Bearing Issues with a Flooded Screw Compressor

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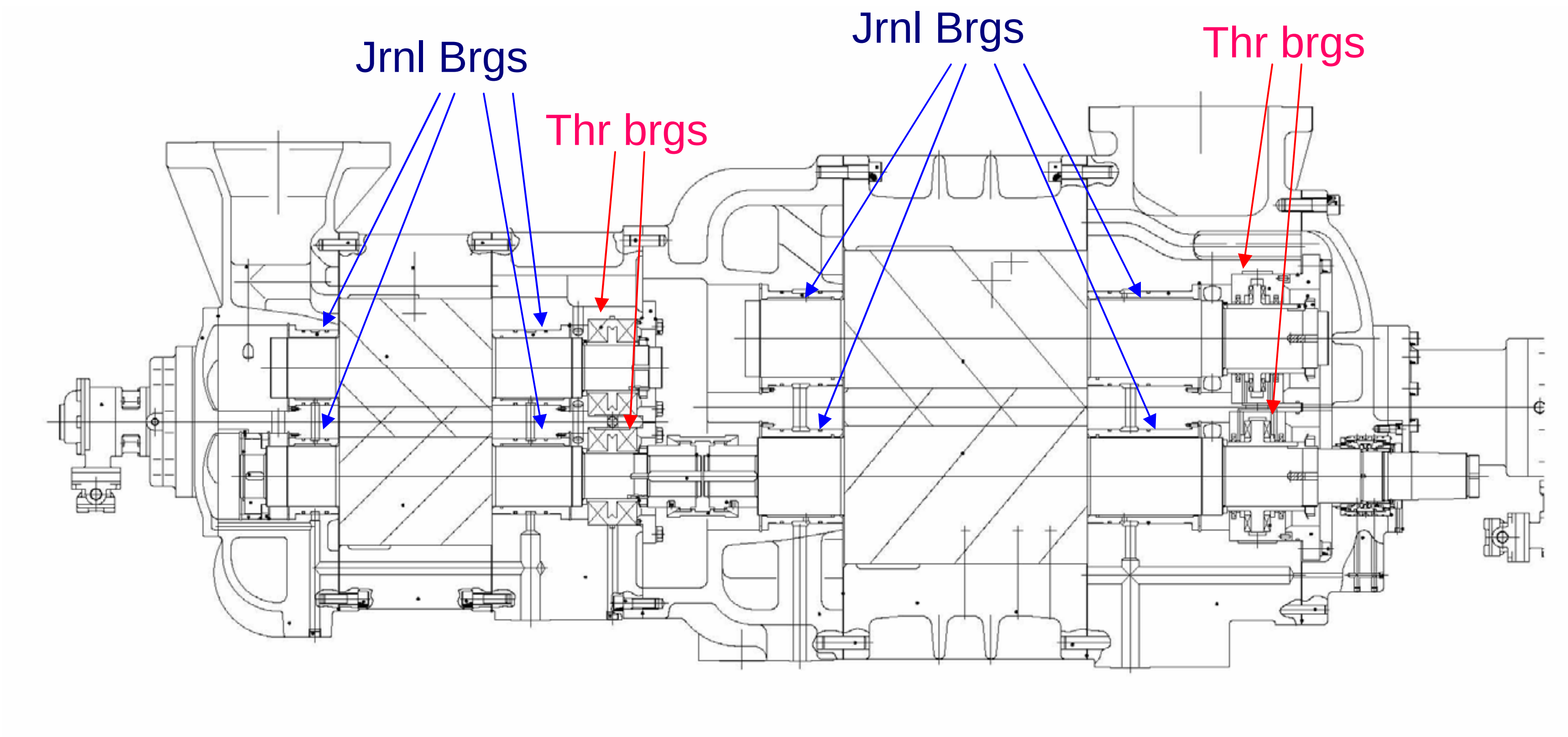
Introduction

