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Presentation on

Reliability improvement of Coker Charge Pump

GUJARAT REFINERY
Where growth is essence of life

By

GUJARAT REFINERY
INDIAN OIL CORPORATION LIMITED (IOCL)

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REFCOMM
BAHRAIN
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Introduction of Presenters

Sunil Kanti *is Chief Maintenance Manager for IndianOil Corporation Ltd. He has 21 years of experience in Maintenance and Commissioning in various positions. He has done, B.Sc, B.Tech in NIT-Rourkela and Management of Education Program in IIM-A. He is Six Sigma Black Belt certificate holder.*

K V Prasad Rakoti *is Senior Engineer for IndianOil Corporation Ltd. He has been working for 7 years. He was conferred upon the Samuhik Upalabdhi Puruskar (Best Suggestion-Team): 2013-14 in Gujarat Refinery. He got gold medal in 2014 at Quality Circle Forum India for presenting best Kaizen.*

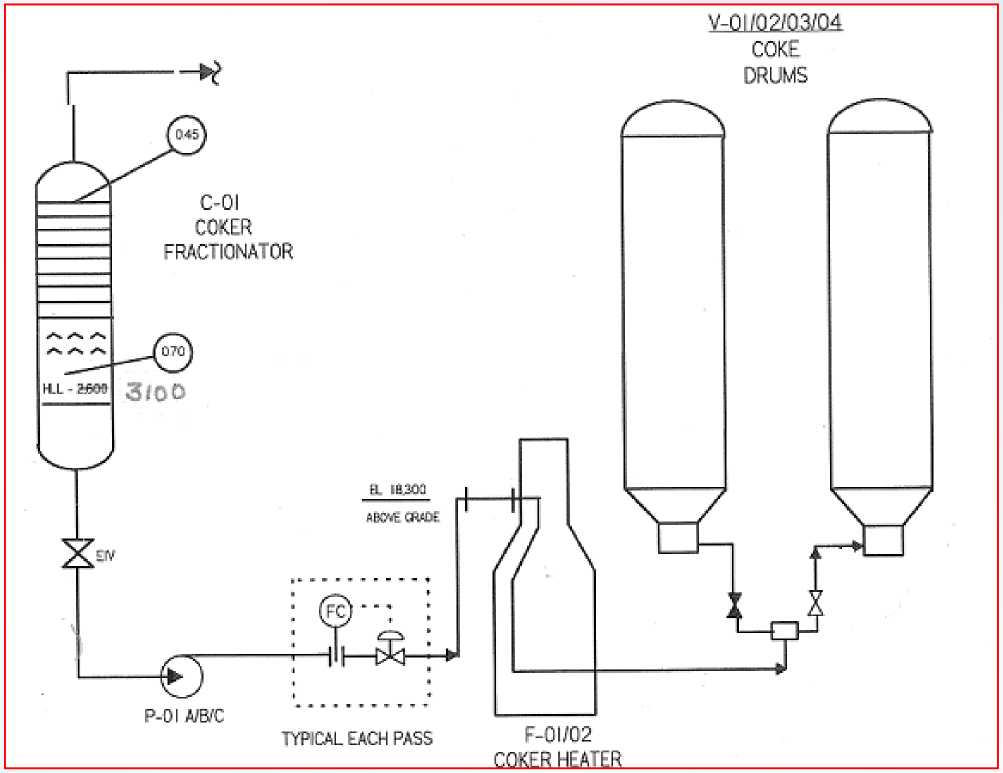
Agenda

- System Description
- Problem Definition
- Root Cause Analysis
- Implemented Actions
  - Short Term
  - Major Modifications
- Achievements
- Q & A

System Description

- Delayed Coker Unit (3.7MMTPA) of Gujarat Refinery is having 4 Drum Operation with Two heaters (2 drums/heater) and three Charge Pumps was Commissioned in April 2011.

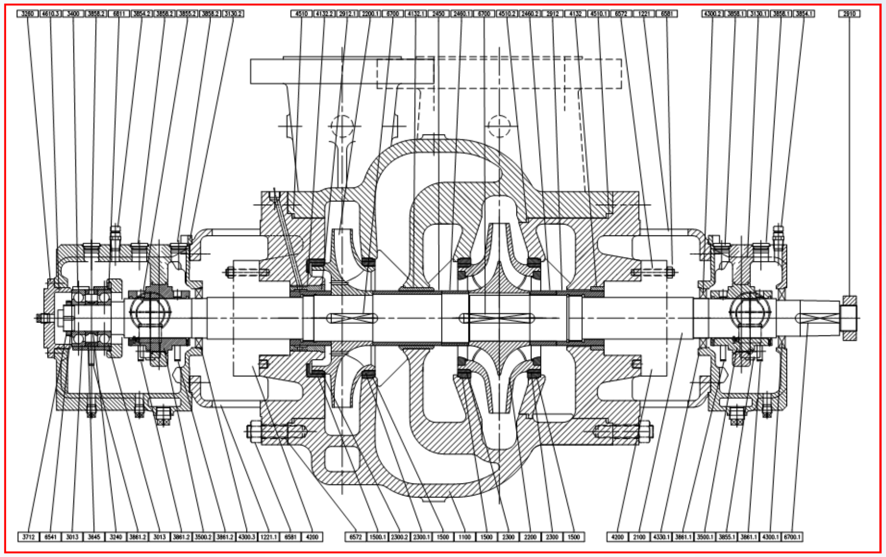
- Coker Charge Pumps, pumps the VR+RCO at 270 Deg C through coker heater as charge to the coke drums.



