

MECHANICAL DESIGN OF PROCESS PLANT EQUIPMENT: STATIC & ROTATING



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ABOUT SMARTBRAINS

SmartBrains is the global market leader in providing high-level training services to the energy sector (Oil and Gas, Petrochemical, Refinery, LNG, Power Plants, Fiscal, Contracts, Strategy & Finance and Leadership & Management). Operating nation wise over the last 8 years, our courses are widely acknowledged within the energy community for quality and up-to-date information. Our success and distinguished reputation is down to our commitment to the industry, a high-level of expertise, sector knowledge, cultural diversity and experience that comes from organising many courses.

SmartBrains Institute provides premium training courses for energy industry executives and fresh engineering graduates. Programs are designed by experienced high level Engineers/Managers and professionals as an option to broaden their skill sets to include management tools and techniques that are applicable to various profiles in Oil & Gas industry. Our success and distinguished reputation is thanks to our commitment to provide first-class programmes to our clients. Combining leading professionals from across the industry as lecturers and an interactive, practical format, the lessons learnt in a SmartBrains for energy course are directly transferable back to the workplace.

WHY SMARTBRAINS

SmartBrains is the ultimate choice for all the working and non working engineers in energy sector training requirements. Our extensive portfolio of energy training courses are:

- ✓ 100% focused on Oil & Gas industry.
- ✓ Guided by the industry renowned professionals with unprecedented knowledge of Oil & Gas industry
- ✓ High interactive program with practical and relevant case studies.
- ✓ Training by extensively researched self developed cutting edge techniques.
- ✓ Skill development techniques with comprehensive set of documentation, practical skills and tools used in the industry.
- ✓ Perfect opportunity to develop network and experiences with knowledge sharing.
- ✓ Internationally acclaimed engineering qualification.
- ✓ Designed for both fresh engineers and working professionals to attain growth in renewably industry
- ✓ One of the finest international faculty.
- ✓ Interactive, interesting and motivational training sessions.
- ✓ Access to enormous reference books and research materials.

OUR STRATEGIC OBJECTIVES

To be recognized by industry and employers as a highly reputable training organization. Provide dynamic leadership, sound management and excellence in training. Continue to improve our services through quality management processes. Invest in and value our people through professional development activities, Grow our business through innovation and to continue to be financially secure. Be influential in the economic development of the industries we serve nationwide.





SmartBrains



ACCREDITATION & AFFILIATION

SmartBrains engineers and technologist Pvt Ltd. has received recognition, endorsement and affiliation from National Skill Development Corporation of India (NSDC) and various Skill Sector Councils as an authorized training provider under various trades. SmartBrains provide skill based training for engineering/non-engineering candidates as per their interest. As a training institute we will provide complete practical knowledge based skill training, recognition & certification from NSDC & Sector Skill Councils. Students who successfully complete their certification from SmartBrains may be able to apply for recognition of their qualification within the local education system. Trainees will be awarded by a National level certification approved & provided by National Skill Development Corporation of India (A PPP promoted by Ministry of Skill Development & Entrepreneurship, Govt. of India) which is broadly accepted & recognized across the globe.

WHAT YOU WILL GAIN

- ▶ Process plant industry overview & basic concepts
- ▶ Production facilities.
- ▶ Engineering, procurement & construction
- ▶ Cost estimation.
- ▶ Material selection considerations pressure vessels.
- ▶ Pressure vessel design & maintenance.
- ▶ Pressure vessel maintenance.
- ▶ Heat exchangers design & maintenance.
- ▶ Fire heaters design & maintenance.
- ▶ Storage tanks design & maintenance.
- ▶ Pump technology–design, operation & maintenance.
- ▶ Compressor design, operation, and maintenance
- ▶ Steam turbine design, operation, and maintenance.
- ▶ Mechanical seals, selection, operation and maintenance.
- ▶ Machinery failure analysis and prevention.

PURPOSE

- Our extensive portfolios of training courses are:
- ✓ 100% focused on Mechanical Design of Process Plant Equipment: Static & Rotating.
 - ✓ Guided by industry renowned professionals with unprecedented knowledge of process plant industry.
 - ✓ High interactive program with practical and relevant case studies.
 - ✓ Training by extensively researched self developed cutting edge techniques.
 - ✓ Perfect opportunity to develop network and experiences with knowledge sharing.
 - ✓ Designed for both fresh engineers and working professionals to attain growth in process plant industry.
 - ✓ Interactive, interesting and motivational training sessions.
 - ✓ Access to enormous reference books and research materials sessions.