- 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

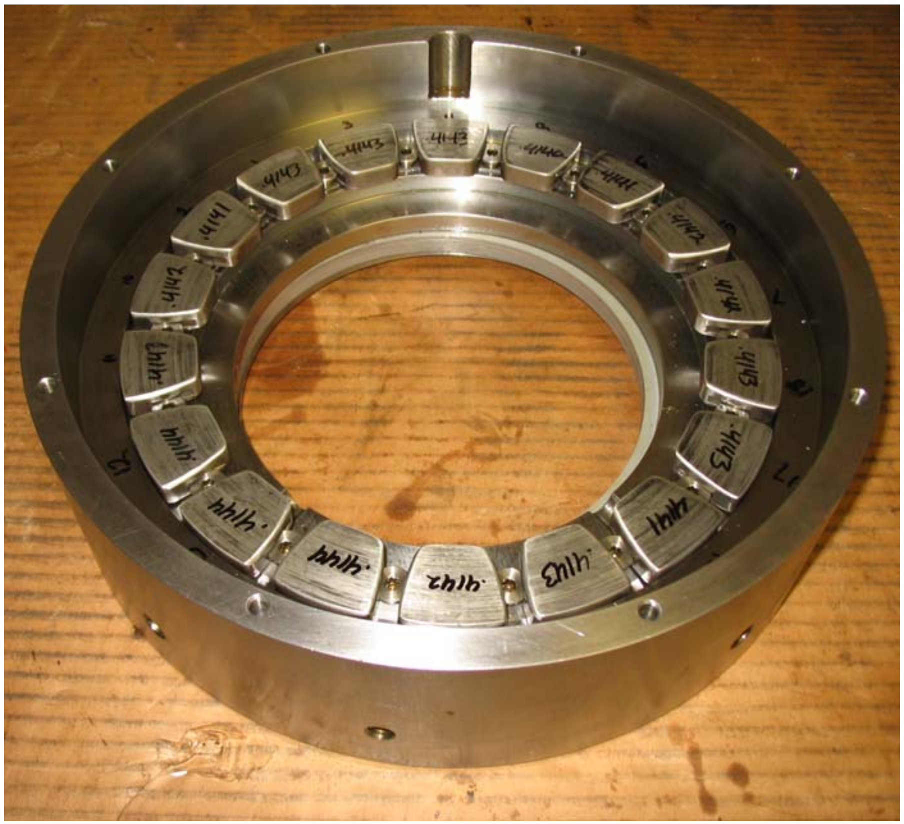


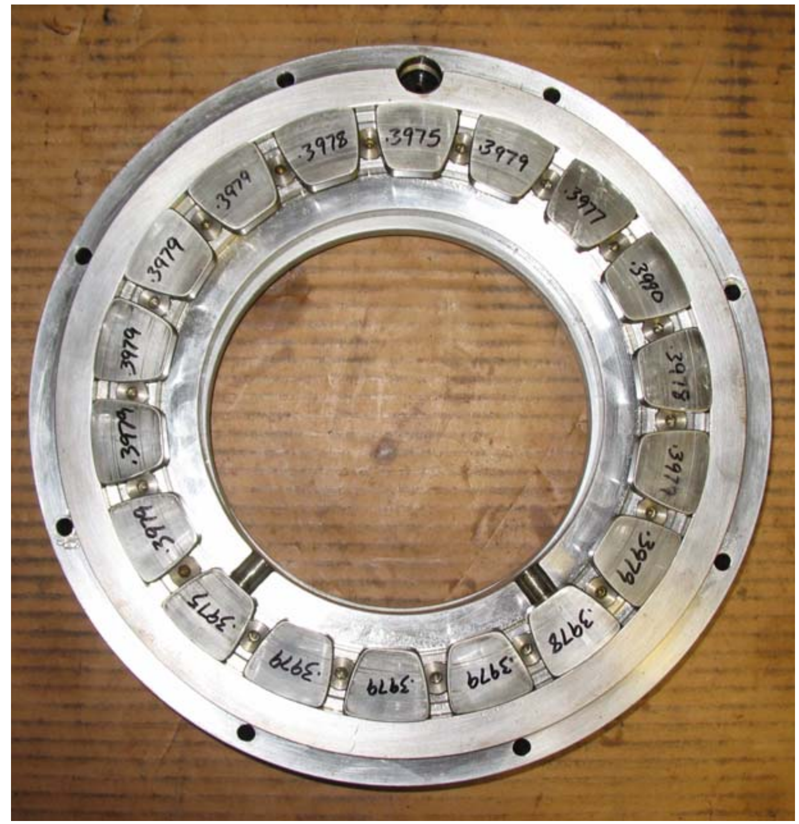
High pressure case

Low pressure case

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

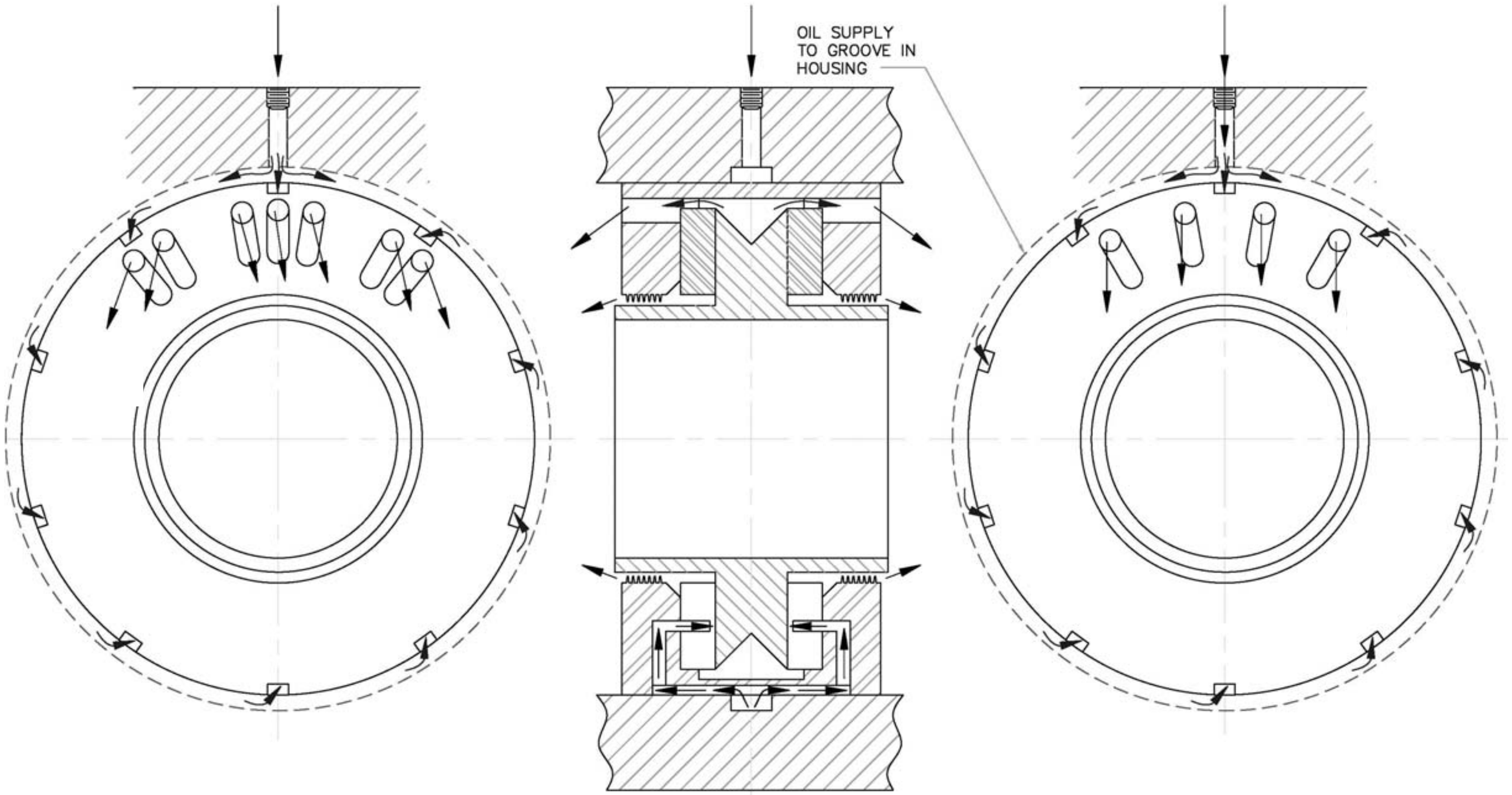
Thrust Bearings

