



ASIA TURBOMACHINERY & PUMP SYMPOSIUM
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Investigation of High Bearing Temperature in Centrifugal Compressor

ExxonMobil
Chemical



**MITSUBISHI HEAVY INDUSTRIES
COMPRESSOR CORPORATION**

TEES
**TURBOMACHINERY
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Contents

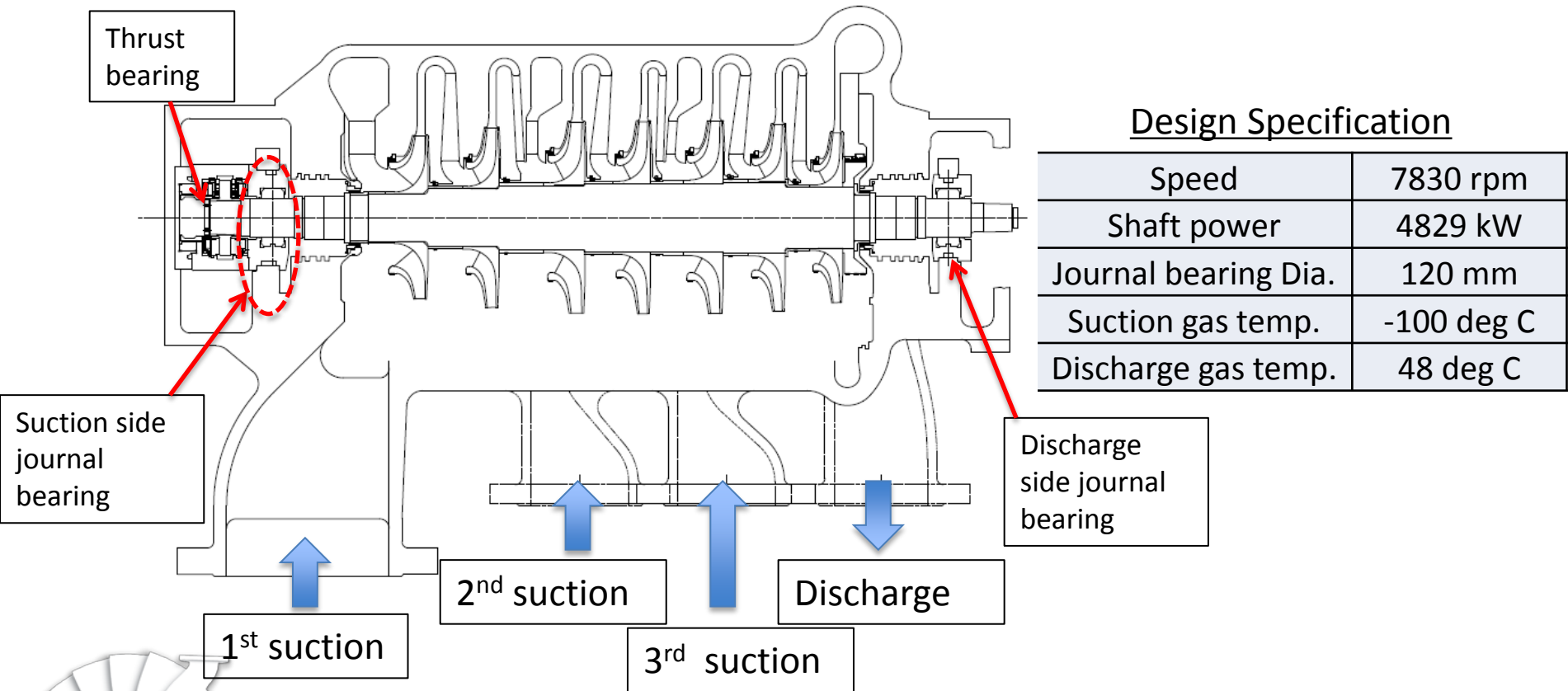
- Abstract
- Machine construction and specification
- Phenomenon
- Root cause analysis
- Observation
- Possible scenario
- Operation data review at start-up condition
- FEM analysis result
- Countermeasure and result
- Conclusion



Abstract

- Suction side Journal bearing temperature increased to around 130 degC from 60 degC instantaneously. Further the temperature was decreased to 80 degC accompanied by increase in rotor vibration.(from 5 to 15 μm p-p)
- Bearing was inspected and damage to bearing pads was found.
- Horizontal side bearing clearance was decreased because of shrink the casing at low suction temperature.(roughly -100 degC)
- As countermeasure, bearing clearance was increased.
After that, bearing temperature became stable.

