Extended safe operation of critical machine with PdM technology for Environment & Reliability Targets

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AGENDA

- BAPCO- RGDP PLANT
- RGDP AIR BLOWER INCIDENT
- VIBRATION-OVERLAPPING ANALYSIS
- CREST-BPFO IMPACT ANALYSIS
- TRIBOLOGY- LUBE OIL ANALYSIS
- IMMEDIATE ACTIONS
- SOLUTION-OPTIONS-RECOMMENDATIONS
- BEARING INSPECTION
- RESULTS
- LEARNING POINTS
RGDP AIR BLOWER INCIDENT

- **BAPCO** - The Bahrain Petroleum Company, Bahrain
- **CAPACITY** : 2,60,000 bpd
- **RGDP** - Refinery gas desulphurisation project
  - To reduce H2S in fuel gas < 150 ppm
  - To improve air and water qualities

- **INCIDENT** -
  - SUDDEN RISE IN VIBRATION ON BLOWER NDE BEARING TEMPERATURE

- **GOAL**
  - TO EXTEND THE RUN OF THE BLOWER FOR PLANNED STOPPAGE TO REDUCE ENVIRONMENT EFFECT (H2S) AND ENSURE RELIABLE SAFE OPERATION
• **RGDP AIR BLOWER-CRITICAL MACHINE**
• **POWER RATING**: 1250 HP / 3515 rpm
• **MOTOR DRIVEN WITH STEP UP GEARBOX**
• **LUBRICATION**: PURGE OIL MIST LUBRICATION
• **ONLINE MONITORING & MACHINE PROTECTION**
AIR BLOWER INCIDENT : 8 FEB-2013
S U D D E N RISE IN VIBRATION TO TRIP LEVEL

• BLOWER RUNNING WITH NORMAL
• ALARM = 7 mm/s Pk
• TRIP = 10 mm/s Pk
• ON 8-FEB-13 : SUDDEN RISE IN VIBRATION FROM 4 mm/s TO 7 mm/s
• FURTHER RISE UP TO 10 mm/s
• SUDDENLY REDUCED TO 5 mm/s Pk
SPECTRUM ANALYSIS
OVERLAPPING TECHNIQUE

OLD SPECTRUM
NORMAL PEAKS

22-JAN-13

NEW PEAKS (BPFO)
BEARING DAMAGE

21-FEB-14

BLOWER NDE BEARING
SPECTRUM ANALYSIS
OVERLAPPING TECHNIQUE

BLOWER DE BEARING

- NO CHANGE IN SPECTRUM
- DE BEARING RUNNING NORMAL
- MONITORED FOR ANY CHANGE
- TRANSMISSION FROM NDE TO DE
- DE BEARING TEMP NORMAL
ADVANCE PdM TOOLS-BPCO & CREST TO CONFIRM- NDE BEARING DAMAGE

BLOWER NDE BEARING-BPFO FAULT FREQUENCY ANALYSIS

BPFO - Ball Pass Frequency

IMPACT ANALYSIS
CREST FACTOR IMPACT
FFT SPECTRUM HISTORY ANALYSIS

FFT DURING NORMAL RUN (08-Jan-13)

HFD SPIKE ENERGY RISING TREND
TRIBOLOGY LUBE OIL ANALYSIS
NDE BEARING

1st Oil Sample
Contamination-Fault

2nd Oil Sample
Wear- Fault

Wear Debris Analysis
Confirmed Bearing
Outer Race Damage

Oil Sample Analysis
De Bearing-Normal
BLOWER NDE BEARING (THRUST)
SUDDEN DAMAGE

• SUDDEN RISE IN VIBRATION LEVEL DUE TO
  SUDDEN DAMAGE OF NDE BEARING.