Process Plant Industry overview & Basic Concepts

- Meaning of process plant & power plant industry.
- Typical process plant & power plant industry objectives.
- Typical process plant & power plant industry activities.
- Industry streams.
- Typical organization chart.
- Company structures.

Production Facilities

- Typical production facilities.
- Artificial systems.
- Treatment and processing.
- Product processing.
- Typical value chain.
- Value products.

Engineering, Procurement & Construction

- EPC overview.
- Risk allocation on EPC Contract.
- Choosing EPC contract compared to other forms of contract.
- Bankability of EPC contract.
- Various entities and other project documents.
- Different modes of contract.
- Contract Jargon: Lump sum, turn-key, EPCM, EPCC, cost-plus, reimbursable.

Cost Estimation

- Cost estimating methods:
 - ✓ Capacity/Scale ratio.
 - ✓ Equipment/Modular Factors.
 - ✓ Detailed quotes.
- Estimate types and accuracy.

- Equipment installation cost factors.
- Contingency allowances.
- Cost escalation.

Material Selection Considerations Pressure Vessels

- Material selection factors:
 - ✓ Material types.
 - ✓ Mechanical properties.
 - ✓ Environmental effects.
 - ✓ Fabricability.
 - ✓ Cost and availability.
 - ✓ Process contamination.
 - ✓ Reliability.
- Metallurgy and application of alloys:
 - ✓ Alloy classes.
 - ✓ Carbon steel.
 - ✓ Low alloy steels.
 - ✓ Stainless steels.
 - ✓ Typical product forms.
 - ✓ Typical material selections.
- Material standards and specifications:
 - ✓ Industry standards.
 - ✓ Carbon steel selection.
 - ✓ Low-alloy steel selection.
 - ✓ Stainless steel selection.
 - ✓ Non-ferrous materials.
- Fracture toughness.
- Special design considerations:
 - ✓ Elevated temperature service.
 - ✓ Hydrogen resistance.
 - ✓ Fracture toughness and impact requirements.
 - ✓ Joining dissimilar metals.
 - ✓ Refractory linings.

STATIC EQUIPMENTS:

Pressure Vessel Design & Maintenance

- Basic pressure vessel concepts:
 - ✓ Main pressure vessel components.
 - ✓ Primary pressure vessel process functions .
- Materials of construction for pressure vessels:
 - ✓ Factors that affect material selection.
 - ✓ Determining maximum allowable stresses.
 - ✓ Material selection requirements.
- Specifying design requirements for pressure vessels:
 - ✓ The ASME code in pressure vessel design.
 - ✓ Specifying design conditions and loadings.
 - ✓ Vessel component thickness design criteria.
 - ✓ Design calculations for pressure vessel components.
 - ✓ Design of pressure vessel supports.
- Fabrication, inspection, and testing of pressure vessels:
 - ✓ Evaluating fabrication drawings for acceptability.
 - ✓ Inspection and testing requirements.

Pressure Vessel Maintenance

- Pressure vessel integrity program:
 - ✓ Overall risk assessment.
 - ✓ Inspection plan.
- Fitness-for-service assessments:
 - ✓ Overview of API RP 579 requirements.
 - ✓ Data requirements.
 - ✓ Assessment methods and acceptance criteria.
- API-510 requirements:
 - ✓ Scope.
 - ✓ Definition.
- Pressure vessel inspection practices:
 - ✓ Causes of vessel deterioration.
 - ✓ Inspection intervals.
 - ✓ Corrosion rate determination.
- Evaluating corroded pressure vessels for continued operation:
 - ✓ Determining minimum actual thickness.
 - ✓ Acceptability of corroded area.
- Brittle fracture assessment:
 - ✓ Fracture toughness determination.
 - ✓ Brittle fracture evaluation of existing equipment.
- Details for welded repairs and alterations:
 - ✓ Classification of repairs and alterations.
 - ✓ Welding and design requirements.
 - ✓ Defect repairs.
- Rerating pressure vessels.

- Changes to original design conditions.
- Hydrotest requirements.