Machine construction and specification



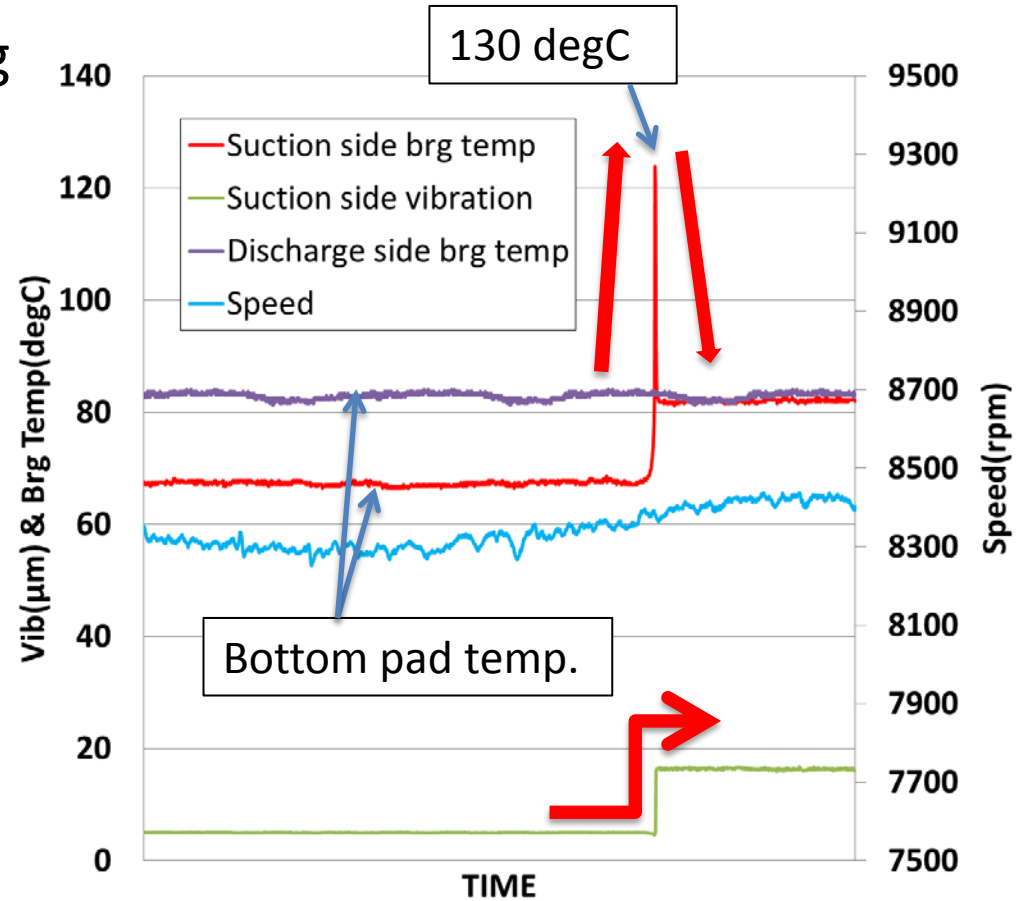
Design Specification

Speed	7830 rpm
Shaft power	4829 kW
Journal bearing Dia.	120 mm
Suction gas temp.	-100 deg C
Discharge gas temp.	48 deg C