- 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

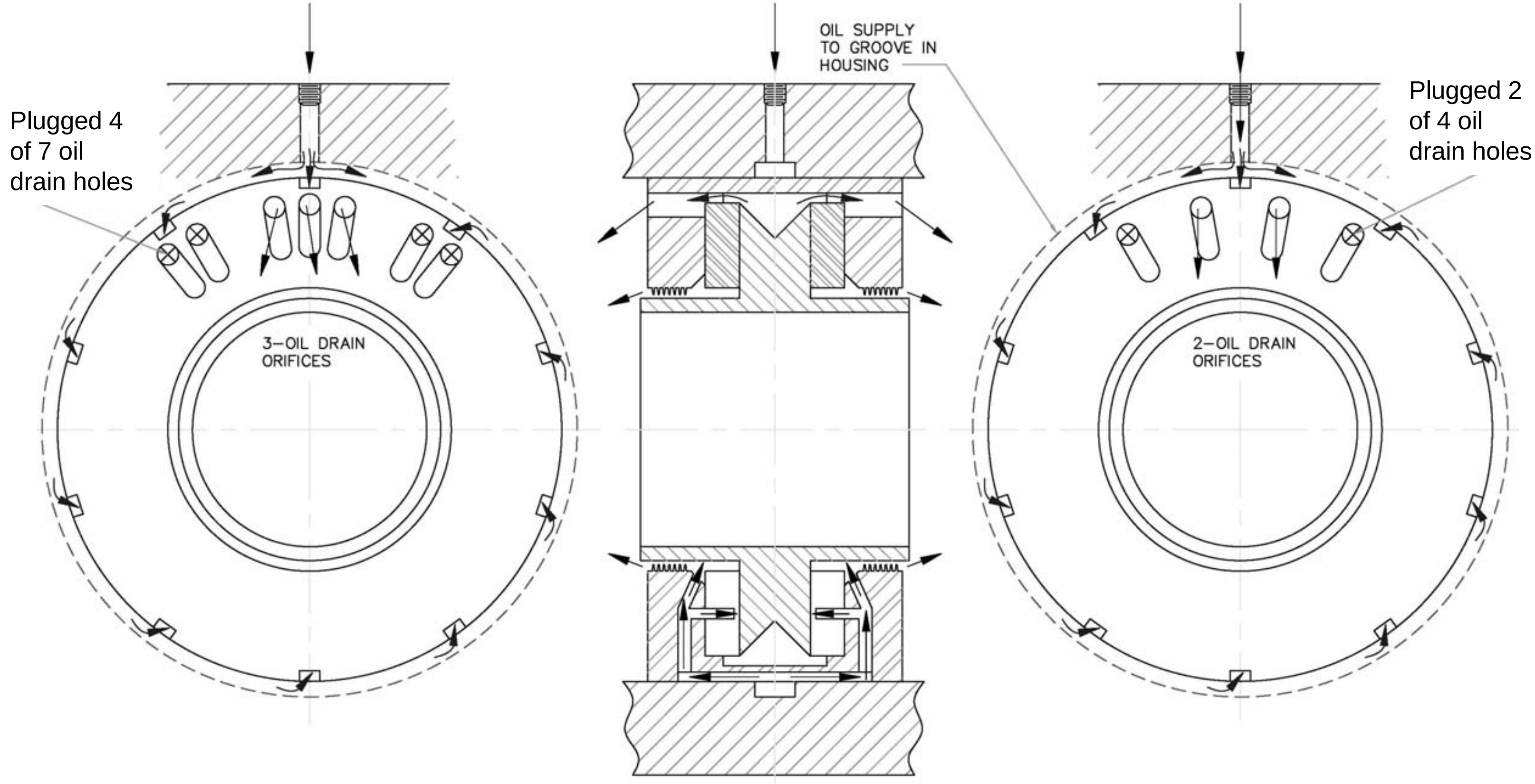
- With drain orifice control the oil pressure drop is taken ***after*** the bearing is lubricated
- With supply orifice control the pressure drop is taken ***before*** the bearing is lubricated.
- Concern that there may have been some degassing of the oil as it took the pressure drop – limiting load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

Thrust Bearings



Oil flow controlled by inlet orifices

Thrust Bearings



Oil flow controlled by outlet orifices

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)