System Description

- **Three Heater charge pumps**
  - **Two pumps running in parallel and third one as stand by. Pump-A is Turbine drive and other two are Electrical drive, Motor.**

- **Pump Details:**
  - **Flow:295.4m3/hr@ 574.74m, 1100KW,**
  - **Make: Flowserve**
  - **Model: 8HED 16 DS**
  - **Between bearing**
  - **Two stages, 1st Stage impeller double suction, double seal**



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System Description

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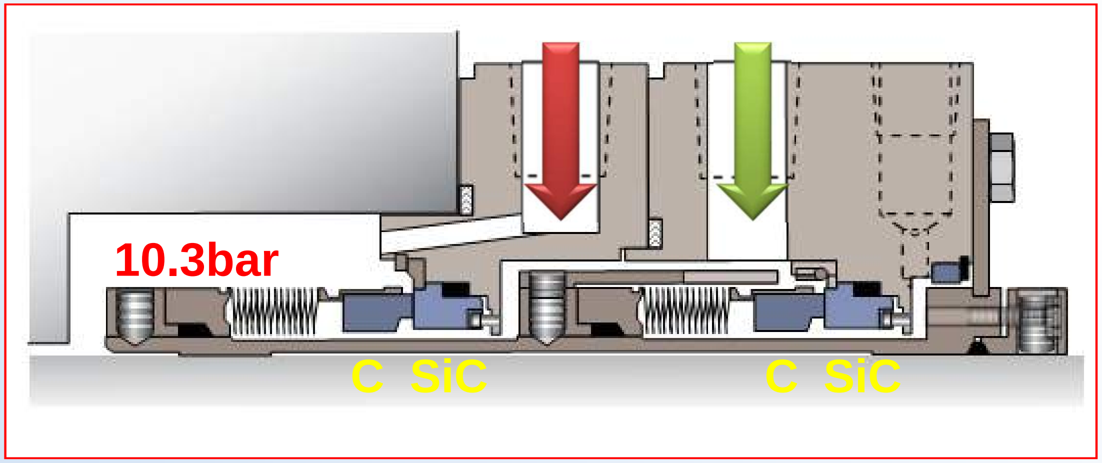
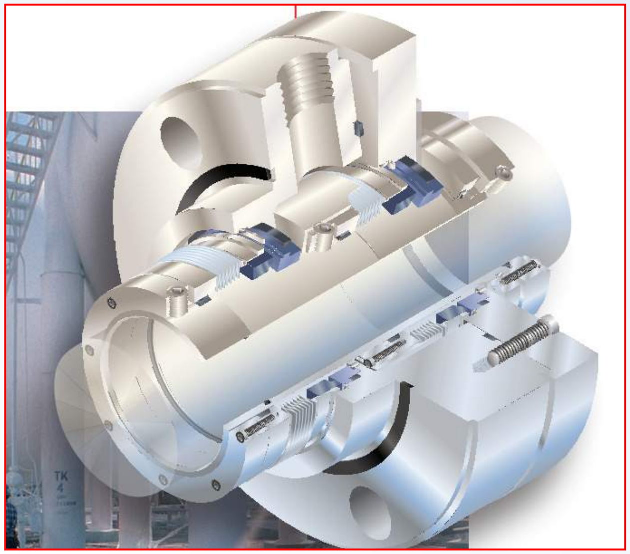
Mechanical Seal:

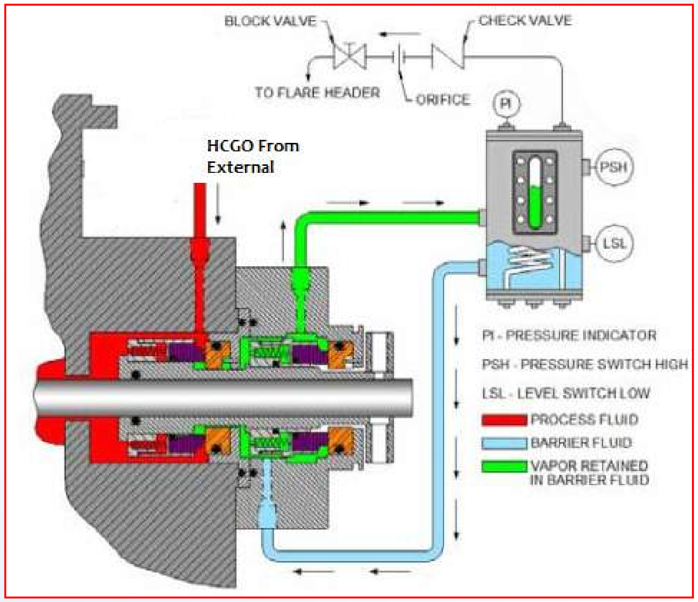
- Make: Flow Serve Sanmar
- Model: BXHH / BXHH
- Size: 4.500 in / 4.500 in
- Arrangement: Dual Unpressurized Seal
- Face Combination: C (R-Bellow) vs SiC (S)
- Stuffing Box Pressure: Max 10.3 bar





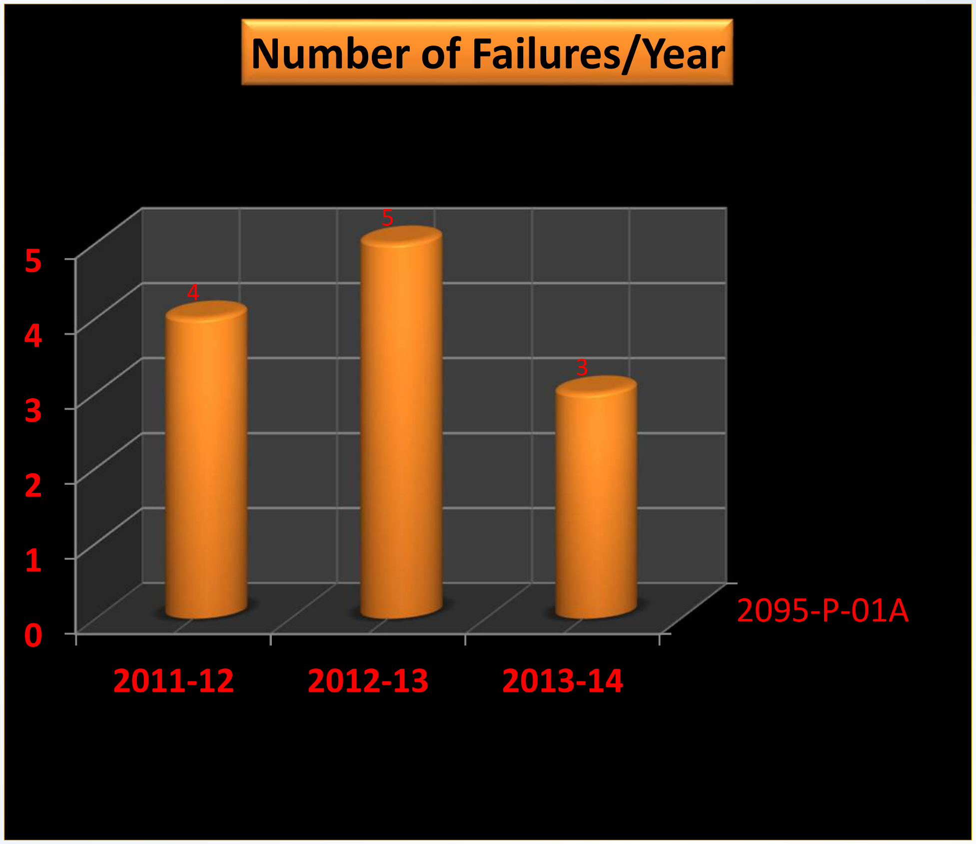
API Seal Flushing Plan: 32(HCGO)+52(Servo prime 46T)

- Plan-32:
  - Primary Seal Flushing Plan
  - HCGO @4-8L/min
- Plan-52:
  - Secondary Seal Flushing Plan
  - Lube Oil (Unpressurized System)