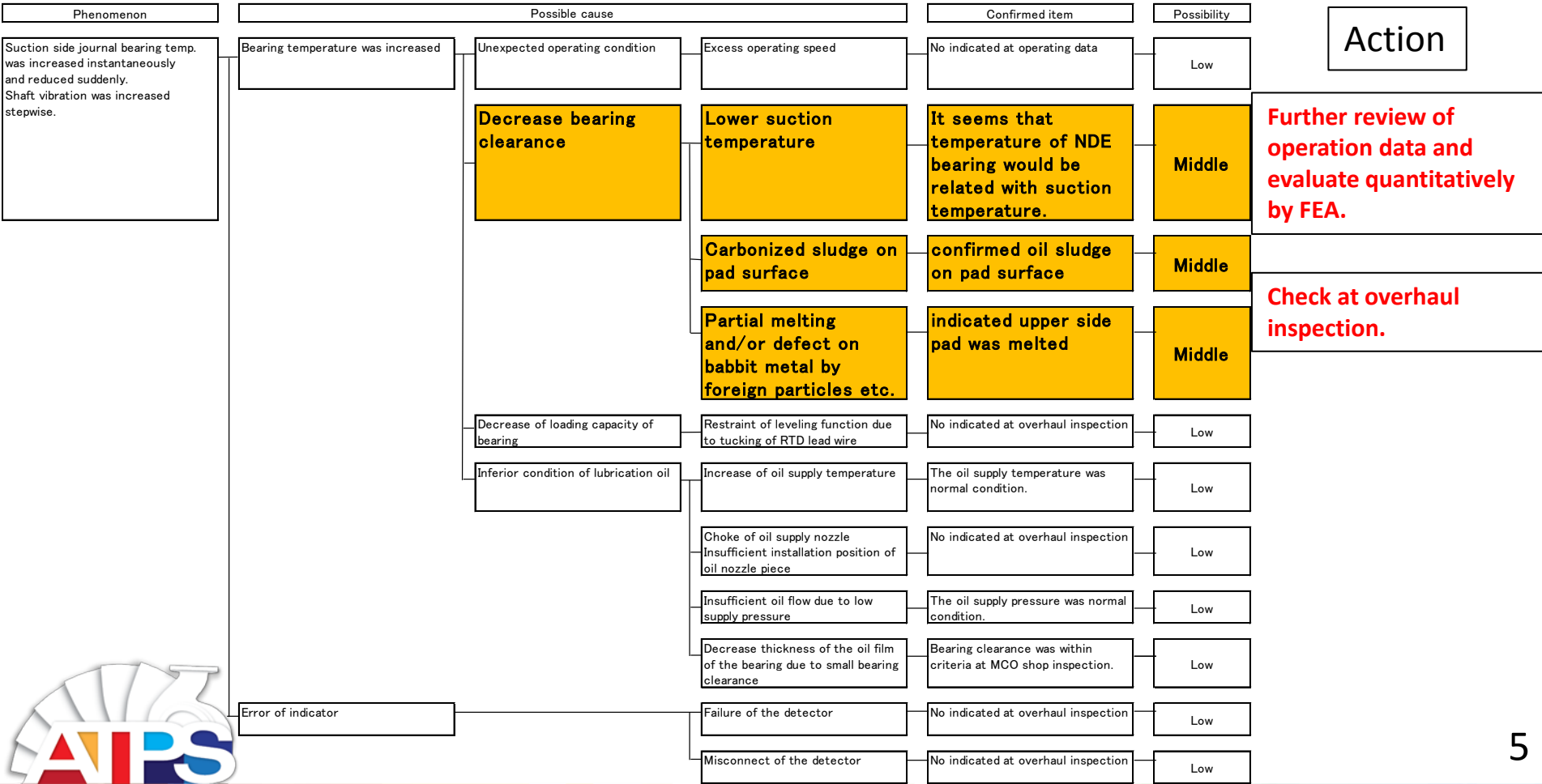


Phenomenon

- Suction side journal bearing temp. was increased instantaneously and reduced suddenly. (65 => 130 => 80 degC)
- Bottom pad temp. was too low before it spikes.
- Shaft vibration was increased stepwise. (5 => 15 μm p-p)

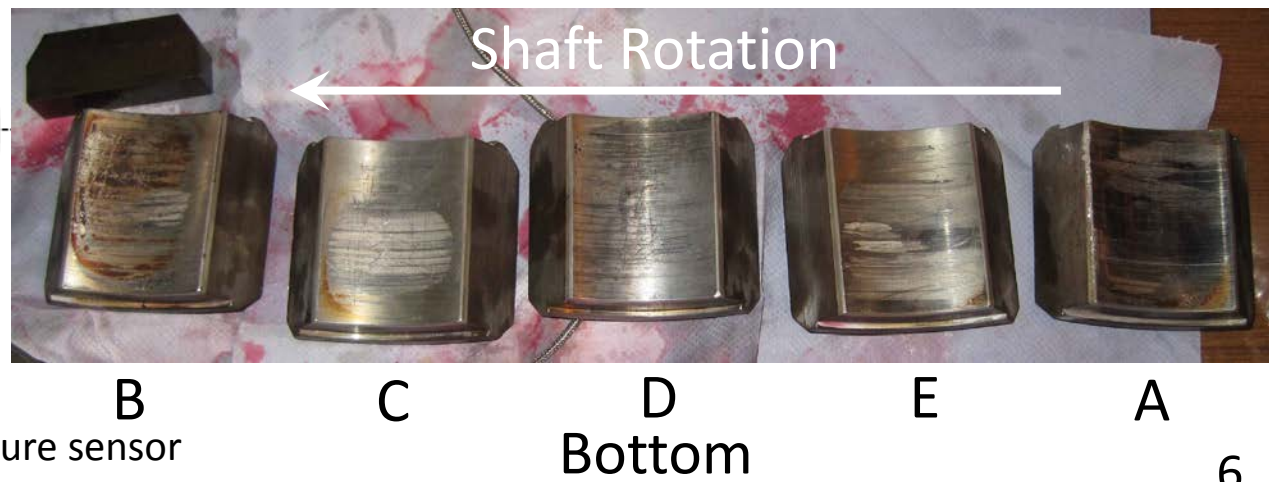
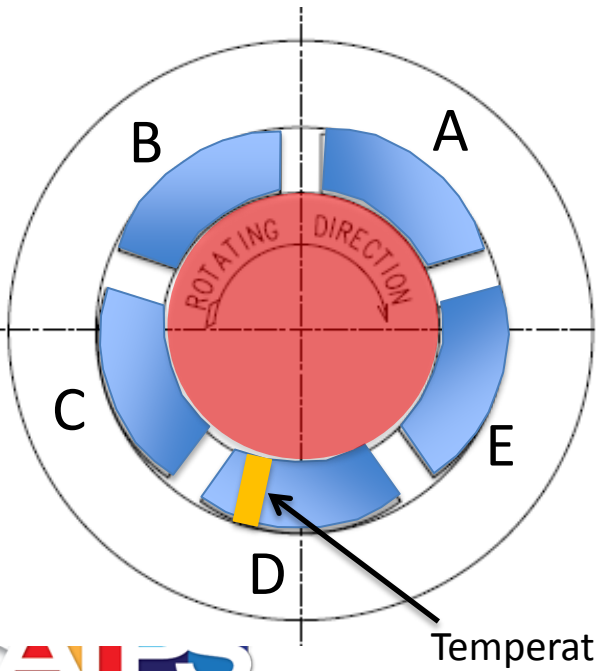


