KEYS TO FAILURE ANALYSIS

1. Don’t go into a problem with a preconceived idea about the cause.
2. Don’t assume anything, verify everything.
3. Don’t overlook the obvious.

TROUBLESHOOTING

• When a component fails the failure is from
  - Contamination
  - Aeration
  - Cavitation
  - Overload conditions
  - Abuse

*Components seldom wear out without contributing factors*
COMMON ERRORS

- Operators are not trained to recognize when they are damaging components
- System was not set up properly, pressure too high or too low
- No filtration
- Wrong fluid, wrong viscosity
- Undersized conductors requiring more horsepower to compensate for backpressure etc.

Three major requirements you need to know to troubleshoot a system

1. Understand flow & pressure concepts
2. Understand the system components and their functions
3. Understand hydraulic symbols, schematics and circuit logic

The troubleshooter must have a systematic approach to problem solving and a means of knowing each system intimately

TYPICAL LOAD SENSING SYSTEM

- Replacing a component may not necessarily correct your performance problem
- The performance problem may be compounded by the failure of more than one component
- When a failed component is replaced the system must be thoroughly flushed; strainers, filters and the fluid must be replaced
• The system will tell the troubleshooter a lot by heat it develops, noise it makes, pressure, and speed the system is operating at

• Due not assume that leaks are mere nuisances, when actually they are warning signs of more serious problems

• Investigate all leaks and make the proper repairs

CONTAMINATION

CAUSE
• Improper filtration
• Low oil level - concentration of contaminant
• Loose or lost breather cap
• Leaking fittings, seals, wipers
• Missing or collapsed inlet strainer
• Poor fill practices
• Clogged filter - by-pass

Effect
• Accelerated wear
  • Bearings, thrust plates, housing
  • Bearing / bushing failure
• Reduced pump efficiency
• Reduced life
• Heat
• Internal leaks
• Failed pump

Effects of Leakage

Rod Seal Leak
Piston Seal Leak
Piston Seal Leak (Meter-Out Circuit)
The fine particles being carried by the hydraulic fluid erodes the thrust plate surface in the trapping groove on the high pressure side of the pump plate. The erosion will be heaviest where the teeth mesh and then migrate towards the low pressure side of the plate. Over time, the wear cuts a channel into the plates' surface allowing the oil to leak back to the pump inlet. The volumetric efficiency of the pump is reduced.

A closer inspection of the plate surface not only reveals the damage in the center of the plate but in the root seal area as well. A light ring around the I.D. root seal area develops due to the very tight clearances. Fine particles wear the thrust plate surface leaving a polished appearance.

When contamination is present two wear bands will develop under the ring seals on the gear shaft of the roller bearing pumps. These bronze high pressure seals are designed to reduce the high pressure oil lubricating the bearings to low pressure before reaching the shaft seal. Tiny particles, under high pressure and velocity, progressively wear the gear journal surface until the ring seal is no longer effective. High pressure jets under the ring seal pressurizing the shaft seal area.
FOREIGN OBJECT DAMAGE

The damage that occurred to this gear set was caused by a hardened foreign object such as a screw or a nut. Additional debris has been generated by the broken gear teeth and component scoring. This type of failure can contaminate the entire hydraulic system.

CAVITATION DAMAGE

CAUSE - Inlet restriction
- Clogged inlet strainer / breather
- Inlet strainer too small
- Inlet line too long
- Inlet line bore too small
- Excessive engine speed
- Collapsed inlet hose
- Suction head too great
- Oil too viscous (cold weather)

Effect
- Noise
- Heat
- Accelerated wear
  - thrust plates / housing
- Internal leaks
- Reduced pump efficiency
- Erratic actuator performance
- Failed pump

AERATION DAMAGE

CAUSE - Air enters oil
- Low oil level
- Vortexing of oil above strainer - whirlpool
- Loose inlet fittings
- Worn pump shaft seal
- Worn cylinder rod seal
- Foam suspended in oil due to sloshing in the reservoir

Effect
- Noise
- Heat
- Accelerated wear
  - thrust plates / housing
- Internal leaks
- Erratic actuator performance
- Reduced pump efficiency
- Failed pump

When the air bubbles implode intense shock waves bombard the surface of the wear plates. The shock waves erode the plates’ surfaces on the high pressure side and trapping groove area. The sealing capability of the plate is reduced resulting in a loss of output flow. The presence of air can also reduce the volume of oil available to carry away heat that is produced by mechanical friction. Vacuum conditions created in the pump rob oil from the bearing and thrust plate areas. The loss of oil in bearing bore upsets the loading which can result in premature bearing failure. Thrust plates, relying on the oil to maintain their balance become unbalanced, resulting in a milling of the plate surface. Physical damage can also be seen on the gear housing bore in the form of a rough surface in the gear wipe area.
This plate has been damaged by cavitation. As the gear teeth come around to the discharge side of the pump (outlet) the oil is exposed to the outlet pressure collapsing the large air bubbles.

A close up of the plate shows the severity of the pitting. The damage is heaviest in the root seal area where the clearance between the plate and the gear face is the tightest. This damage allows high pressure oil to escape down the gear journal into the bearing or bushing.

