PISTON PUMP FAILURE ANALYSIS
A Guide to Analyzing Axial Piston Pump Failures

TYPICAL FAILURE MODES

- Contamination
- Fluid Issue
- Over Pressurization
- Improper Inlet Condition
- Case To Inlet Differential
- Miscellaneous

CONTAMINATION
- PISTON SEIZED IN BORE, PULLS SHOE OFF.
- PISTONS SHOW FINE SCRATCHES, DULL FINISH.
- EXCESSIVE WEAR ON SWASHBLOCK FACE, SHOE FACE AND VALVE PLATE FACE.
- EXCESSIVE WEAR ON SADDLE BEARINGS.
- HYDRO-DYNAMIC BEARING WORN.
- CONTROL UNSTABLE: PISTON STICKING, COMPENSATOR SPOOL STUCK OR WORN, ORIFICE IN CONTROL PISTON PLUGGED.
CONTAMINATION EXAMPLES

- Vertical scratches on the piston barrel.
- Note Metal Transfer

A Clear Indication of Contamination

Dull and scratchy finish

- Normal Appearance: A Mirror Finish
- Abnormal Appearance: A Steel Wool Look

SHOE WEAR PLATE SHOWING SIGNS OF WEAR DUE TO DIRT

- Scratchy Uneven Wear
FLUID ISSUE
Viscosity too Low, Operating Temperature too High, Not a Hydraulic Fluid, Fluid Breaking Down

- PISTON SEIZED IN BORE, PULLS PISTON SHOE
- SHOE FACES AND OR VALVE PLATE FACE SMEARED
- BALL WORN THROUGH SHOE RETAINER
- SHAFT SEAL LEAKS
- CAVITATION, AIR ENTRAINMENT
- EXCESSIVE SADDLE BEARING WEAR

VALVE PLATE RUN ON A BAD FLUID
Note the Smeared Running Surface

WORN FULCRUM BALL
Typical Failure on Low Lubricity Fluid
The fulcrum ball is between the rotating group and the shoe retainer plate.

WORN SADDLE BEARING
Note the material has delaminated
OVER PRESSURIZATION/SPIKES
Spike Relief Always Recommended

- Excessive swashblock face, cylinder to valve plate wear
- Pistons broken at necks
- Broken shaft where cylinder rides
- Broken tail shaft (dual)
- Control pin broken
- Cylinder cracked between kidneys
- Control O-ring, gasket failure (PVW)

EXCESSIVE WEAR ON CYLINDER FACE

- Cracks would appear between kidneys

TORSIONAL FATIGUE:
Note Cone Shaped Failure

BENDING FATIGUE FAILURE
Note Straight Break
IMPROPER INLET CONDITIONS

What are the improper inlet conditions for piston pumps?

- CAVITATION ON VALVE PLATE FACE
- NOISE (MARBLE SOUND)

CASE TO INLET DIFFERENTIAL

Case to inlet differential refers to the pressure difference between the inlet pressure (vacuum) and the case drain pressure.

The pressure in the case has to be vented back to the reservoir below fluid level. As the pump creates flow the inefficiencies are drained into the case. If the case drain line or fittings are undersized this will cause the case pressure to increase.

DIFFERENTIAL CANNOT EXCEED 10 PSI

Examples of high case pressure differential:

- SHOE EDGES ROUNDED
- SHOES LOOSE ON BALLS
- SWASHBLOCK WEAR, HALF MOON SHAPE
- EXCESSIVE WEAR ON BACK OF SHOE FLANGES
- SEAL RETAINER BENT
SHOE LOOSE ON BALL

This is an example of a shoe that became loose on the ball and with repeated high case pressure fatigued the slipper and finally cracked. This is called Shoe Lift, the sound associated with it would be constant machine gun noise typically worse at full stroke.

STAGES OF DAMAGE DUE TO SHOE LIFT

1st Stage
2nd Stage
3rd Stage

THE FINAL STAGE OF SHOE LIFT

HALF MOON SHAPED MARKS

A sure sign of shoe lift
As can be seen in the picture the retainer is clearly bent, that is from the case pressure pushing the seal against retainer. The surface on the shaft where the seal rides will have a groove cut in it making unusable again.

After removal of the shaft assembly, the seal retainer is accessible. The seal retainer is placed between the outboard side of the pump and behind the bearing.
Seal retainer in position on the pump shaft.

Once the seal retainer has been removed the shaft seal is exposed for removal. Investigate the seal closely and you probably notice that it has been pushed out of the pump housing a little distance.

Seal retainer in position on the pump shaft.

MISCELLANEOUS

- INPUT SHAFT BROKEN
  - MISALIGNMENT

- CONTROL INSTABILITY
  - AIR

- PUMP VIBRATES
  - MISALIGNMENT

FRETTED DRIVESHAFT

62. This splined drive shaft has been worn by fretting corrosion. To prevent this damage the drive coupling should be cleaned regularly followed with the application of a light coat of synthetic grease.
HELPFUL HINTS FOR ANALYZING BASKET CASES

1. The last piece to fail will have the least amount of damage.
2. Try to piece together the broken parts. This may seem like a waste of time but many times you will observe things which can help you determine the original cause of failure.
3. Get the history of events:
   - What recently changed?
   - What was going on just prior to failure?
   - How long was pump running for?
   - Talk to the operators.

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.