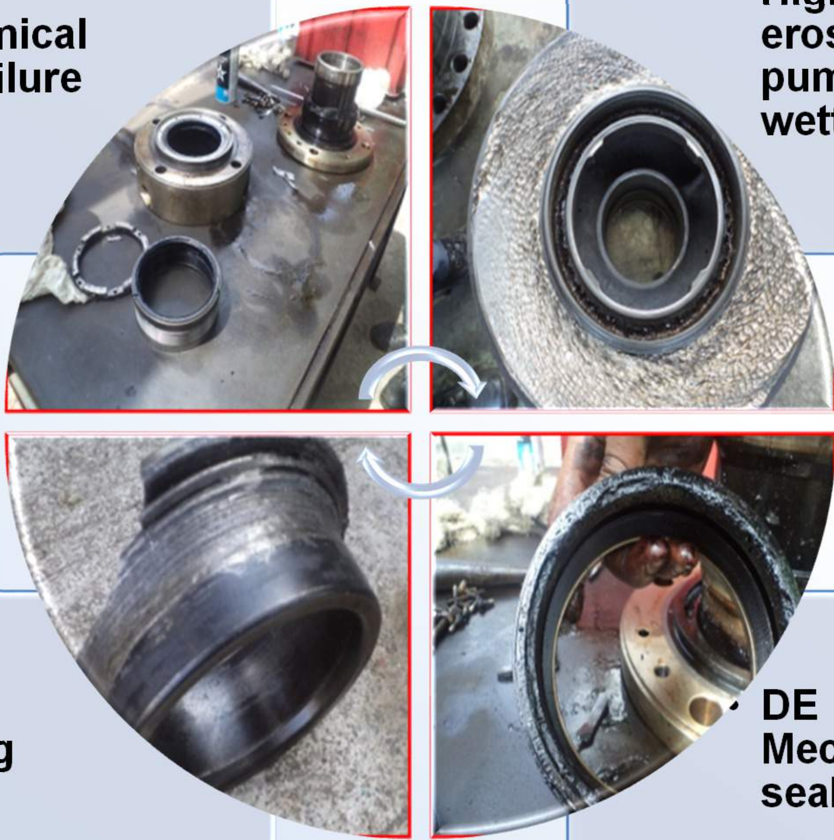
Problem Definition

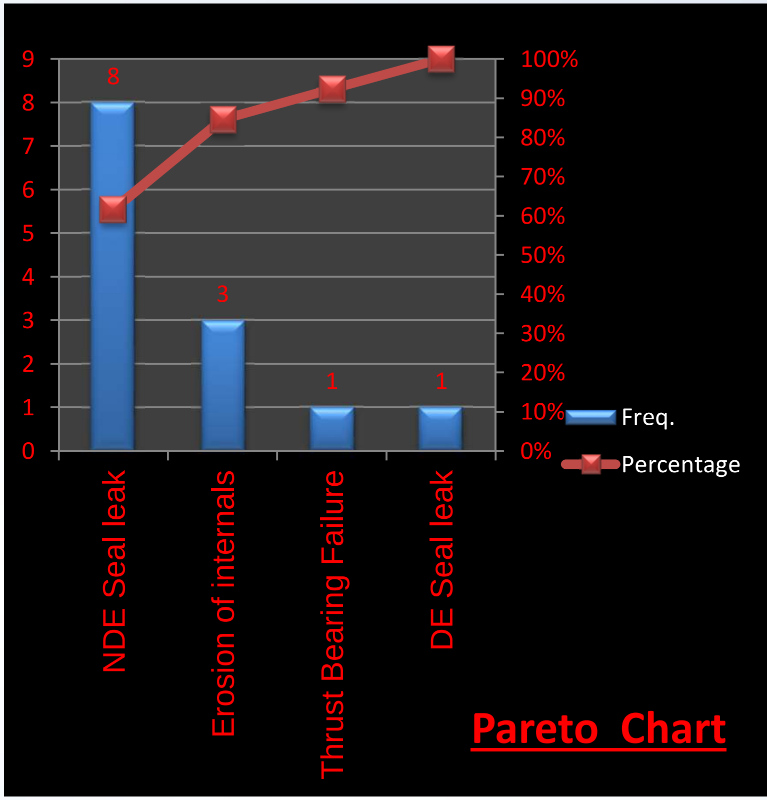
- **Heater Charge Pump History:**
  - Failure rate 3-4/Year
  - MTBF: 100 Day
- **Effect on the Production:**
  - Catches Fire incase of seal leak
  - Unsafe pro area (change over)
  - Reduction in through put
  - Unreliable



Problem Definition

- NDE Mechanical seal failure
- High erosion on pump wetted parts
- Thrust bearing failure
- DE Mechanical seal failure





Pareto Chart

Modes of Failure

Root Cause Analysis

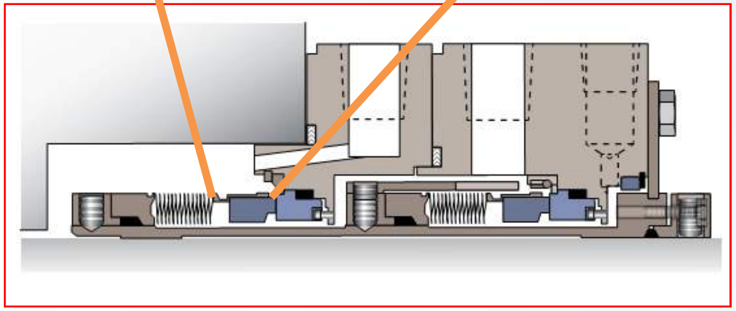
Mechanical seal failure:

Observations: High wear and wear marks on Bellow

Root Cause-1: Insufficient API Plan-32 Seal oil flow

Root Cause-2: Improper selection of seal face combinations

Failed Seal Components



High erosion on pump wetted parts:

Observations: Decrease in discharge Pressure

Root Cause-1: Catalyst carryover through CLO

Root Cause-2: High velocity at wetted areas

Root Cause-3: Cavitation issues

Eroded Components

Pump Casing

Wear Ring

Impeller

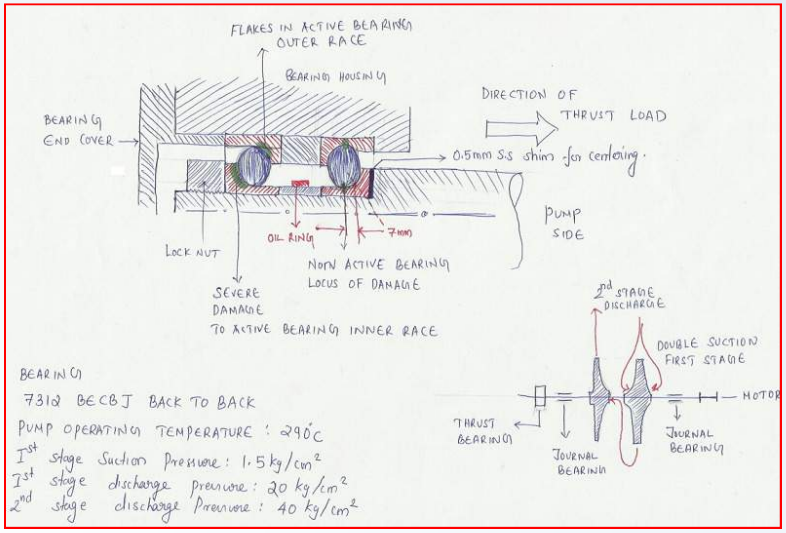
Root Cause Analysis

✸ **Failure of thrust bearing:**

Observations: Dent marks on inner race & Slippage of lock nut

Root Cause-1: Insufficient minimum flow during start up.

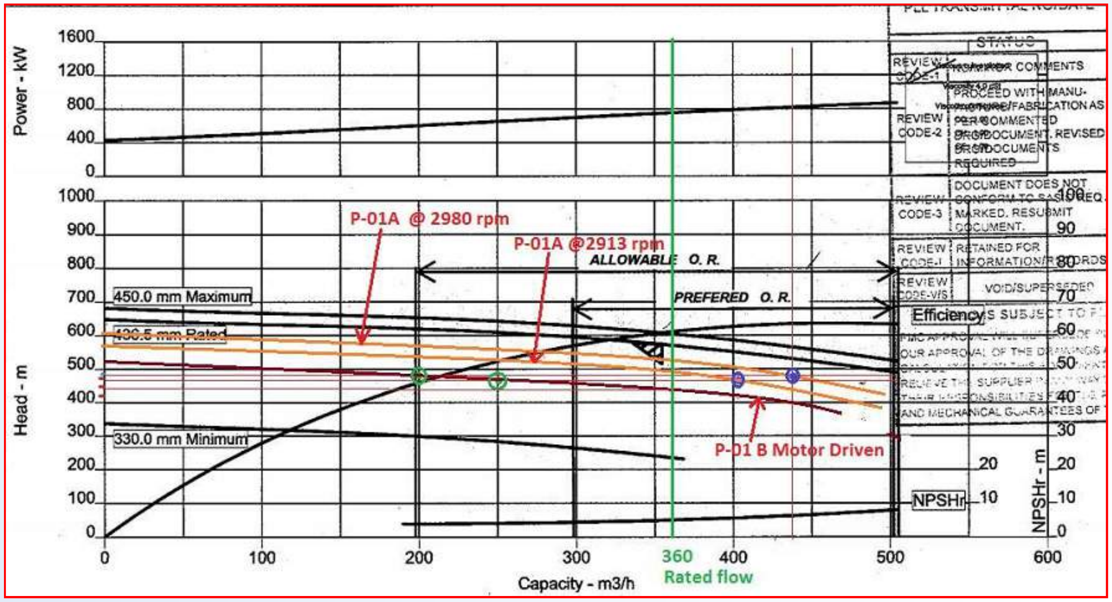
Inner Race



✸ **Problem with the parallel operation:**

Observations: Differences in discharge pressure

Root Cause-1: Due to erosion of internals



Implemented Actions (Short term measures)

