

TECHNICAL SEMINARS FOR ROTATING/RECIPROCATING MACHINES

Beta Machinery Analysis provides training on the following topics. These range from 1 hour to 3 day classes. We customize the seminars to meet the interests and needs of our customers.

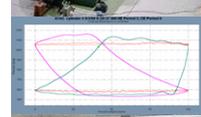
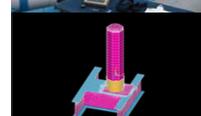
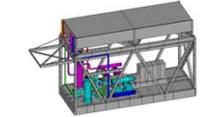
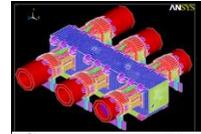
The following topics are organized into different segments. This allows customers to pick and choose topics of interest. Our seminars utilize animations, case studies, theory, and practical applications.

Who Should Attend? These courses are for engineers and technical staff involved in the design, maintenance, reliability and operations of rotating/reciprocating equipment.

More information? Contact Hilmar Bleckmann for more information on rates, schedules, or to book your own seminar: +1 - 403 - 245 5666, hbleckmann@BetaMachinery.com.

Seminar Topics

1. **Vibration Overview.** The following terms are discussed: resonance; mechanical, torsional and acoustic natural frequencies; dynamic forces; and vibration guidelines and standards.
2. **Pulsation/Mechanical Studies for Reciprocating Compressor and Pump Packages.**
 - **Basics** Overview of pulsation analysis, mechanical analysis of piping and compressor systems, API 618/API 674, skid and foundations, risk assessments and more.
 - **API 618 Requirements for Pulsation Studies (5th edition)** Overview of the changes to API 618 and how it impacts pulsation studies.
 - **Advanced Pulsation Analysis** Acoustical theory, acoustical analysis, modeling techniques, pressure drop, bottle sizing, pulsation effects and performance impacts.
 - **Advanced Mechanical Analysis** Support and clamp design, small bore piping, high risk vs. low risk applications, FEA modeling techniques, MNFs, vibration and stress, forced response, compressor mounting, case studies.
 - **Station Analysis** Evaluate pulsations in the station headers and piping system due to the interaction of multiple compressors, and/or the interaction between reciprocating and centrifugal compressors.
3. **Centrifugal Compressor – Surge Control Design Analysis.** Overview of the dynamic issues affecting surge control and operating reliability. The course is focused on surge control during start-up, operations and ESD, and identifies transient analysis for new or modified systems.
4. **Torsional Vibration Analysis (TVA).** Application issues affecting torsional vibration, engines vs. motors, torsional natural frequencies, forced response, coupling design, risk factors, case studies, field measurements.
5. **Piping Vibration, including Small Bore Piping.** Avoidance of Vibration Induced Fatigue Failures (AVIFF) is a common concern for facility piping system owner operators. This training will



discuss the steps required to address AVIFF in a proactive way at the design or operating stages. Discussion will include Flow Induced Vibration (FIV), Acoustic Induced Vibration (AIV), Flow Induced Turbulence (FIT), Transient Events, Small Bore Piping, and other sources. Applicable industry standards and approaches used to assess vibration risk (such as Energy Institute) will be presented.

- 6. Reciprocating Pump (Positive Displacement or Plunger Pump).** API Standard 674 defines the pulsation and vibration control requirements for a positive displacement (plunger) pump. This seminar addresses the unique needs for acoustic and mechanical designs. It also explores field and reliability issues affecting damaged pulsation dampeners and stabilizer internals, valve dynamics, and other considerations to pump design.
- 7. Centrifugal Pumping Systems.** Medium to large pump applications can face vibration challenges, including small bore piping vibration, transient piping vibration, and pipe fatigue due to acoustically induced vibration (AIV). This seminar outlines the types of excitation forces in a liquid pumping system and the design methods available to reduce piping vibration. Numerous field case studies are presented to identify pumping vibration issues
- 8. Thermal Analysis (Piping Flexibility).** Techniques and case studies for assessing piping flexibility and stress (B31.3, B31.8 and other codes), off-skid analysis, specialized clamp designs, coordinating design to accommodate both mechanical (dynamic stiffness) and thermal (flexibility) requirements.
- 9. Pressure Drop in Pipeline Compressor Stations.** Specialized design for reciprocating compressors used in the pipeline industry. Reduce pressure drop through the piping system and improve operating flexibility/reliability for new or upgraded reciprocating compressors. Design approaches including System Performance Modeling (fence to fence pressure drop), capacity control, and the Safety Map. Also includes discussion of performance testing, small bore piping and other design considerations.
- 10. Blow down and Transient/Water Hammer Analysis.** The integrity of the piping system can be affected by transient or blow down situations. This seminar discusses both liquid and gas piping systems and how to avoid piping fatigue failure due to water hammer, blow down or emergency shutdown (ESD), start-up or other transient events. Various case examples are discussed.
- 11. Troubleshooting Machinery Problems.** Wide range of field issues including vibration, performance, installation, base line assessments and vibration guidelines. Addresses troubleshooting on compressors, pumps, engines, turbines and paper machines. Additional topics include field vibration guidelines, station vibration analysis, small bore evaluation, performance, etc.
- 12. Vibration/Performance Monitoring Programs.** Comparison of monitoring programs, best practices, remote vs. onsite programs and condition assessments. Covering monitoring programs for rotating/reciprocating machines.
- 13. Structural Dynamic Analysis for Offshore Applications such as Platforms or FPSOs.** Design and field case studies for techniques to avoid resonance and vibration on offshore production facilities.
- 14. Foundation Design for Machine Applications.** Overview of dynamic analysis requirements for foundation and compressor mounting, including gravel, piles and concrete foundations.
- 15. Best Practices to Avoid Vibration on Reciprocating Compressors.** This seminar is for compressor packagers. It covers piping layout, scrubber design, skid design, gussets, mounting, shop testing, wedge supports and other topics.