Root cause analysis



Observation at overhaul inspection

- Damage was identified on suction side journal bearing pad except for bottom pad.



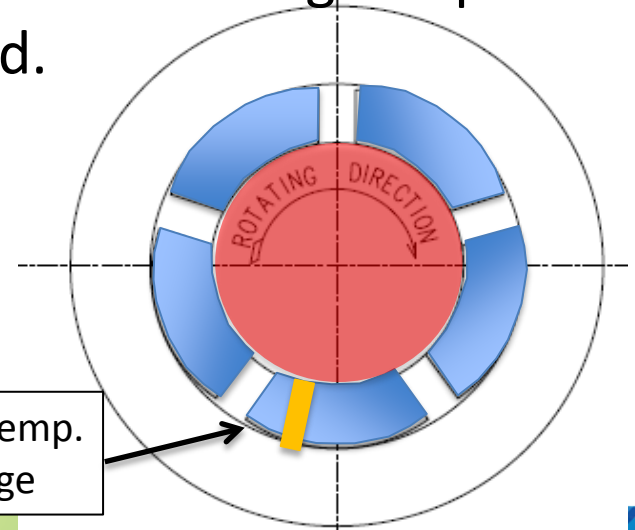
Observation result

- Suction side bottom journal temp. was too low indicating abnormal condition.
- Based upon the disassembly inspection, pads were found to be in damaged condition.

Uncertain Points

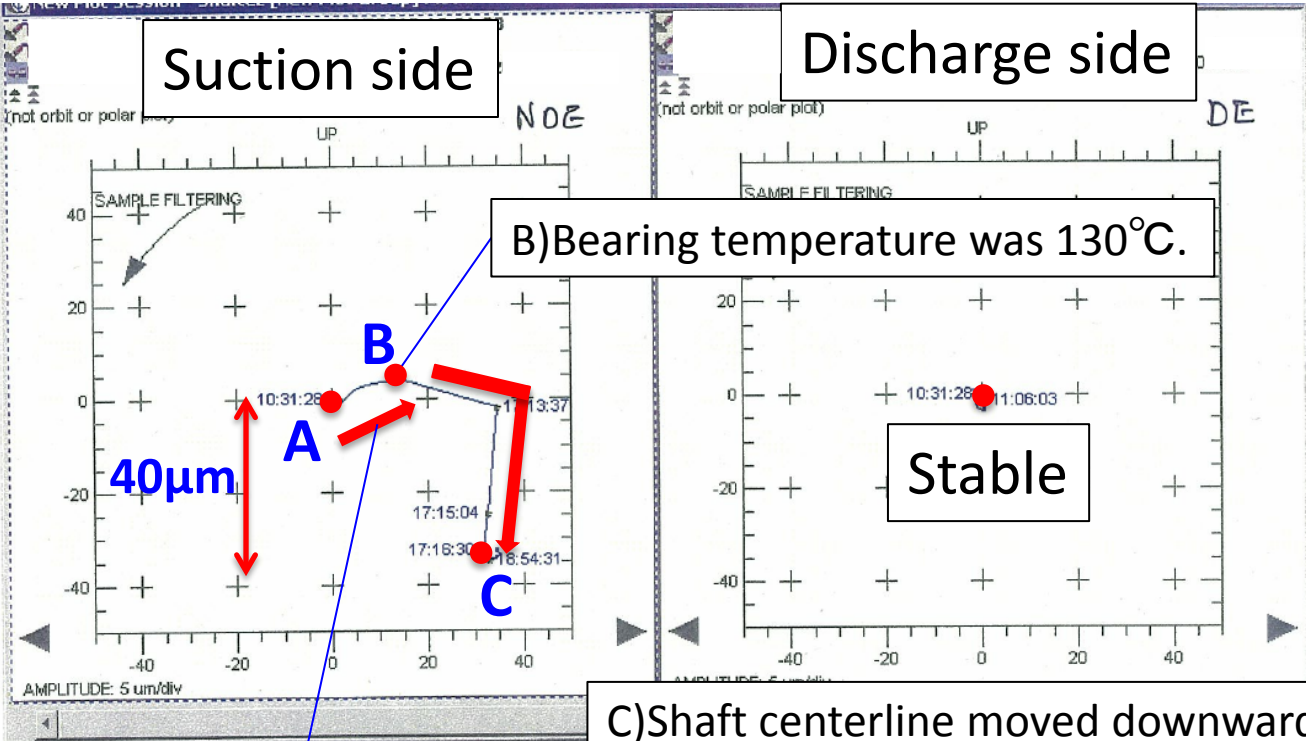
- Before temperature spike, suction side bottom bearing temp. was too low and no damage on the bottom pad.
- What is the trigger of temp increase?