- Mechanical seal failure due to low flushing flow after a period of time because of increase in stuffing box pressure over a period of 2-3 months and damage of carbon bellow
  - **Set alarm limits on DCS for Plan-32 Flow**

- High erosion on pump wetted parts, caused by Catalyst carryover through CLO from FCCU (mixed in feed tank), high velocity at wetted areas and cavitation problem
  - **Replaced the pump internals with available spares.**
  - **Modified strainer mesh size to improve the NPSHa**

- Failure of thrust bearing due to high thrust load during the startup and slippage of lock nut.
  - **Installed the double lock nut to avoid the slippage.**
  - **Maintained minimum flow during the start up.**

- Problem with the parallel operation of two motor driven pumps with the action of wear and tear of pump internals
  - **Maintained the flow based on the load sharing using turbine and Motor.**

Major Modifications

- To avoid Mechanical seal failure:
  - **Primary Seal faces combination changed from C vs SiC to SiC vs SiC**

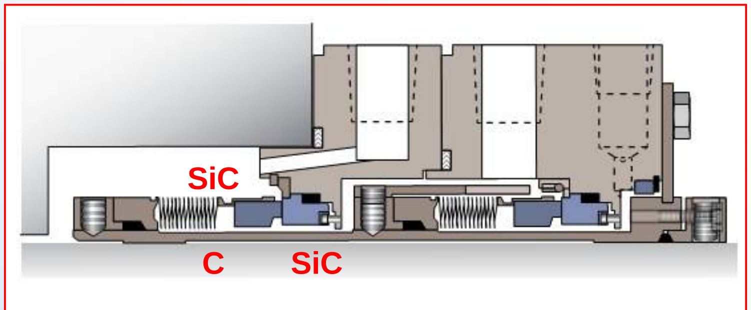
Vendor Analysis to select faces combinations C vs SiC:

- PV value: obtained 67 bar m/s
- Designed as per Stuffing box pressure 10 bar
- Avoided hard faces combination which limits the loading (Standard Design)
- Small amount of coke fins in HCGO flushing fluid was not considered.

Face Combination	PV Limits (bar m/sec)
C vs SS	15
SiC vs SiC	250
WC vs WC	270
WC vs SiC	350
C vs WC	500
C vs SiC	1300

IOC Analysis to select faces combination SiC vs SiC:

- Analysis of seal faces: Stationary face (SiC) intact but Rotary bellow face (C) found worn out and erosion marks in most cases. Running groves observed.
- PV value: Calculated and value is 100-150 bar m/s
- Constraints: Higher throat bush clearances. Stuffing box pressure 10-15bar
- Use of Composite Material for Hard Faces: Sintered SiC can be used to reduce the face loading.
- Some special characteristics of SiC over C
- As per API 682 (ISO 21049) Point: 6.1.6.2.4: Abrasive, viscous and high pressure service may required hard faces



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Major Modifications

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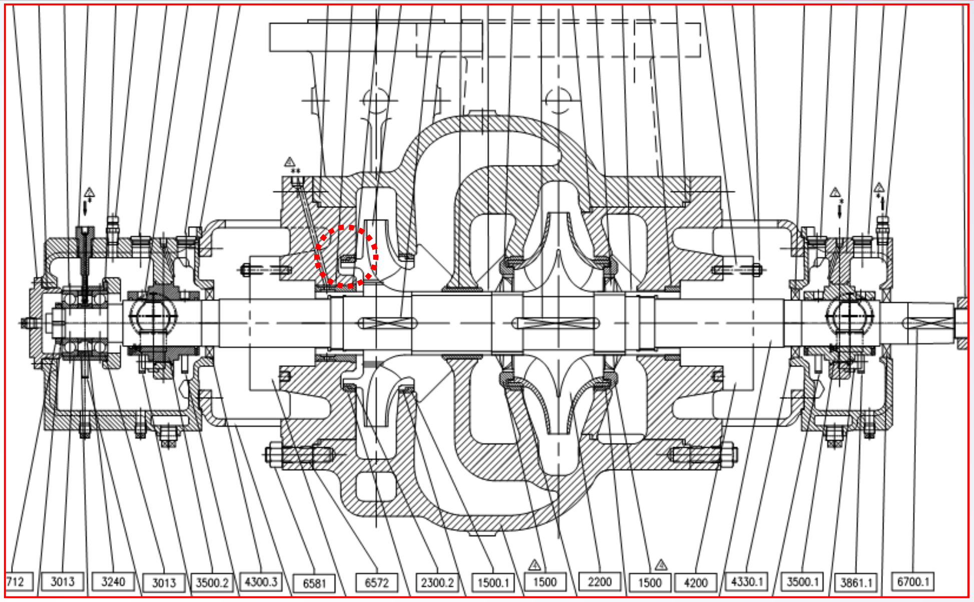
- To eliminate High erosion on pump wetted parts:

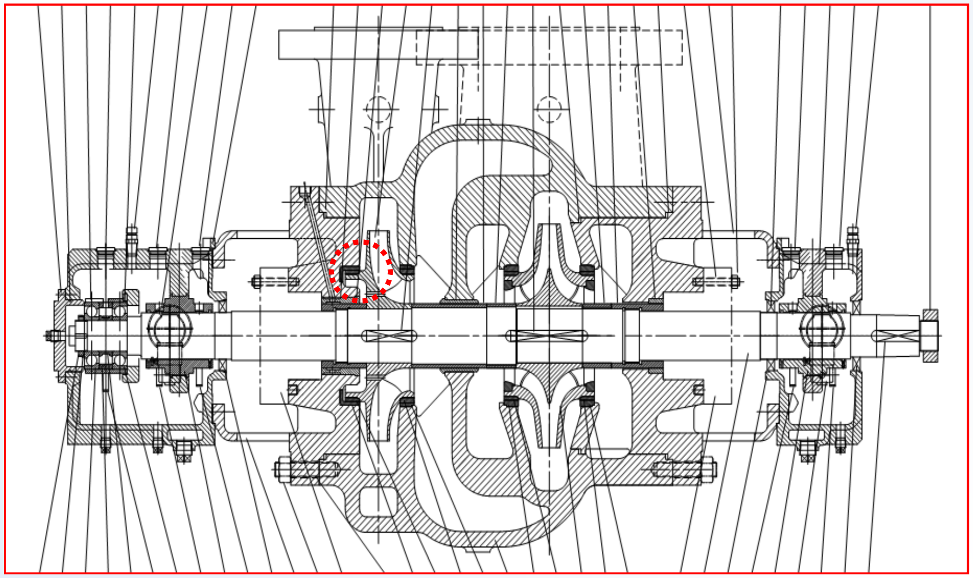
- Analyze the failure modes and directed the OEM to reduce the velocity at landed areas. Replaced the Crusher ring with Chock Rings to avoid lower NPSH problem.

- Tungsten carbide (WC) coating on casing internal surface using HVOF thermal spray system.

- Impeller metallurgy upgraded to A532 CL III A (upgraded to better response to HVOF process)

- Second stage wear ring design has changed to minimize the clearances.



