N627: Reciprocating Compressor Fundamentals

Instructor(s): Dr. Bryan Long or Devin Lavioe

2 Days	Competence Level: Awareness
Classroom Course	

Summary

This two-day course is geared to engineers and technicians involved in assessing the performance and/or reliability of reciprocating compressors. Participants are equipped to identify actual performance, expected performance and to resolve differences. Important reliability factors, including rod loading, pulsation and vibration, are covered. The course involves case studies in which attendees actively engage in resolving problems.

Upon completing this course, participants will have: a thorough understanding of performance measures including capacity, power, efficiency, rod loading; the ability to address differences between expected and actual performance; and the proficiency to accurately predict performance of a compressor under new operating scenarios. Also improved ability to perform troubleshooting and failure analysis on reciprocating compressors.

Learning Outcomes

Participants will learn to

1. Evaluate actual compressor performance versus predicted or expected compressor performance
2. Assess methods which are used to determine actual power, capacity and efficiency
3. Form the bases for predicting performance, including the use of OEM sizing software
4. Bring together by using examples and approaches that determining the causes of discrepancies between actual and predicted performance
5. Analyse compressor performance characteristics and operating limits
6. Define how pulsation and vibration can effect reciprocating compressor performance and reliability
7. Apply these methods to ongoing condition and performance monitoring

Duration and Training Method

Two classroom days providing 1.6 CEU (Continuing Education Credits) or 16 PDH (Professional Development Hours)

Who Should Attend

The course is targeted at rotating equipment engineers, engineering technicians and performance specialists. It is recommended that attendees be familiar with reciprocating compressor components and terminology.

Course Content

Course Agenda

Day One

1. Course overview and introductions
2. The compression process and pressure-time (p-t) curves; head end curves vs. crank end curves; factors that determine curve shape
3. The compression process and pressure-volume (p-v) curves; head end curves vs. crank end curves;

factors that determine curve shape
4. Capacity from measured p-v curves; definition of volumetric efficiency; deriving capacity at standard temperature and pressure. Accuracy and sources of error.
5. Predicting capacity; ideal compression process; theoretical volumetric efficiency; empirical corrections; adjusting for internal versus external cylinder conditions; the effect of adding clearance; predicting capacity of multi-stage compressors; causes of inaccurate flow predictions.
6. Power from measured pressure-volume curves; indicated power; effects of valve pressure drop. Assessing compression efficiency. Power from MCC parameters; power from measured shaft torque. Getting to brake power.
7. Predicting power from theory; ideal power; accounting for losses; isentropic efficiency definition and examples; valve loss modelling.
8. How gas properties compressibility and isentropic/polytropic exponent affect performance measures and predictions. How compressibility varies with pressure and temperature. Tips concerning compressibility of heavy gases. Isentropic exponent; variation of k (Cp/Cv) with pressure and temperature; examples. Use of volume exponent Nv versus using k. Equations of state used in modelling programs.
9. Performance modelling; OEM sizing software; specifying pressure drops. Sizing demo. Using sizing programs to help resolve performance issues.

Day Two

10. Case Study 3 - Operating company believed that actual power required for one of its compressors was significantly higher than predicted. A field study was conducted. Participants are provided summarized information and asked to determine whether they agree with the operator. If so, participants are then expected to investigate the evidence, perform some basic analysis and identify the sources of the discrepancy.
11. Compressor valves; valve components and function; flow areas and pressure drops; importance of lift height. Resistance factors. Valve dynamics. Examples of effects of changing lift. Causes of failures and examples.
12. Rod and crosshead loading; gas rod loads; inertia loads; net rod and crosshead loads. OEM limits, including reversal requirements. Effect of unloading cylinder ends. Case study.
13. Loading curves; predicting compressor performance over a range of operating conditions; loading curve formats. Load step definitions. How operating limits restrict the range of safe, efficient and reliable application. Example curves. Discussion of methods of capacity control. Case study.
14. Pulsation and vibration in reciprocating compressor systems; how gas pressure pulsations effect performance and reliability; vibration due to pulsation and other forces; vibration guidelines video presentations.
15. Condition monitoring; effects of mechanical condition on performance. How p-v curves change with suction or discharge valve leaks & ring leaks. Tools and techniques for compressor condition monitoring. Case studies.