Bearing Issues with a Flooded Screw Compressor

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Introduction

- Flooded screw compressor on offshore platform had thrust and journal bearing failures
- Redesigned high case thrust bearings to run with “pressurized cavity”
- Redesigned journal bearings to increase reliability
Compressor

- Vapor recovery service
- Tandem compressor design
  - Two screw compressors bolted together
  - Male rotors coupled together
- Both male rotors run at 3600 rpm
- Both female rotors run at 2175 rpm
Compressor Bearings

High pressure case

Low pressure case

Jrnl Brgs

Thr brgs

Jrnl Brgs

Thr brgs
LC Thrust Bearing
Active & Inactive / Male & Female - Good condition
HC Thrust Bearing Pads

Severe failure of active pads (male and female)
Thrust bearings

- LC and HC Bearings were different design
  - Both were equalized tilting pad
- LC did not fail - HC did fail
- Recorded step increases in HC rotor position
  - February had 12-15 mils float
  - June had 30 mils float
  - July – tripped on high axial movement
Thrust Bearings

- Decision made to duplicate LC design aspects in the HC thrust bearings and upgrade bearing design
  - Main difference was LC has drain orifice control and the HC had supply orifice control
  - Upgraded HC bearings to utilize copper pads
  - Also upgraded HC to offset pivots
Thrust Bearings

- With drain orifice control the oil pressure drop is taken *after* the bearing is lubricated.
- With supply orifice control the pressure drop is taken *before* the bearing is lubricated.
- Concern that there may have been some degassing of the oil as it took the pressure drop – limiting load carrying capabilities.
Thrust Bearings

Oil flow controlled by inlet orifices
Thrust Bearings

Plugged 4 of 7 oil drain holes

Oil flow controlled by outlet orifices

Plugged 2 of 4 oil drain holes
Journal Bearings

- All 8 journal bearings wiped
- All bearings had same design concepts
- Oil flow through bearings contributed to lobe lubrication
- Improved reliability by increased clearance and increased oil flow (by opening flow passages in bearing bores)
Journal bearings
Journal Bearings
Journal Bearings

- Clearances ran about ¾ mils per inch
  - Decided to open closer to 1 mil per inch
- Axial oil distributions grooves had “Bleed off” notches (chamfers) to control oil flow
  - Increased number and size of these chamfers
Journal Bearings

Three axial grooves

Bleed off “chamfers”
Journal Bearings
Journal Bearings

- Oil flow though a journal bearing consists of:
  - Side Leakage
  - Chamfer flow

- Increasing clearance increases side leakage
- Increasing chamfer size and/or number increases chamfer flow
Journal Bearings

- Bearings had different oil supply and drain pressures
  - Resulted in different flows
  - Resulted in uneven flow in some bearings
    - More flow towards screws on some and more flow away from screws on others
    - Also concerns with fluctuating pressure on screw side
Compressor Oil Pressures (psig)

- 320 supply
- 85 drain
- (both sides)

- 320 supply
- 85 drain right
- 290 drain left

- 320 supply
- 85 drain left
- 5 drain right

- 115 supply
- 85 drain left
- 5 drain right
Journal Bearings

- Increased clearance and chamfer flow added together to increase reliability
- Bearings ran good with no reliability issues
- Unfortunately increased bearing flow resulted in increased oil flow to lobes
  - This resulted in process gas condensation issues due to lowering gas temperature coupled with low dew point gas
Journal Bearings

- Needed to come up with a “compromise” with clearance and chamfer flow
- Testing verified chamfer flow coefficients
- Journal bearing computer analysis verified:
  - Impact of clearance on total bearing flow
  - Affect of chamfer flow on bearing reliability
Test rig
Test rig
Test rig

- Tested various configurations under actual operating speed.
- Utilized actual bearings and modified for
  - Different “chamfer” configurations
    - Size and number
  - Different clearances
- Tweaked analysis
  - “side” leakage agreement with computer code
  - Chamfer flow coefficients
Journal Bearings

Effect of Clearance on Metal Temperature

Assumed load of 200 psi, no chamfer flow
Journal Bearings

Effect of Flow on Metal Temperature

Assumed load of 200 psi, 6 mils diametral clearance
Journal Bearings

- Opted to retain OEM notch configurations and increase bearing clearances
- Result is improved bearing reliability with reduced process gas condensation problems
- Demonstrated use of computerized analysis to determine best design configuration
Conclusions - Thrust

- By recognizing proven thrust bearing design concepts AND a proven LC thrust bearing design - user was able to significantly increase thrust bearing reliability

- No further thrust bearing issues since redesign installed during the summer of 2005
Conclusions – Journal

- Journal Bearing failure pointed to inadequate clearance and lack of lubrication
- Redesign to increase clearance improved reliability but introduced process gas condensation problem.
- Analysis of bearing clearance and oil flow allowed optimum bearing design.
  - No more journal bearing failures
  - Minimize condensation issues