Heat Exchangers Design & Maintenance

- Main types of heat exchangers and their primary components:
 - ✓ TEMA-type.
 - ✓ Air-cooled.
 - ✓ Double-pipe.
 - ✓ Plate-and-frame.
- Primary process functions of heat exchangers.
- Principal applications and limitations of shell and-tube and air-cooled heat exchangers .
- Primary factors affecting heat transfer duty.
- Specifying design requirements.
- Design of primary exchanger components:
 - ✓ Girth flanges.
 - ✓ Pass partition gaskets.
 - ✓ Flat channel cover.
 - ✓ Tubesheets.
 - ✓ Internal floating heads.
 - ✓ Tubes.
 - ✓ Pass partition plates.
 - ✓ Non pressure-containing parts.
- Vibration considerations:
 - ✓ Causes of vibration.
 - ✓ Possible types of damage.
 - ✓ Design and operating parameters affecting vibration.
 - ✓ Potential solutions to vibration problems
- Maintenance and repair:
 - ✓ Evaluating the suitability of corroded components.
 - ✓ Typical maintenance and inspection procedures.
 - Locating leaks.
 - Leak repairs.
 - Retubing considerations.
 - Typical cleaning methods.
 - Tube inspection techniques.
 - Rerating exchangers.

Fire Heaters Design & Maintenance

- Common fired heater designs.
- Combustion basics:
 - ✓ Simple combustion equations.
 - ✓ Adiabatic flame temperature.
 - ✓ Flammability limits and minimum oxygen concentration.
 - ✓ Gas fuels.

- ✓ Liquid fuels/atomization.
- ✓ Flue gas composition.
- ✓ Carbon monoxide issues.
- ✓ NOX issues.
- ✓ Emissions
- Efficiency:
 - ✓ Excess air.
 - ✓ Natural draft.
 - ✓ Heat recovery.
 - ✓ Air leakage.
- Furnace construction:
 - ✓ Casing.
 - ✓ Refractory and purpose.
 - ✓ Stack and use with natural draft burners.
 - ✓ Radiant tubes.
 - ✓ Convection coils (plain and finned).
- Heat transfer basics:
 - ✓ Outside tubes.
 - Radiant heat transfer
 - Convective heat transfer.
 - Effect of excess air level.
 - ✓ Inside tubes.
 - Convective heat transfer.
 - Boiling (steam generation).

Storage tanks design & maintenance

- Storage tank types and features:
 - ✓ Tank types and functions.
 - ✓ Primary components.
 - ✓ Appurtenances.
 - ✓ Design specifications.
- Material Selection:
 - ✓ Material property considerations.
 - ✓ Acceptable material specification.
- Mechanical design requirements.
 - ✓ Mechanical design parameters.
 - ✓ Shell thickness determination.
 - ✓ Wind girder requirements.
 - ✓ Nozzle design details.
 - ✓ Roof requirements.
 - ✓ Bottom requirements.
 - ✓ Designing tanks for small internal pressures.
 - ✓ Optional design basis for small tanks.
 - ✓ Elevated temperature storage tanks.
 - ✓ Austenitic stainless steel storage tanks.
- Fabrication details:

- ✓ Types of welded joints.
- ✓ Welding methodology.
- ✓ Weld detail requirements.
- Inspection and testing requirements:-
 - ✓ Types of weld defects.
 - ✓ Inspection methods.
 - ✓ Inspection requirements.
 - ✓ Dimensional/tolerances.
 - ✓ Testing.
- Vents and fire protection systems:
 - ✓ Vents for fixed roof tanks.
 - ✓ Vents for floating roof tanks.
 - ✓ Fire protection systems.
- Storage tank maintenance:
 - ✓ Tank inspection.
 - Objectives.
 - Prioritization.
 - Inspection frequencies.
 - Record keeping.
 - Inspector qualification
 - ✓ Tank component evaluation.
 - Shell.
 - Bottom.
 - Nozzles.
 - Roof.
 - Foundation
 - Shell and bottom settlement
 - ✓ Leak detection methods.
 - ✓ Tank repair and alteration.
 - General considerations.
 - Material considerations.
 - General requirements for repair and alteration.
 - Removal, repair, and replacement of shell plate material.
 - Repair, addition, replacement, and alteration of shell penetrations.
 - Repair of tank bottoms.
 - Tank roof repair.
 - ✓ Dismantling and reconstruction.
 - Dismantling methods.
 - Reconstruction.
 - Dimensional tolerances.
 - ✓ Examination and testing.
 - General.
 - Welding inspection.
 - Hydrostatic testing.