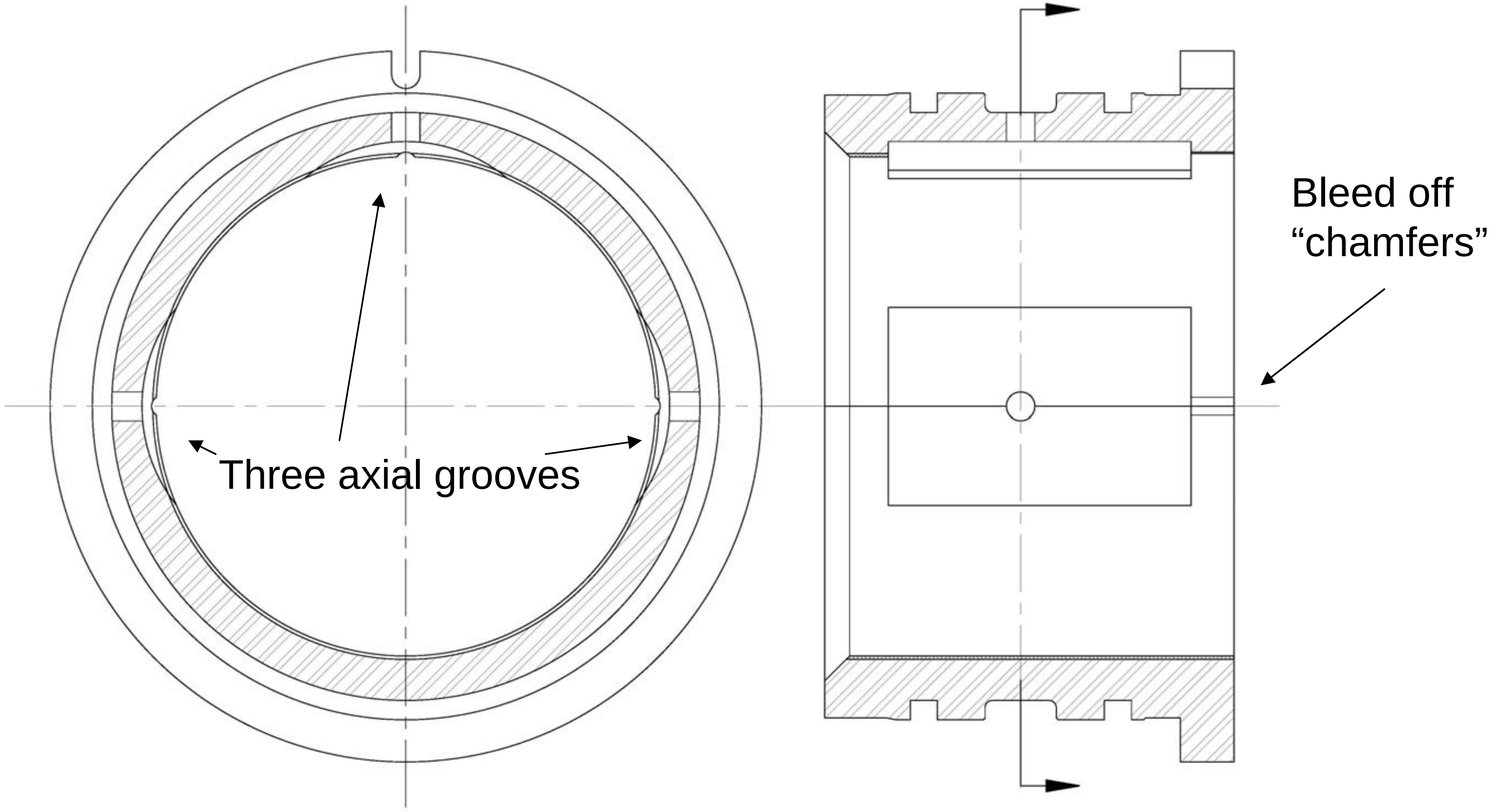
Journal bearings

Journal Bearings

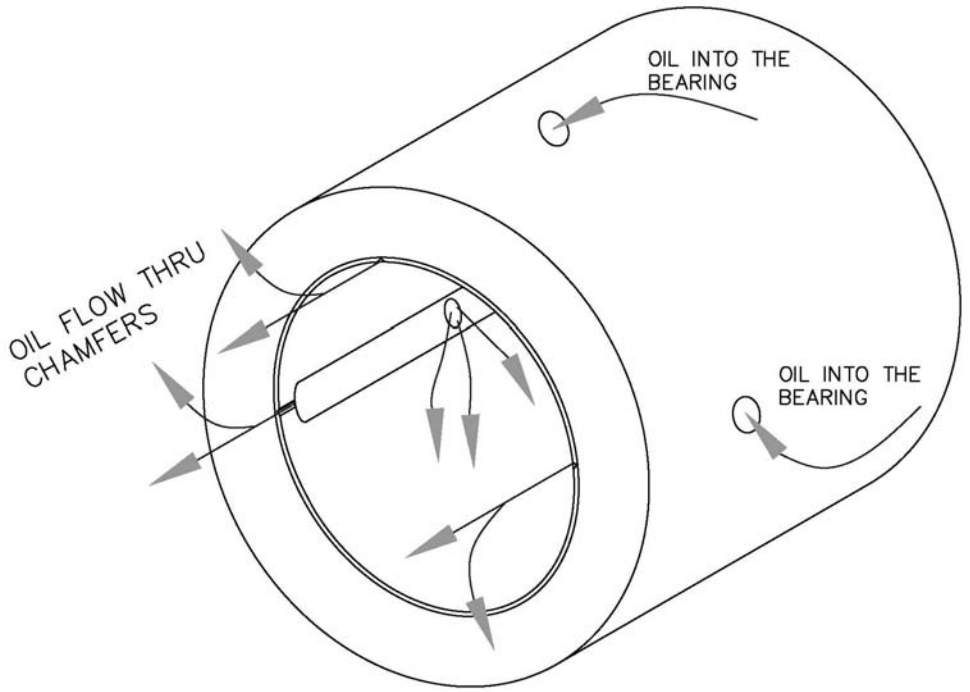
Journal Bearings

- 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