The system pressure deflects the gears into the low pressure inlet side of the pump. If the system pressure increases above the pressure rating of the pump, then the gears deflect too far and the gear housing causing the cut-out to become excessive. Internal slip increases and the pump becomes less efficient. The contaminant created by the cut-out can foul relief valves and other system components. If the housing cut-out exceeds .005" (.007" for a bushing pump gear housing) the gear housing should be replaced.
Hydraulic shock loads can cause an immediate component failure in your hydraulic system. Sudden pressure spikes that exceed the pressure rating of the pump can crack the housing at the port location and bolt hole areas of the casting. A slow acting or malfunctioning relief valve can cause excessive pressure spikes in the system.

This slide shows the inner race of the bearing and the damage caused by excessive loading.

As the bearing wears the gear journal becomes damaged by the direct contact of the journal to the needle bearings.

Thrust plates can also be damaged by excessive pressure. The above plate split through the middle due to excessive loads. The thrust plates used in the roller bearing product are most susceptible to damage between the two bearing bores. A small bleed hole, needed for balancing pressures in the bearing bores, is machined on the back side of the plate in this area. Couple this with fact that the greatest pressure in the pump occurs at the center of the plate where the gear teeth mesh. The oblong bores in the above plate are due to a bearing failure.
Excessive pressures can also cause coining damage to the thrust plate. This is a deformation of material on the low pressure inlet side of the plate. The heavy loading pushes the plate into the gear housing with enough force to cause a bulging of material in the relieved edge of the plate. The major O.D. is flattened.

Hydraulic shock and excessive pressure can also cause failures to the pump drive line. Many times the drive coupling or pump drive shaft will fail. In the above example, the pump drive shaft broke where the shaft diameter is the smallest. The drive shaft was not strong enough to withstand the torque load generated by the high pressure.

With the loss of lubrication the thrust plate becomes heated rapidly. If the condition persists the plates will become so heated that lead in the alloy will be drawn out of the plate.

HEAT DAMAGE

**CAUSE**
- Low oil level
- Cavitation / aeration / water
- Contamination
- Inlet restriction
- Relief valve
- Incorrect fluid
- Poor reservoir design
- Undersized fittings, hoses, components

**EFFECT**
- Breakdown of oil
- Loss of lubricity
- Accelerated wear
- Reduced efficiency
- Leakage
- Varnish / sludge
- Internal seal destruction
- Seizure
As the lead comes to the surface the trailing gear tooth smears the lead over the surface of the plate. The plate will become blackened by the lead oxidation.

Excessive heat can cause a thrust plate material to become brittle and crack.

With excessive heat the ends of the gear teeth near the gear face become discolored. The high heat causes a bluing of the teeth. With continued operation the gear face and thrust plate will start to weld together. The continued motion of the gear tears thrust plate material from the plates surface. The friction can generate enough heat that the pump could eventually seize up.
START-UP PROCEDURE

• Bleed Air:
  – Loosen allen screw at “Air-Bleed Plug”, start system and allow a little oil to bleed out. (Otherwise can run a permanent hose from this plug and “T” it into the control drain line.

• Clean Fluid:
  – Install "Jumper Hose" at rear of truck in Auger Circuit, operate auger (jumper hose) and run for a few minutes, through return filter.
  – Remove MRV on valve and replace with plug, then run any function and oil will simply go back to tank, through return filter.
TROUBLESHOOTING

No pump flow/pressure when a valve spool is shifted:
* Pump is air locked
* Compensator spool in pump stuck
* Contamination in the compensator orifice
* High-pressure pilot dart stuck open (contamination)
* Pump differential PSI is too low (reset 400-500)
* Excessive leakage at valve load sense orifice

Pump is noisy:
* Air in the system
* Insufficient oil, cavitation
* Driveline out of phase, angle to steep, worn joints
* Plugged strainer

Pump is getting hot:
CAUSE:
* Insufficient oil/wrong viscosity
* Pump stuck in high pressure
* High pressure drops in the system
* Worn pump components

TESTING PUMP WITH INLINE TESTER

Remove ORB plug #4, with an allen wrench remove the plug in position #1.

Install a pressure gauge in the #4 port. Ensure that the gauge is capable of 5000 PSI.

Start the system, if the pump goes to high pressure the problem is in the valve.
V20 TROUBLESHOOTING

1. No response at cylinders or motors (all spools.)
   * determine would type of system it is, load sense or unloader.
   * check pressure gauge on ADD-A-STACK
   * check system main relief
   * check hydraulic pump.
   * manually operate spools when possible.
   * check electrical power to solenoids.
   * check unloader to make sure that it is not open.

2. One or all spools respond jerky or erratic.
   * check pilot pressure (pressure reducing valve.)
   * check for bare or loose connections.
   * check the pressure on the port being affected, if the pressure that is required to move the load is lower than the pilot pressure this can cause the same problem.

3. Section will not meter or it is jerky
   * check solenoid or cartridge valve, may be sticky.

4. One section will not operate but all others do.
   * operate a section to left or right of the bad section and operate the bad section at the same time, if the * bad section operates now there is a problem in the load sense portion of this section

SHUTTLE VALVE LOGIC

- Valve opening
- To other valves in manifold
- Connected to other shuttle valves
- Pump
- Load sense line to pump

Add-A-Fold® Valve

- Typical valve assembly
- Manual override connection
- Shuttle valves, 1 per section
Contamination in the load sense passage way will cause the valve to stay in the open position. Continuous high pressure would be an indication that the spool is stuck in the closed position.

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