• NDE THRUST BEARING OUTER RACE DAMAGE
  – SPECTRUM ANALYSIS
  – OVERLAPPING TECNIQUE
  – BEARING DEFECT FREQ ANALYSIS (BPFO)
  – CREST FACTOR ANALYSIS
  – LUBE OIL ANALYSIS

• DE BEARING RUNNING NORMAL
  - SPECTRUM ANALYSIS
  - CHECKED FOR TRANSMISSION OF
    VIBRATION FROM NDE TO DE BEARING
IMMEDIATE ACTIONS TAKEN

• IMMEDIATE ACTION
  – NDE BEARING LUBE OIL FLUSHED
  – LUBE OIL SAMPLE ANALYSIS DONE
  – VIBRATION ANALYSIS USING HAND HELD ANALYSER
  – DE BEARING CONDITION CHECKED
  – DE BEARING LUBE OIL FLUSHED AS A PREVENTIVE ACTION
  – MOTOR & GEARBOX CONDITION CHECKED
  – BLOWER OPERATING CONDITIONS CHECKED AND ANALYSED
  – FLOW CONDITIONS IMPROVED TO OPERATE AWAY FROM SURGE AREA
SOLUTION-OPTIONS

OPTIONS CONSIDERED

1. IMMEDIATE SHUTDOWN- TO STOP THE BLOWER IMMEDIATELY FOR INSPECTION AND REPAIR
   • CAN LEAD TO ENVIRONMENT EFFECT (H2S)
   • CAN LEAD TO FEED REDUCTION OF ANOTHER PLANT (LSFO)
   • CAN LEAD TO TOTAL SHUTDOWN OF LSFO
   • UNPLANNED SHUTDOWN MAY INCREASE IN MAINTENANCE TIME AND COST

2. PLANNED SHUTDOWN- TO EXTEND THE BLOWER OPERATION WITH PdM MONITORING
   • EVALUATE THE CONDITION OF BLOWER NDE BEARING FOR EXTENDED RUN OF BLOWER
   • USE PdM CLOSE MONITORING USING VIBRAITION, LUBE OIL ANALYSIS, ONLINE MONITORING FOR ANY CHANGE IN BLOWER CONDITION
   • PREVENTIVE CARE WITH LUBE OIL FLUSHING
   • IMPROVE & CHANGE BLOWER OPERATING CONDITIONS (AWAY FROM SURGE CONDITIONS)
SOLUTION-OPTION 2
EXTENDED BLOWER OPERATION – 19 DAYS

• LUBE OIL FLUSHING
• OIL ANALYSIS
• ONLINE MONITORING
• RELIABLE OPERATION
• DAILY CLOSE MONITORING
• VISUAL INSPECTION

BLOWER EXTEND RUN = 19 DAYS

8-FEB-13  →  27-FEB-13
BLOWER NDE BEARING TEMPERATURE TREND

TEMPERATURE MONITORING DURING EXTENDED RUN
BLOWER DE BEARING MONITORING

DE BEARING MONITORED WHILE RUNNING BLOWER
WITH DAMAGE ON NDE BEARING

VIBRAITON-SOME RISE AT END

BLOWER DE BEARING TEMP MONITORED

BEARING TEMPERATURE-NO CHANGE
BLOWER NDE BEARING INSPECTION

NDE THRUST BEARING

OUTER RACE DAMAGE (BPFO – CREST FACTOR)
RESULTS

1. AVOIDED UNPLANNED SHUTDOWN OF BLOWER AND RGDP / LSFO PLANT
2. SAFE & RELIABLE BLOWER OPERATION FOR EXTENDED RUN – 19 DAYS
3. RELIABILITY CLOCK ACHIVED TARGET = 180

4. IMPROVED SAFETY & ENVIRONMENT RECORD
5. AVOIDED SECONDARY DAMAGE
LEARNING POINTS

• PdM TECHNOLOGY & TOOLS HELPS IN
  o Monitoring Of Developing Problems
  o Early Event Detection
  o Real-time Condition Status
  o Reduction Of Maintenance Costs/Risk
  o Improved Plant Production-avoid unplanned stoppage
  o Extend the operation of asset with developing problems
  o Avoid secondary damage with repairs at appropriate time

• PdM TECHNOLOGY HELPS TO DETECT EXACT CAUSE OF FAILURE, SEVERITY OF FAILURE FOR EXTENDED OPERATION OF CRITICAL MACHINE TRAIN & PLAN A SAFE SHUTDOWN.
Questions and Discussion
THANK YOU

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