ROTATING EQUIPMENTS**Pump technology–design, operation & maintenance**

- Pump types and terminology:
 - ✓ Pumps.
 - ✓ Pump terminology
 - ✓ Pump types.
- Centrifugal pumps:
 - ✓ Centrifugal pump theory.
 - ✓ Operating characteristics.
 - ✓ Centrifugal pump operation.
 - ✓ Types of centrifugal pumps.
 - ✓ Parts of centrifugal pumps.
- Centrifugal pumps (continued):
 - ✓ Factors affecting performance.
 - ✓ Troubleshooting centrifugal pumps.
 - ✓ Inspecting centrifugal pumps components for wear.
 - ✓ Centrifugal pump overhaul.
- Positive displacement pumps.
 - ✓ Reciprocating pumps.
 - ✓ Rotary pump theory and operation.
 - ✓ Special purpose pumps: metering pumps, plunger pumps, diaphragm pumps, rotary metering pumps.
- Packing and mechanical seals:
 - ✓ Compression/molded packing.
 - ✓ Mechanical seals.
 - ✓ Dual mechanical seals.
 - ✓ Gas seal application to liquid pumps.
- Bearing care and maintenance:
 - ✓ Basic concepts of bearings.
 - ✓ Bearing classifications.
 - ✓ Bearing care and maintenance.
- Couplings and alignment:
 - ✓ Purpose of couplings.
 - ✓ Types of couplings.
 - ✓ Alignment methods.
- Installation Design:
 - ✓ location.
 - ✓ Baseplate.
 - ✓ Tolerances
 - ✓ Suction & discharge piping
 - ✓ Bypasses.
 - ✓ Piping loads.
 - ✓ Handling & storage.
- Pump operation:
 - ✓ New or overhauled pump startup
 - ✓ Starting & stopping.

- ✓ Monitoring operation and performance.
- Valves and piping systems:
 - ✓ Valves used in pump applications.
 - ✓ Valve characteristics.
 - ✓ Valve sizing and loss minimization.
 - ✓ Valves vs variable speed drives.
- Pump drivers:
 - ✓ Electric motors - design, controls, standard motors, variable frequency drives, maintenance.
 - ✓ Steam turbines – mechanical drive turbines, application ranges, maintenance.
- Troubleshooting:
 - ✓ fundamentals.
 - ✓ Symptom/cause matrix.
 - ✓ Questions and answer session.

Compressor Design, Operation, and Maintenance

- Introduction to compressor types:
 - ✓ Centrifugal, axial, reciprocating, helical screw, ranges of application and limitations, selection considerations.
- Mechanical design of centrifugal compressors:
 - ✓ Compressor side streams, rotors, balancing, rotor dynamics, impellers, casings, bearings, seals, couplings, controls.
- Design and materials of reciprocating compressor components:
 - ✓ Design and materials, design of non-lubricated compressors, piston rod and frame loading, distributing forces and balancing.
- Basic Compressor Parameters:
 - ✓ Thermodynamics, capacity, power, efficiencies, gas properties, intercooling.
- Selection of centrifugal and reciprocating process compressors:
 - ✓ Calculation methods, characteristic curves, stability.
- Turbo-compressor train operation, inspection, maintenance, overhaul and repair - IMO&R:
 - ✓ IMO&R planning, execution, documentation, troubleshooting.
- Operation and maintenance of reciprocating compressors":
 - ✓ Lubrication and lubrication systems, valves, valve problems and rebuilding, packing and packing problems, non-lubricated compressors, controls and cooling systems.

- Overhaul and repair of reciprocating compressors:
 - ✓ Methods of repair and overhaul, alignment and piston rod run-out, foundation problems and repair, component repair and rebuild.
- Predictive vs Preventative maintenance (PDM vs PM) technique - reciprocating compressors:
 - ✓ Types of maintenance programs, purpose of pm, inspection and inspection forms, vendor and contractor requirements, planning and implementation.
- Basic approaches to machinery troubleshooting:
 - ✓ Troubleshooting compressor problems: typical problems and solutions diagnostic tests, compressed air system evaluation.
- Safety in compressor operation and maintenance:
 - ✓ Basic safety rules, safety devices and shutdowns, safety maintenance procedures.
- Machinery reliability audits and reviews:
 - ✓ Overview, reliability impact on plants.