Journal Bearings



CHAMFER FLOW

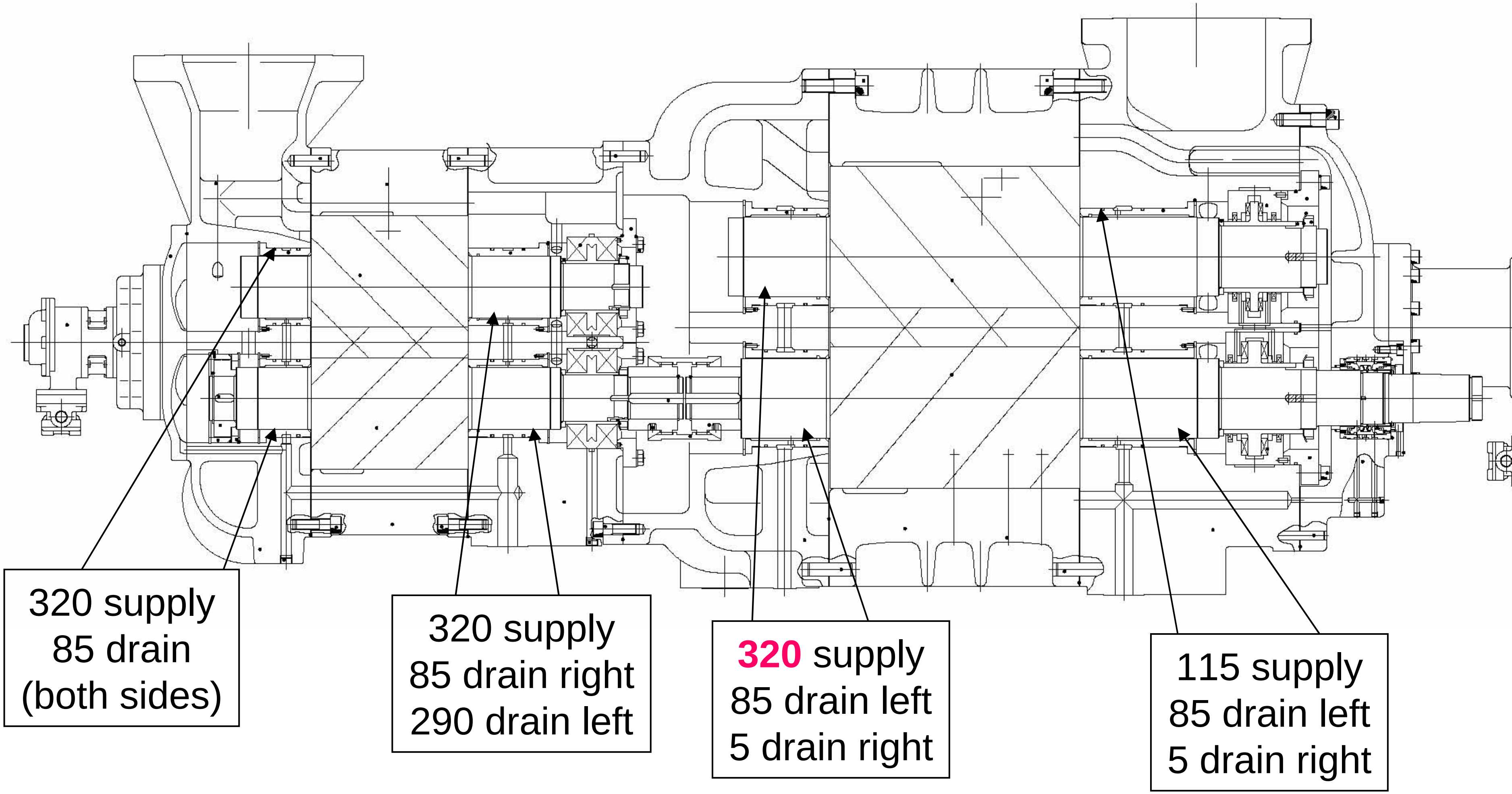
Journal Bearings

- 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)