⇒ **Checked more operation data**



Observation at shaft vibration data

Shaft position moved only at suction side, discharge side was stable.



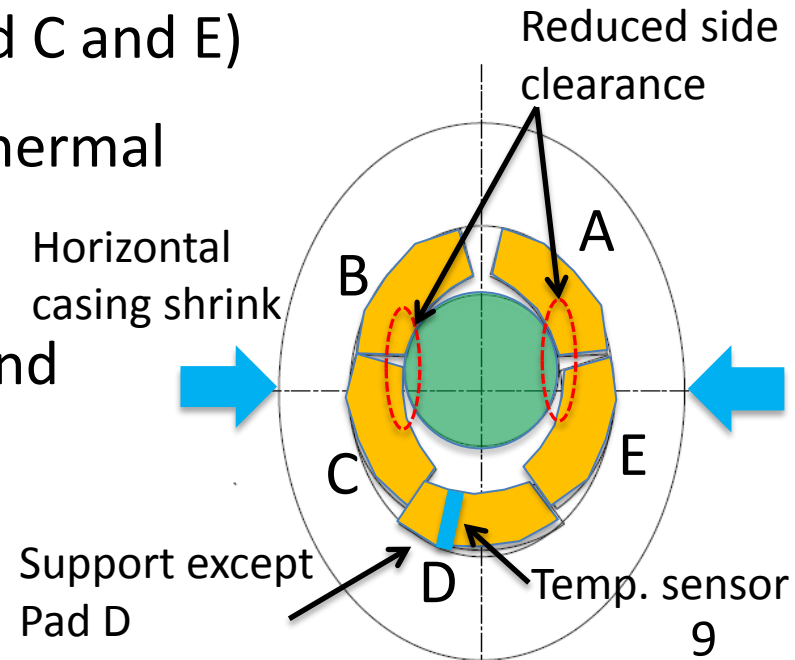
B) Bearing temperature was 130°C.

A) Shaft position moved 15µm during temperature rise.

C) Shaft centerline moved downward 40µm during temperature decrease. This would be caused by bearing damage (reduce white metal thickness).

