STARK STATE COLLEGE

GENERAL SYLLABUS

Course Information

Course Name: Advanced Compressor Coatings
Course Number: ARL237

Required Materials

Textbook(s): Advanced Compressor Coatings Handbook Ariel Corp.
Required Readings: None
Additional Materials: Scientific Calculator, Laptops, Note Pads, Writing Utensils, Web Links, Handouts and related items as provided in class.

Course Outline/Calendar

The date of coverage and order of coverage may be modified based on the faculty member and events beyond the control of faculty members that interfere with class times and teaching.

Week	Chapter/Topic/Lab
1: Compressor Fundamentals and Deteroration	• Introduction to compressors: Review of compressor types (positive displacement and dynamic), components, and industrial applications. • Environmental challenges: Overview of operational environments, including fouling, corrosion, and erosion, and their impact on performance. • Economic impact of degradation: Analysis of how compressor degradation affects fuel consumption, maintenance costs, and overall operational expenses.
2: Materials Science and Surface Engineering	• Material selection: Examination of common compressor materials, such as steel, titanium, and nickel-based alloys. • Introduction to surface engineering: The role of coatings in enhancing material properties like wear and corrosion resistance. • Coatings classification: Overview of different coating types and their general applications in rotating machinery.
3: Cleaning and Pre-Treatment	• Importance of surface preparation: Understanding how surface cleanliness affects coating adhesion and performance. • Chemical cleaning techniques: Methods such as alkaline washes and chemical stripping to remove contaminants. • Mechanical cleaning techniques: Abrasive blast cleaning, water jetting, and other methods for surface profiling and scale removal.
4: Advanced Preparation and Quality Control	• Thermal and chemical preparation: Techniques like pre-baking stainless steel and applying phosphate coatings for specific applications.

Week	Chapter/Topic/Lab
	• Surface assessment and inspection: Use of inspection equipment to check for surface cleanliness, profile, and remaining contamination. • Standards and specifications: Adherence to industry standards for surface preparation and environmental conditions during application.
5: Metallic-Ceramic Coatings	• Introduction to metallic-ceramic coatings: Properties, application, and advantages in resisting corrosion and erosion. • Sacrificial cathodic protection: Explanation of the mechanism used by coatings like Sulzer's HICoat series. • Metallic-ceramic-polymeric coatings: Exploration of PTFE-impregnated coatings for anti-fouling characteristics.
6: Thermal Spray Coatings	• Principles of thermal spraying: Methods such as High-Velocity Oxy-Fuel (HVOF), plasma spraying, and electric arc spraying. • Applications of thermal spraying: Using thermal spray to apply wear and corrosion-resistant coatings, including ceramic and tungsten carbide composites. • Thermal barrier coatings (TBCs): Use of ceramic-based coatings for high-temperature applications, such as in gas turbines.
7: Polymer and Slurry Coatings	• High-performance polymer coatings: Examination of advanced polymers like PEEK and PTFE used for improved release and antifouling properties. • Slurry aluminum coatings: Review of the application and benefits of using slurry coatings for corrosion resistance, especially for on-site repairs. • Application methods: Differences in applying liquid polymer coatings versus thermal spray and slurry techniques.
8: Physical Vapor Deposition (PVD) Coatings	• Fundamentals of PVD: Explanation of processes like cathodic arc PVD (CAPVD) used for applying thin, dense coatings. • Erosion-resistant PVD coatings: Examination of multi-layer ceramic-metallic coatings for use in military engines and other demanding environments. • Case studies: Evaluation of successful PVD coating applications on compressor components.
9: Diffusion and Hybrid Coatings	• Diffusion coatings: Study of diffusion aluminide coatings for high-temperature resistance. • Hybrid coating systems: Combining different coating types to achieve a synergistic effect, such as PVD topcoats over other layers. • Advanced materials: Emerging materials and techniques for coating applications in severe environments.
10: Coating Application and Process Control	• Application equipment: Safe and effective use of spray guns, mixing equipment, and heating elements. • Environmental control: Managing factors like humidity, temperature, and air purity during the coating process to ensure adhesion. • Inspection of wet coatings: Using tools like notched gauges for immediate quality checks during the application process.
11: Testing and Inspection	• Non-destructive testing (NDT): Methods for inspecting finished coatings, such as thickness testing and visual inspection. • Destructive testing: Techniques for evaluating coating adhesion, erosion resistance, and other mechanical properties. • Oil and component analysis: Using oil analysis and other methods to detect early signs of component wear and coating degradation.
12: Failure Analysis and Troubleshooting	• Root causes of failure: Common failure modes like blistering, cracking, and delamination. • Troubleshooting techniques: Systematic approach to identifying and addressing the causes of coating failure. • Process improvement: Strategies for improving surface preparation, application, and formulation to prevent future failures.
13: Coating Repair and Maintenance	• On-site repair guidelines: Methods for repairing coatings on large components without extensive disassembly. • Specialized repair procedures: Techniques for repairing and resurfacing worn components like piston rods and bearings.

Week	Chapter/Topic/Lab
	• Restoration to "better than new": Case studies on extending component life through effective coating repair.
14: Case Studies and Applied Problem-Solving	• Industrial case studies: Analysis of real-world coating applications and failures in various industries, including aerospace and power generation. • Problem-solving workshops: Students work through complex coating scenarios and propose solutions. • Compressor performance improvement: Quantifying the benefits of advanced coatings, such as improved aerodynamic efficiency.
15: Environmental and Safety Considerations	• Eco-friendly coatings: Discussion of low-VOC and waterborne coating systems. • REACH compliance: Overview of regulations and use of compliant materials, such as chromium-free paints. • Safety protocols: Best practices for handling and applying advanced coating materials.
16: Future of Compressor Coatings	• Nanotechnology in coatings: Exploration of nanomaterials for enhanced properties like UV resistance and corrosion protection. • Smart coatings: Potential of coatings that respond to environmental stimuli. • Digitalization and automation: Integration of Industry 4.0 technologies into coating processes. • Final project presentations: Students present their findings on a specific coating application or failure analysis.