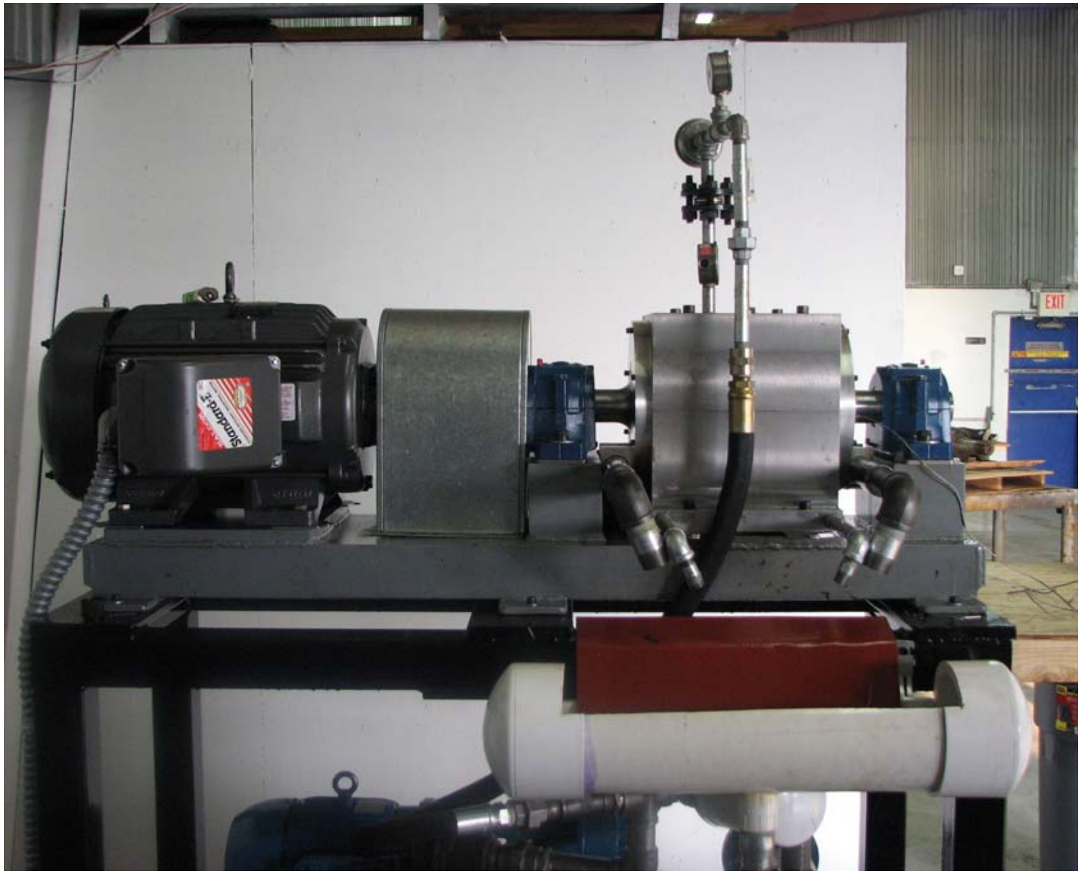
Journal Bearings

- 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

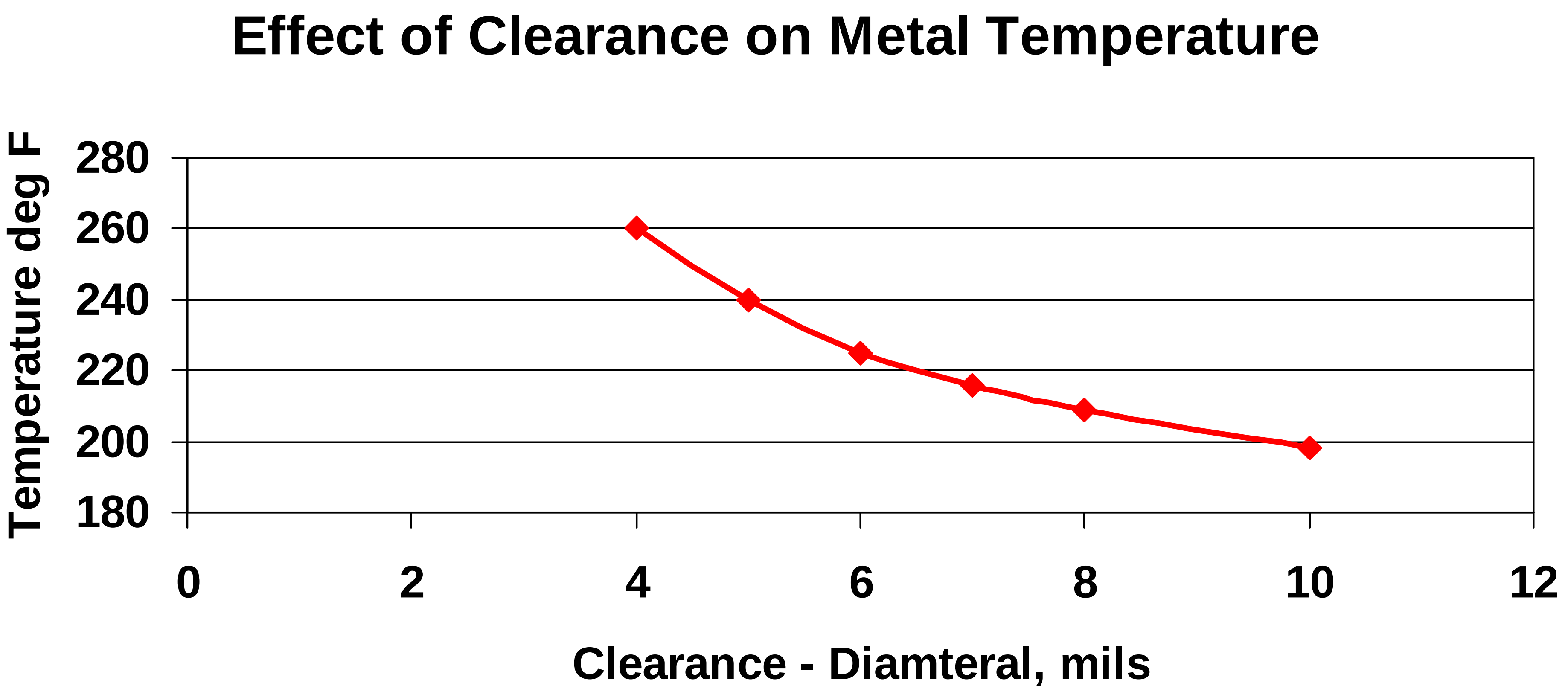


Test rig

Test rig

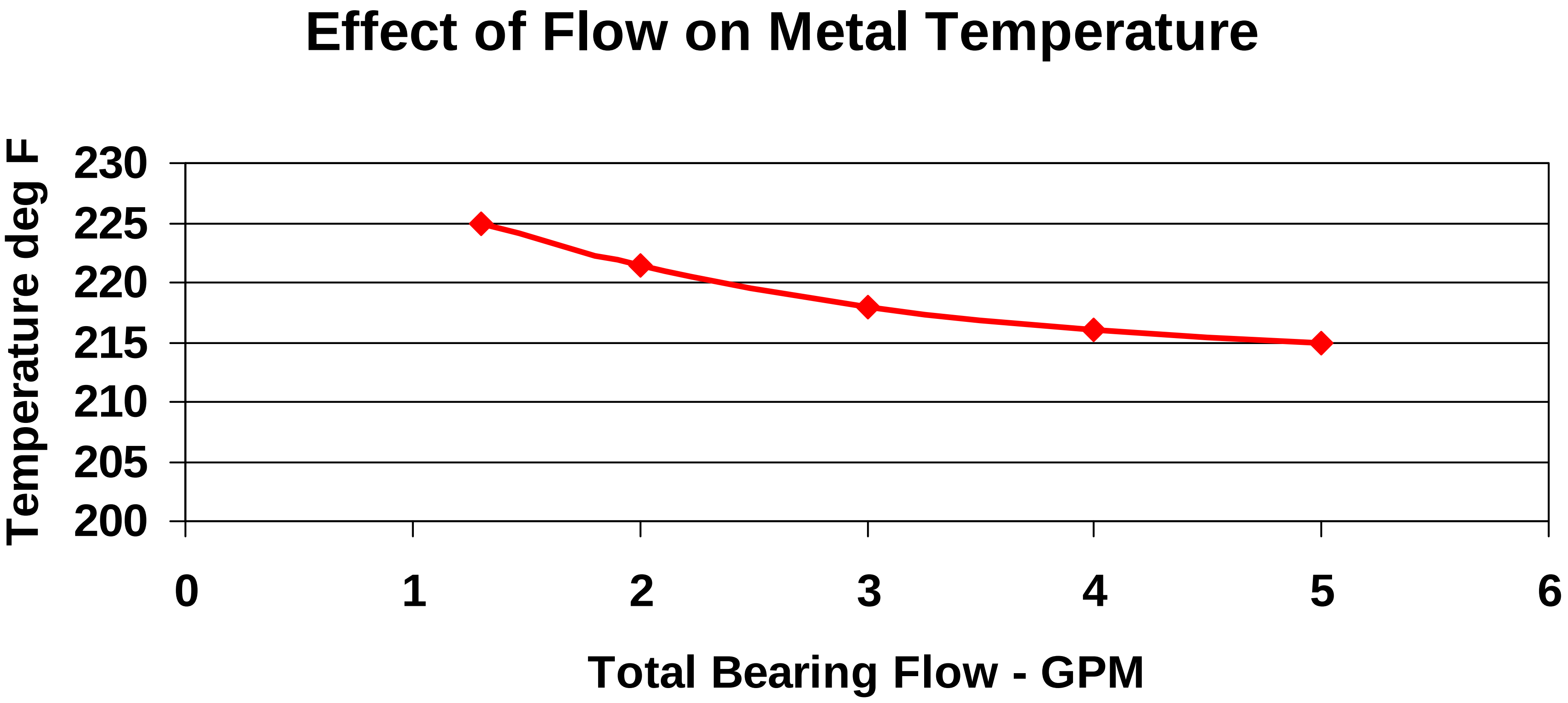
- Tested various configurations under actual operating speed.
- Utilized actual bearings and modified for
  - Different “chamfer” configurations
    - Size and number
  - Different clearances
- Tweaked analysis
  - “side” leakage agreement with computer code
  - Chamfer flow coefficients

Journal Bearings



Assumed load of 200 psi, no chamfer flow

Journal Bearings



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