Steam Turbine Design, Operation, and Maintenance

- Steam turbines:
 - ✓ Operating principles, impulse turbines, reaction turbines, application ranges, configurations, application constraints
- Turbine components:
 - ✓ Turbine rotors, blading, diaphragms, nozzles, steam chests, glands and gland systems, bearings, balancing, rotor dynamics, governing systems, lube oil management.
- Overview of selection and sizing of steam turbines for reliability:
 - ✓ Thermodynamics, steam (water) rates, condensing and backpressure turbines, single and multistage types, process considerations
- Operation and maintenance of steam turbines:
 - ✓ Commissioning, start-up, run-in and shut-down, surveillance and health monitoring, performance measurement, monitoring and tracking, steam turbine washing, steam turbine inspection, maintenance, overhaul and repair (IMO&R)
- Basic approaches to machinery troubleshooting:
 - ✓ Examples from recent failure incidents attributed to design defects, processing and manufacturing deficiencies, assembly errors, off-design or

unintended service conditions, maintenance deficiencies etc.

- Predictive vs preventive maintenance techniques:
 - ✓ Determination of which method to use
- Machinery reliability audits and reviews:
 - ✓ Overview, reliability impact on plants.

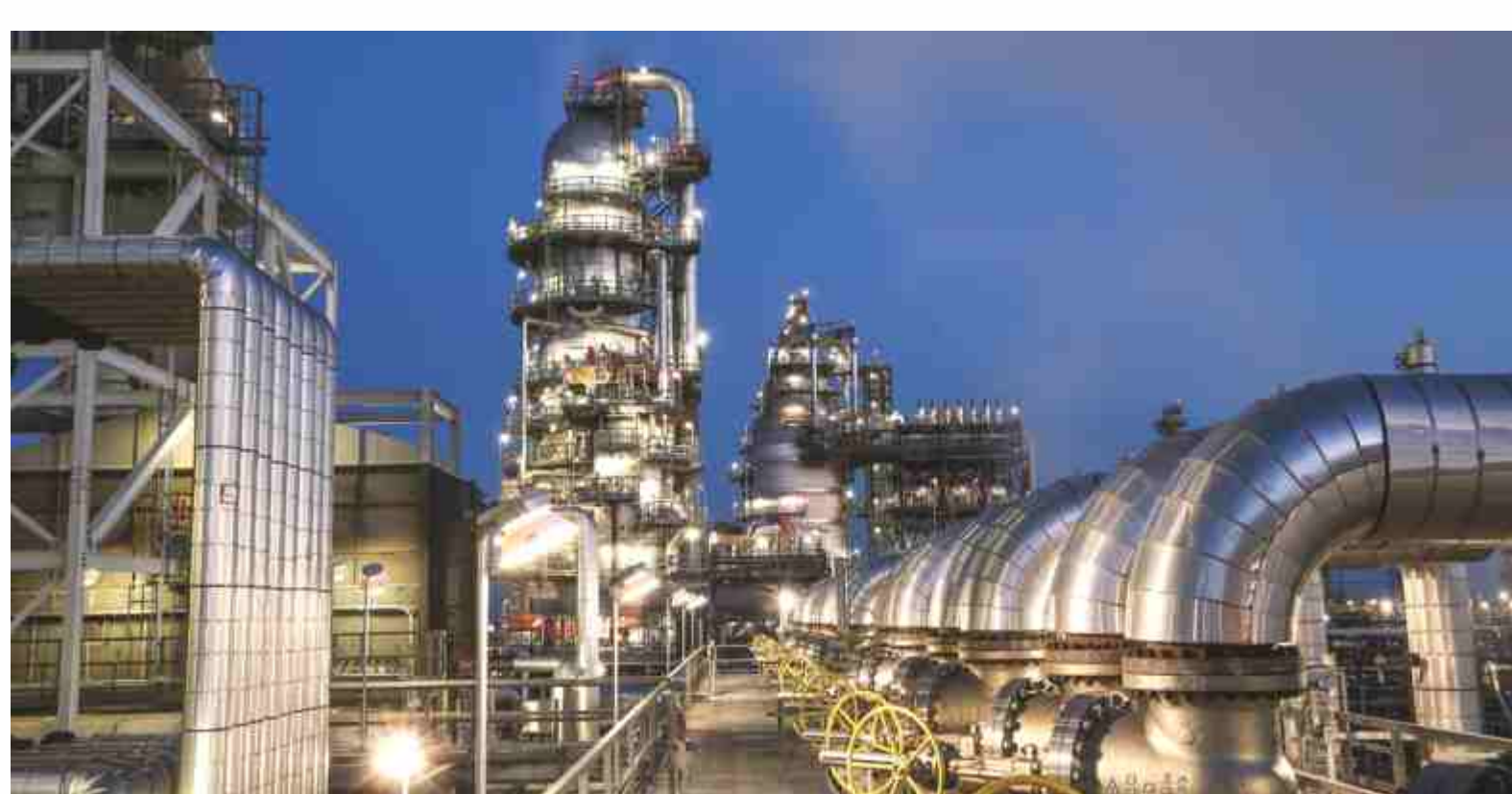
Mechanical Seals, Selection, Operation and Maintenance

