Operation and Maintenance of Turbocompressors

Looking at the list of topics we have been discussing here it occurred to me that this column never really dealt specifically with operation and maintenance of centrifugal compressors. Centrifugal compressors or turbocompressors are well known and they are widely used because they are reliable due to their robust and generally simple design. Their main representative is the inline type, often also the "pipe liner", typically designed to industry standard such as API 617 "Centrifugal Compressors for Petroleum, Chemical, and Gas Services Industries"[1].

A prominent, but dated source[2] cites 13% of all failures of turbocompressors as being due to errors or omissions in condition monitoring and maintenance. With the advance in monitoring technology and modern operating and maintenance practices one would assume that this general number might not be near as high today. What then are good monitoring and maintenance practices around turbocompressors?

Compressor condition monitoring has the following components:

1. Proper response to supervisory instrumentation such as alarms and trips.
2. Periodic observation and evaluation of operating parameters such as the compressor physical condition and its performance efficiency. This would include measuring and judging the rate of deterioration of mechanical and performance conditions for input into maintenance plans. Vibration analysis and aerodynamic performance calculations come to mind. Daily compressor operator rounds should be structured following the principles of Operator Driven Reliability (ODR)[3].
3. Evaluation of operating trends. This should include auxiliary systems such as lubrication and seal oil consoles, compressor on-line washing facilities and dry gas seal support systems[4].
4. Periodic testing of lubrication and seal oils. Six basic analysis are required: Appearance test, testing for dissolved water, flash point test, viscosity test, the determination of the Total Acid Number (TAN), and the determination of the additive content.
5. Periodic testing of emergency safety and shutdown devices (ESD) and other fail-to-danger components, such as exercising the compressor's surge control valve loop and the trip and throttle (T&T) valve on steam turbine driven compressor trains.
6. Data logging and automated record keeping such as the number of unplanned trips per train per year as a basic indication of compressor reliability.
7. Diagnosis of problems, appraising their severity and deciding what action to take.
8. Remedial action and execution planning.
9. Corrective measures should be preferably applied on-stream to reduce the impact on compressor availability. On line washing would be a good example.

Generally, turbocompressors require inspections, maintenance, repairs and overhauls (IMRO), also referred to as turnarounds or shutdowns, in intervals ranging from two to ten years depending upon the type of service. Maintenance intervals in clean services in the hydrocarbon industries of six to ten years are not uncommon. The extent of IMRO efforts ranges from simple bearing inspections to opening the compressor and replacing the

[1] API 617 8th Edition, Sep. 2014

[2] HB of Loss Prevention, Allianz (Insurance), Munich 1984

[3] See Pipeline & Gas Technology, December 2005.

[4] API 692 1st Edition, June 2018, *Dry Gas Sealing Systems for Axial, Centrifugal, and Rotary Screw Compressors and Expanders.*

rotor with a spare rotor drawn from specialized spare parts storage. Used rotors are examined for rubs at labyrinth seal locations and for fissures and cracks around impeller eyes on radial compressors. On axial compressors moving and stationary blades receive thorough attention. In all cases non-destructive test (NDT) procedures are being applied.

As the opportunity for a compressor turnaround approaches we should review the machine's operating and maintenance history and if there are any defects or faults noted it would be well to ask the following questions:

1. Are any of the defects repeaters?
2. If so, can they be expected at this turnaround?
3. What steps can be taken to eliminate them?
4. What action should be taken at this time?

A thorough pre-turnaround review should be undertaken in order to plan the work required. It should consist of:

1. An assessment of the compressor's mechanical condition
2. A performance check
3. Review of the machine's past history

Table 1 may help to approach the compressor turnaround in an organized manner.

Reference:
Practical Machinery Management for Process Plants: Volume4*; Major Process Equipment Maintenance and Repair,* Second Edition by H.P. Bloch and F.K. Geitner, ISBN 0-8841-5663-X, 1997, www.gulfppp.com

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Table 1. Turbocompressor IMRO schedule.

ITEM	INSPECTION FREQUENCY	REQUIRED THIS TIME (Yes/No)
Bearings	Each turnaround but not more frequently than every 18 months.	
Control System	Inspection based on current instrumentation practice & pre-turnaround response check.	
Couplings	Each turnaround but not more frequently than every 12 months.	
Internal Inspection	Whenever cover is removed according to following schedule: 1st run.....3 years 2nd run.....6 years 3rd & subsequent runs....10 years	
Lube & Oil System	Clean & refill reservoir, check coolers for leaks & replace filter cartridges at each turnaround provided not done within last 3 years.	
Non-return Valves	Examine undamped swing checks & *Mission Duo* checks at same frequency as internal inspection.	
Seal Eductor Systems	Inspect piping every turnaround	
Seals	Every turnaround on mechanical oil seals operating above 10,500 rpm	
Trip Systems	Check all trips at each shutdown.	