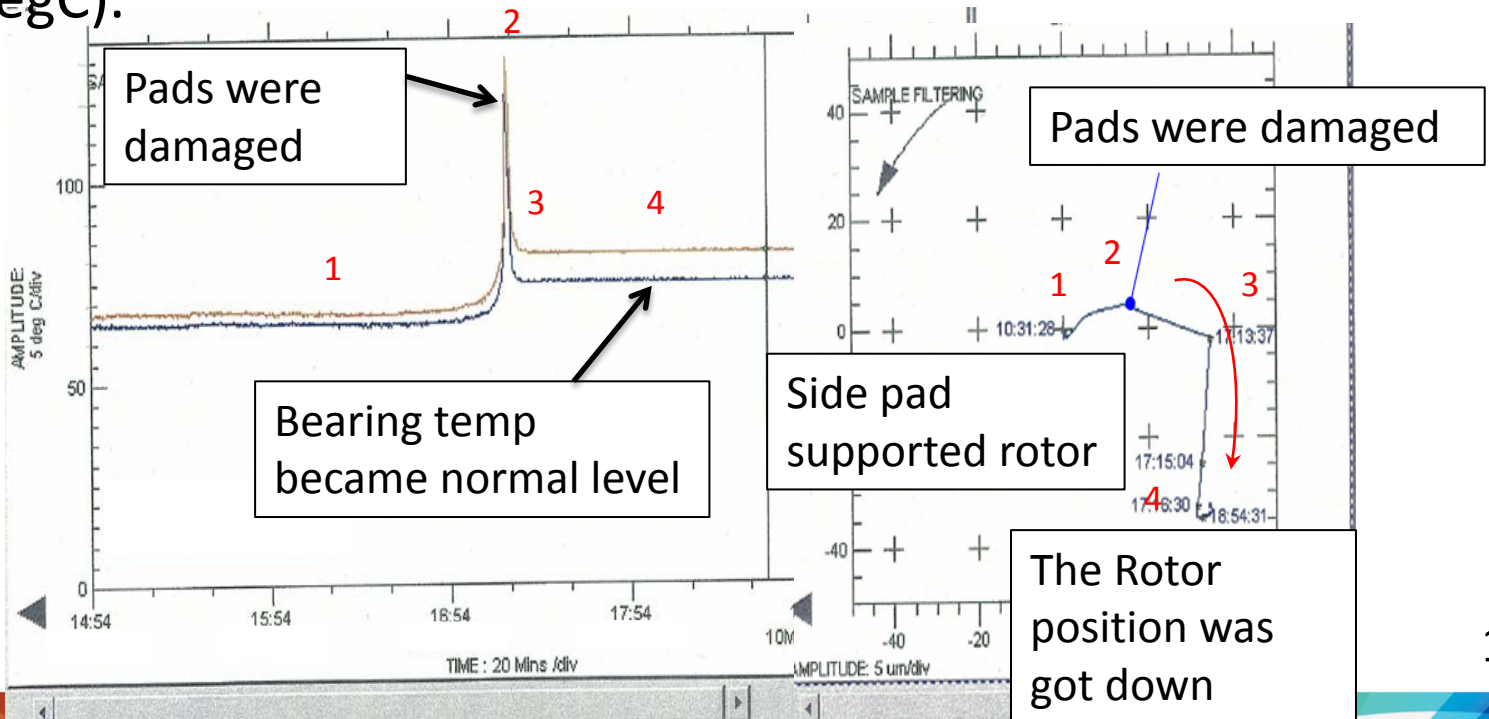
Possible Scenario

1. Casing shrinkage by low temp. suction gas.
2. Bearing clearance was decreased in horizontal direction.
(Bearing housing was compressed in horizontal direction.)
3. Rotor was supported by side pads. (pad C and E)
4. It made the clearance smaller due to thermal expansion of bearing pads and shaft.
Then, it generated much higher heat and finally damaged.



