PISTON PUMP FAILURE ANALYSIS

A Guide to Analyzing Axial Piston Pump Failures

2

TYPICAL FAILURE MODES

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

3

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.

4

CONTAMINATION EXAMPLES

Vertical scratches on the piston barrel.

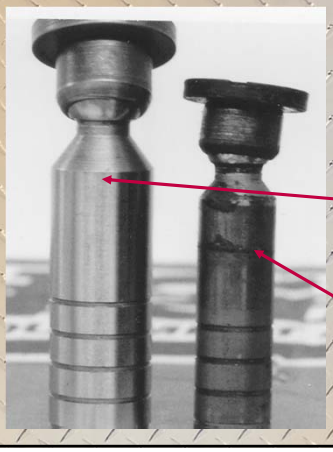
Note Metal Transfer

5

A Clear Indication of Contamination

6

Dull and scratchy finish

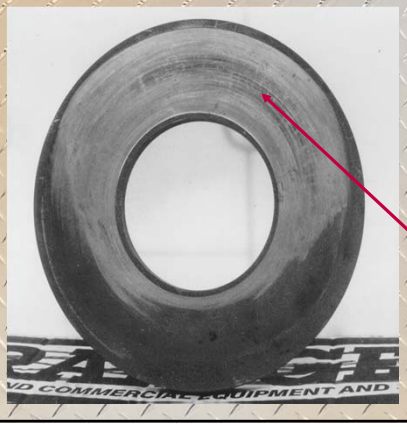


Normal Appearance: A Mirror Finish

Abnormal Appearance: A Steel Wool Look

7

SHOE WEAR PLATE SHOWING SIGNS OF WEAR DUE TO DIRT



Scratchy Uneven Wear

8

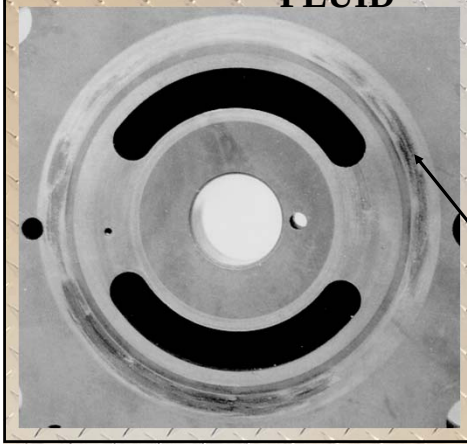
FLUID ISSUE

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

9

VALVE PLATE RUN ON A BAD FLUID



10

WORN FULCRUM BALL

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

11

WORN SADDLE BEARING

12

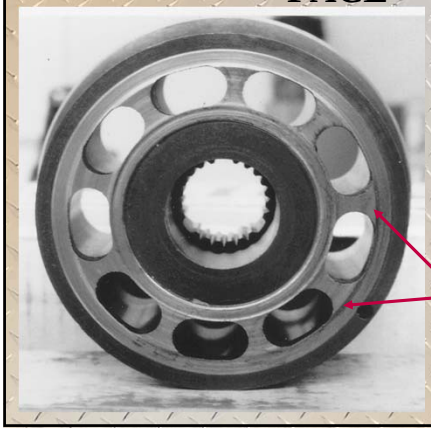
OVER PRESSURIZATION/SPIKES

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)

13

EXCESSIVEWEAR ON CYLINDER FACE

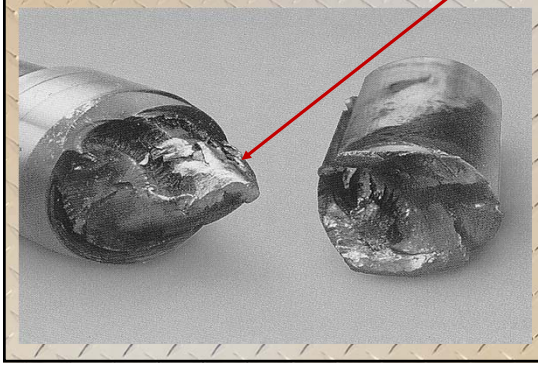


Cracks Would Appear Between Kidneys

14

TORSIONAL FATIGUE:

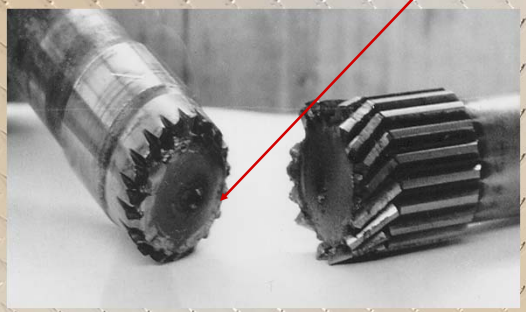
Note Cone Shaped Failure



15

BENDING FATIGUE FAILURE

Note Straight Break



16

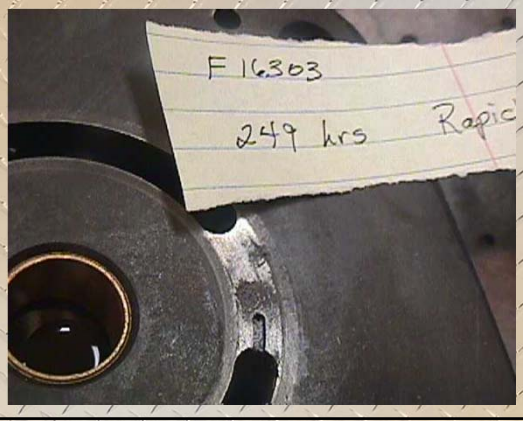
IMPROPER INLET CONDITIONS

What are the improper inlet conditions for piston pumps?

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

17

CAVITATION ON COMPRESSION BRIDGE



18

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.

19

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

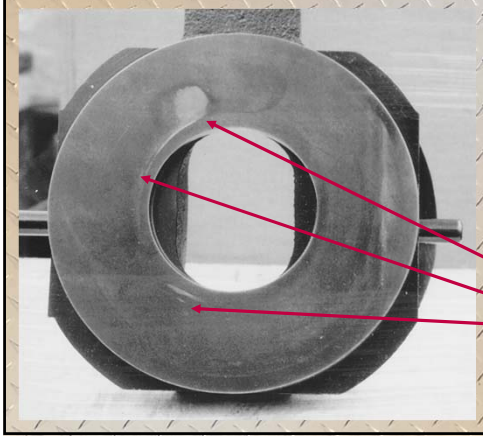
20

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.

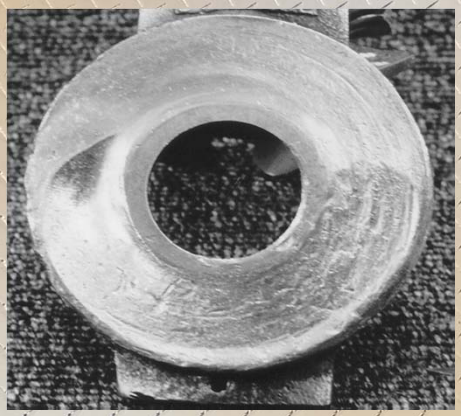
21

STAGES OF DAMAGE DUE TO SHOE LIFT



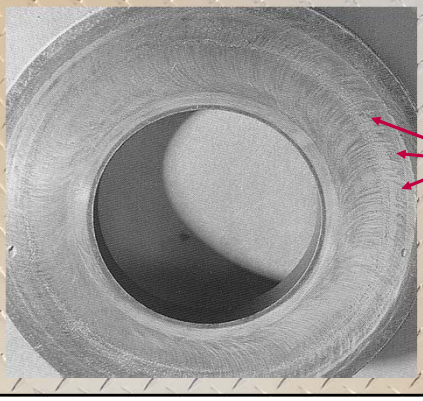
22

THE FINAL STAGE OF SHOE LIFT



23

HALF MOON SHAPED MARKS

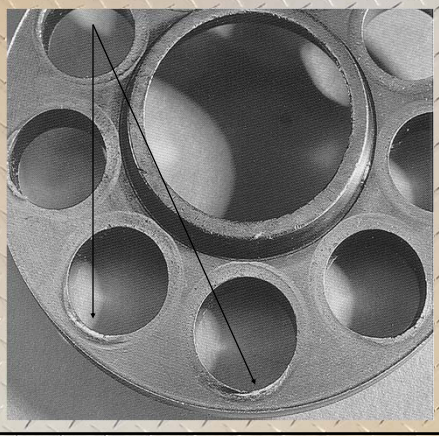


24

ROLLED SHOES: THE TELL TALE OF SHOE LIFT

25

WEAR ON SHOE RETAINER FROM SHOE FLANGES



26

BENT SEAL RETAINER

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.

27

SEAL RETAINER

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.

28

SEAL RETAINER

Seal retainer in position on the pump shaft.

29

SEAL RETAINER REMOVED

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.

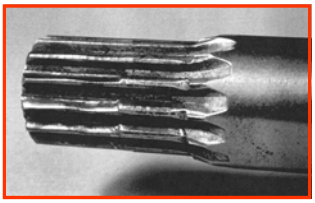
30

MISCELLANEOUS

- **INPUT SHAFT BROKEN**
  - **MISALIGNMENT**
- **CONTROL INSTABILITY**
  - **AIR**
- **PUMP VIBRATES**
  - **MISALIGNMENT**

31

FRETTED DRIVESHAFT



62

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

- The last piece to fail will have the least amount of damage.
- 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.
- 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.

33

KEYS TO FAILURE ANALYSIS

- Don't go into a problem with a preconceived idea about the cause.
- Don't assume anything, verify everything.
- Don't overlook the obvious.

34