? Speed? Stored energy?

Nitrogen pre-charge pressure **CAN NOT** be measured while system is running

Potential for unexpected discharge (stored energy)
Most Important Tools

- Eyes
- Ears
- Hands
- Nose
- Use your senses

And... ASK QUESTIONS!
Preventative Maintenance

Be proactive
Conduct regular PM activities

- Monitor fluid condition
- Conduct filter changes as required
- Monitor pump leakage rate
- Monitor system temperatures

ASK QUESTIONS!
Preventative Maintenance

Complete Product Life Cycle

Maintenance Lifecycle
- Initial maintenance cost is high
- Long period of stable operation
- Maintenance cost ramps up
- Spare parts become obsolete

Modernization Concept
- Reduce maintenance cost
- Reduce operating cost

How fit am I really??

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Where to Get More Information

- Books, Trade magazine articles, Internet, etc.
- Formal Hydraulic Training Sessions
- On-Site Consulting Services
- Emergency Field service 1-888-Flodyne (1-888-356-3963)
- 24 Hour Emergency Support Hotline  (1-800-REXROTH)