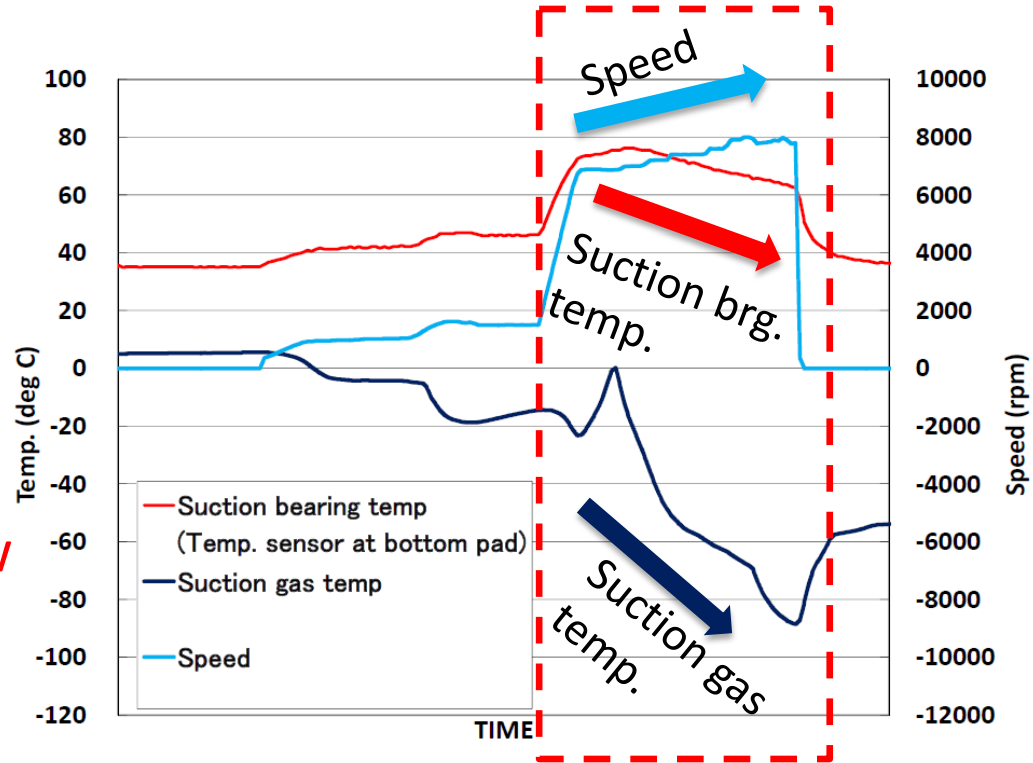
Possible Scenario

- 5. Bearing clearance was increased by melting of babbitt metal.
- 6. The rotor position was got down.
- 7. After that, bottom pad temperature became to normal level (75-82 degC).



Operation data review at start-up condition

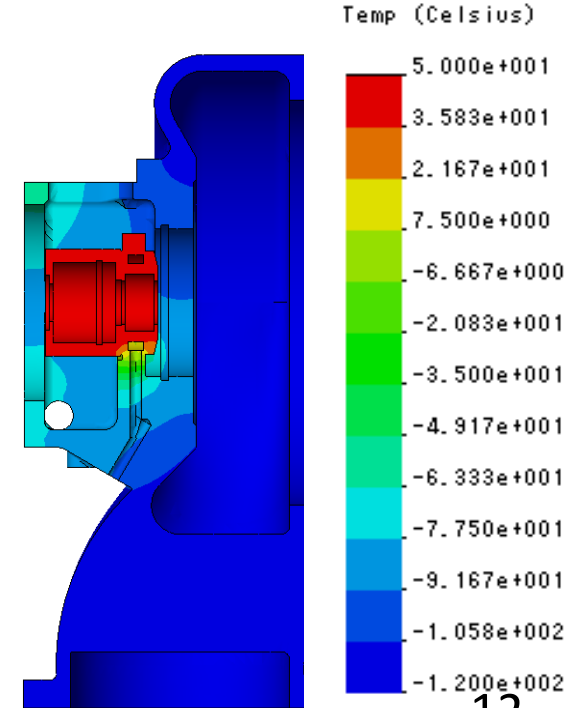
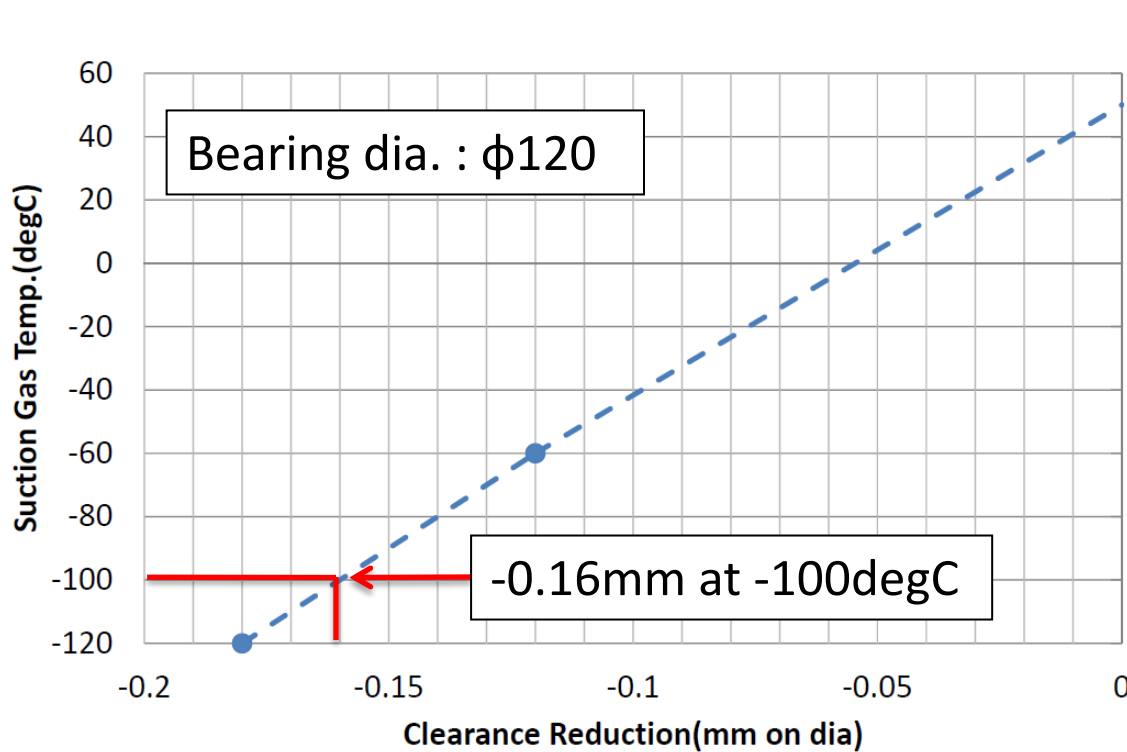
- When suction gas temperature was decreased, bearing temperature also decreased, though the operating speed was increased.
- This also affirms the below possible scenario.
- Bearing clearance in horizontal direction was decreased by low temp. gas.
- Rotor was supported by side pads, and the load on bottom pad was decreased.