- Basic principles of mechanical seals:
 - ✓ Principles of operation.
 - ✓ Thermal considerations.
 - ✓ Maintaining the fluid film.
- Design and types:
 - ✓ Design – overview.
 - ✓ Types – overview.
 - ✓ Seal classification.
 - ✓ Seal designs.
- Metal bellows and pusher seals:
 - ✓ Three views of the bellows seal.
 - ✓ Convolutions.
 - ✓ Comparison of bellows with pusher seals.
 - ✓ Welded bellows materials.
 - ✓ High temperature sealing.
 - ✓ Cartridge seals.
- Seal environment:
 - ✓ Sealing abrasives.
 - ✓ Sealing crystallizing fluid.
 - ✓ Sealing hot water.
- Mechanical seal selection:
 - ✓ Materials of construction.
 - ✓ MS specifications.
 - ✓ Seal arrangement selection.
 - ✓ Secondary sealing devices.
- Seal design audit.
- Seal installation:
 - ✓ Measuring seal faces.
 - ✓ Secondary/auxiliary sealing devices .
- Gas seals technology:
 - ✓ Selection.
 - ✓ Auxiliary systems.
- Mechanical seal failure analysis.
- Mechanical seal standardization/consolidation:
 - ✓ Principles.
 - ✓ Examples.
- Controlling fugitive emissions from MS.

- Seal calculations.
 - ✓ Leakage potential calculations.
 - ✓ Analysing flashing between seal faces.
 - ✓ Calculating heat generation.
 - ✓ Balance calculations.
 - ✓ Changing balance ratios.
- Mechanical seal execution examples:
 - ✓ Ethylene product pump seals.
 - ✓ Hot tar pump tandem seal.
 - ✓ Gear pump double seal.
 - ✓ Sundyne compressor seal.
- ANSI/API 682 seal specifications.
- Alternatives to mechanical seals.

Machinery Failure Analysis and Prevention

- Failure analysis and troubleshooting:
 - ✓ Causes of machinery failure.
 - ✓ Contributing factors often overlooked.
- Metallurgical failure analysis methodology:
 - ✓ Failure analysis of bolted joints.
 - ✓ Shaft failures and their origins.
 - ✓ Ductile vs brittle failures and stress raisers.
 - ✓ Redesign opportunities.
- Machinery component analysis and reliability improvement:
 - ✓ Wear failures.
 - ✓ Couplings, bearings and gear failure analysis.
- Machinery component analysis and reliability improvement (continued):
 - ✓ Mechanical seals and O-Ring failures – selection strategies.
- Machinery component analysis and reliability improvement (continued):
 - ✓ Machinery lubrication management (economics & optimization).
- Vendor selection and reliability review methods:
 - ✓ Why reliability reviews are justified.
 - ✓ Centrifugal pump selection examples.
- Vendor selection and reliability review methods (continued):
 - ✓ Compressor reliability review examples.
- Machinery troubleshooting:
 - ✓ The matrix approach to machinery troubleshooting (for pumps, compressors, fans, turbines, and others).
 - ✓ Examples from litigation cases.
- Vibration analysis - a management overview:
 - ✓ Specific machinery problems.
 - ✓ Monitoring and analysis methods.
 - ✓ Future outlook.
- Structured problem solving sequence:
 - ✓ Situation analysis.
 - ✓ Cause analysis.
 - ✓ Action generation.
 - ✓ Decision making.





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