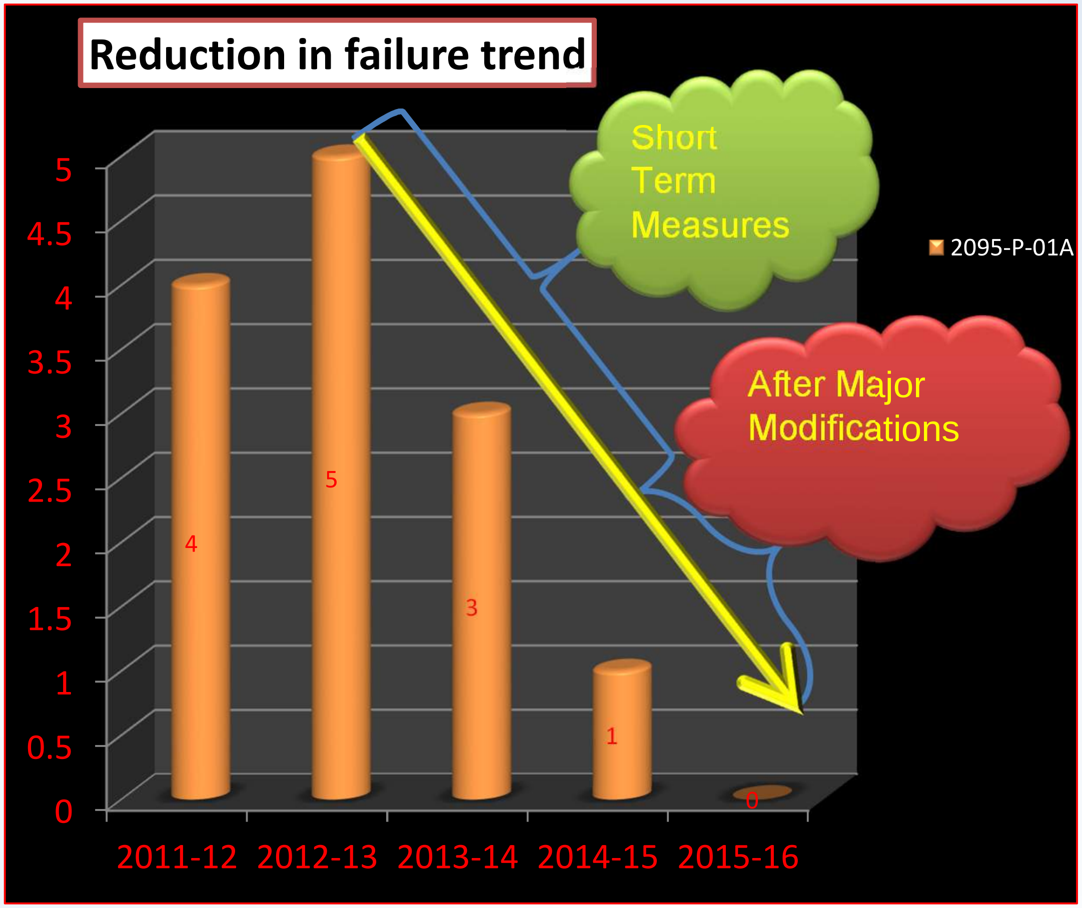


Implemented Actions-Summary

- Mechanical seal failure due to low flushing flow after a period of time because of increase in stuffing box pressure over a period of 2-3 months and damage of carbon bellow
  - **Replaced the primary Caron bellow with SiC (Harder face)**
  - **Set alarm limits on DCS for Plan-32 Flow**
- High erosion on pump wetted parts, caused by Catalyst carryover through CLO from FCCU (mixed in feed tank), high velocity at wetted areas and low surface hardness.
  - **Change pump wetted parts material from A487 CA 6NM/A to A532 CL III A (Impellers), applied hard coating tungsten carbide (HVOF- HIGH VELOCITY OXYGEN FUEL) on casing internals and reduced the velocities at landed area by changes in geometry.**
- Failure of thrust bearing due to high thrust load during the startup and slippage of lock nut.
  - **Installed the double lock nut to avoid the slippage.**
  - **Maintained minimum flow during the start up.**
- Problem with the parallel operation of turbine driven and motor driven with the action of wear and tear of pump internals
  - **Maintained the flow based on the load sharing.**

Achievements

- After implementation of short term measures:
  - Reduced failure rate and improved MTBF.
  - Thrust bearing failure avoided.
- After major modifications
  - No Mechanical seal failure observed
  - Avoided reduction of coker throughput due to loss of head
- Safety: Avoided fire incidents due to seal leakages.
- Seal design modification done with out any extra cost implications.
- Seal consumption cost reduced from 147 lacs to 30 lacs



Achievements

Steam Saving

* **Steam saving of 5Kg/MT of cost Rs. 584 Lacs after replacement of eroded components.**

(Approximate saving in HP Steam consumption is 5 kg/MT of feed which approximates to 57500 kg of steam per day (Unit t 'put of 11500 MT/day). This would be equivalent to approximately 4100 kg of SRFT. Price of 1000 kg of SRFT is approximately Rs. 40,000. So approximate saving is Rs. 1,60,000 per day.)

AFTER REPLACEMENT OF INTERNALS					
DATE	THROUGHPUT MT/hr	TOTAL STEAM CONSUMPTION kg/hr	WGC CONSUMPTION kg/hr	P01 + Reboiler Steam Consumption (kg/hr)	P01 + Reboiler Steam Consumption (kg/MT of feed)
14-Nov-2014	400.50	88253.07	37509.31	50743.76	93.66
15-Nov-2014	401.32	87866.66	37580.55	50286.11	93.64
16-Nov-2014	418.39	90092.09	39095.84	50996.25	93.44
17-Nov-2014	432.00	90705.38	38919.48	51785.90	90.09
19-Nov-2014	440.03	97743.92	42583.48	55160.44	96.77
20-Nov-2014	454.03	94483.87	40522.24	53961.63	89.25
18-Nov-2014	461.00	95468.54	42519.10	52949.44	92.23
21-Nov-2014	475.91	93864.00	40934.88	52929.12	86.01
22-Nov-2014	480.20	94501.33	40209.62	54291.70	83.74
AVERAGE HP Steam CONSUMPTION (kg/MT of feed)					90.98
BEFORE MODIFICATIONS					
30-Oct-2014	393.09	99191.83	41846.44	57345.39	106.46
13-Oct-2014	413.00	104929.47	45570.20	59359.27	110.34
9-Oct-2014	434.83	91554.89	35734.94	55819.96	82.18
10-Oct-2014	456.93	104614.13	43496.93	61117.20	95.19
15-Oct-2014	461.53	100263.57	42763.07	57500.50	92.66
16-Oct-2014	467.37	104220.73	42328.10	61892.62	90.57
22-Oct-2014	468.45	106157.18	45166.84	60990.33	96.42
20-Oct-2014	470.00	106860.62	46271.44	60589.18	98.45
17-Oct-2014	475.28	103524.06	43702.92	59821.14	91.95
AVERAGE HP Steam CONSUMPTION (kg/MT of feed)					96.02

Q & A

Questions & Answers

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