FEM Analysis Result

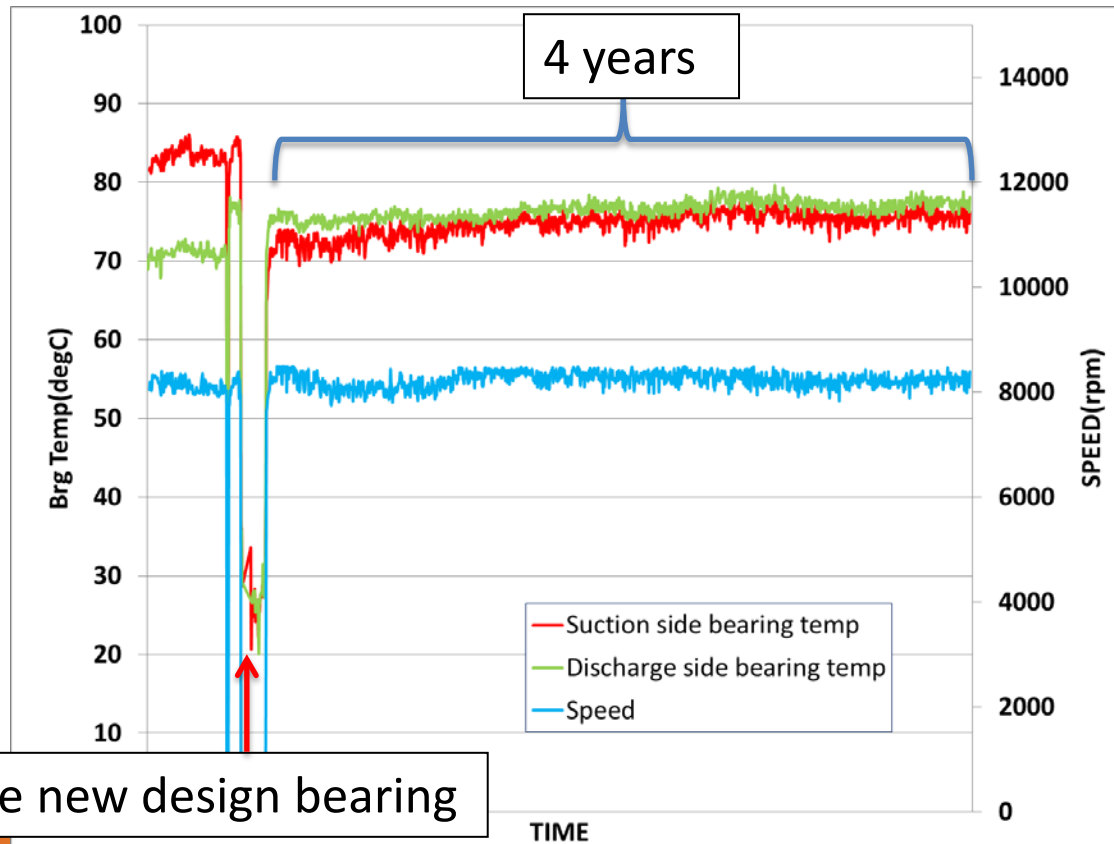
Suction gas temperature and bearing heat by the rotation were considered into the analytical model.

Reduction amount is 75% at -100deg C of normal bearing clearance.



Countermeasure and result

As countermeasure, journal bearing clearance was increased.
Journal bearing temperature could be stable.(70 to 80 degC)



Replace new design bearing



Conclusion

1. Suction side bearing was damaged by the following steps.
 - a.Low temp suction gas
 - b.Casing shrinkage
 - c.Smaller clearance in horizontal direction
 - d.Higher load except for the bottom pad and damage on bearing pad
2. After clearance increased, journal bearing temperature is stable.
3. In this case, even though the journal bearing metal had been melted, the vibration level was sufficiently low and stable operation could be continued. But, in case of abnormal behavior is observed(e.g. temp spike in this study), it is very important to analyze what was happened and what was the reason of it .In this study, user and OEM made the detail review of operation data, discussions and RCA for reliable long term operations.