CONTENTS

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## CONTENTS

### VOLUME I

#### Mechanical Engineering

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1. Introduction
2. Mechanical Engineering Stages
   2.1. Origins of Mechanical Engineering
   2.2. Mechanical Engineering in more Recent Times
3. Scientific and Technological Progress and Mechanical Engineering

#### Strength of Materials and Damage Assessment

A.V. Berezin, *Laboratory of mathematical modeling of vibroacoustic process, A.A. Blagonravov Institute of Mechanical Engineering, Russian Academy of Sciences, Moscow, Russia*

1. Damage and Mechanical Behavior of Materials
2. General Ideas and Definitions
3. Structures and Bond Types of Solids
4. A Physical View of Defects
5. Dislocation Mechanisms of Origin and Growth of Cracks
6. Fractography of Surfaces of Extending Cracks
7. Fundamental Definitions of Defects
8. Methods for Evaluating the Level of Damage

#### Nonlinear models and Plasticity

A.V. Berezin, *A.A. Blagonravov Institute of Mechanical Engineering, Russian Academy of Sciences, Moscow, Russia (Laboratory of mathematical modeling of vibroacoustic process)*

1. Plasticity
2. Theory of Slipping
3. The Deformation Theory
4. The Yielding Theory. A Regular Plasticity
5. A Singular Plasticity
6. An Analytical Plasticity
7. A Principle of Macrodeterminism
8. A Behavior of Elastic-plastic Materials with Defects

#### Pressure Vessels and Shell Structures

N.A. Makhutov, *Mechanical Engineering Research Institute of the Russian Academy of Science, Moscow, Russia*

Yu. G. Matvienko, *Mechanical Engineering Research Institute of the Russian Academy of Science, Moscow, Russia*

1. Introduction
2. Areas of Application of Pressure Vessels and Shell Structures
3. Design of Pressure Vessels
4. Structural Elements of Pressure Vessels
5. Shell Structures of Composite Materials
6. Strength and Analysis of Pressure Vessels and Shell Structures
   6.1. Strength of Pressure Vessels
   6.2. Robust Hull Strength of Submarine Vessels
   6.3. Fuselage Strength of Aircraft

<table>
<thead>
<tr>
<th>Reliability, Diagnostics and Fault Correction</th>
<th>159</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.V. Bolotin, Institute of Mechanical Engineering Research, Russian Academy of Sciences, Moscow, Russia</td>
<td></td>
</tr>
<tr>
<td>V.V. Klyuev, Moscow Scientific Industrial Association “Spectrum”, Moscow, Russia</td>
<td></td>
</tr>
</tbody>
</table>

1. The Subject of Reliability Theory
2. Standardization in Reliability
3. Reliability and its Components
4. States, Failures and their Classification
5. Reliability Measures
6. Repairable Items
7. Diagnostics and Condition Monitoring in Mechanical Engineering
8. Non-Destructive Testing
9. Fault Correction
10. Trends and Perspectives

<table>
<thead>
<tr>
<th>System Reliability Analysis</th>
<th>182</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.V. Bolotin, Laboratory of Reliability, Institute of Mechanical Engineering Research, Russian Academy of Sciences, Moscow, Russia</td>
<td></td>
</tr>
</tbody>
</table>

1. Reliability Measures for Elements
2. Statistical Estimation of Reliability Measures
3. Series Configuration Systems
4. Parallel Configuration Systems
5. Complex Systems and Redundancy
6. Fault Tree Analysis
7. Event Tree Analysis
8. Two-Side Estimates for Reliability Measures

<table>
<thead>
<tr>
<th>Mathematical Models of Physical Reliability Theory</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.V. Bolotin, Laboratory of Reliability, Institute of Mechanical Engineering Research, Russian Academy of Sciences, Moscow, Russia</td>
<td></td>
</tr>
</tbody>
</table>

1. Failures in Mechanical Systems
2. General Concepts of the Physical Reliability Theory
3. Load-Strength Model
4. Multidimensional Time-independent Models
5. Cumulative Time-dependent Models
6. Poisson Models
7. Failure as the First Excursion of a Random Process

<table>
<thead>
<tr>
<th>Reliability Against Fracture and Fatigue</th>
<th>220</th>
</tr>
</thead>
<tbody>
<tr>
<td>V.V. Bolotin, Laboratory of Reliability, Institute of Mechanical Engineering Research, Russian Academy of Sciences, Moscow, Russia</td>
<td></td>
</tr>
</tbody>
</table>

1. Fracture and Fatigue in Mechanical Engineering
2. Linear Fracture Mechanics
3. Nonlinear Fracture Mechanics
4. Traditional Approach to Fatigue Analysis
5. Theory of Fatigue Crack Growth
6. Failure as the Loss of Integrity

**Fault Detection and Diagnostics of Failures**

V. V. Klyuev, Moscow Scientific Industrial Association “Spectrum”, Moscow, Russia
V. N. Filinov, MSIA “Spectrum”, Moscow, Russia

1. Basic Concepts
2. Relationship between Diagnostics and Reliability
3. Diagnostics aspects at the Design Stage
4. Diagnostics at the Manufacturing Stage
5. Diagnostics at the Operation Stage
6. Diagnostics at the Repair and Storage Stages

**Non-Destructive Testing**

V.V. Klyuev, Moscow Scientific Industrial Association "Spectrum", Moscow, Russia

1. Classification of NDT Methods
2. Magnetic NDT Methods
3. Electric NDT Methods
4. Eddy Current NDT Methods
5. Microwave NDT Methods
6. Infrared NDT Methods
7. Optical NDT Methods
8. Radiographic NDT Methods
9. Ultrasonic NDT Methods
10. Penetrant NDT Methods
11. Other NDT Methods

**Fault Correction in Mechanical Systems**

V.V. Klyuev, Moscow Scientific Industrial Association, Russia
F.R. Sosnin, Moscow Scientific Industrial Association, Russia

1. General Information about Faults
2. Defects in Welds, their Causes and Removal
3. Methods to Minimize Welding Deformations, Stresses and Shifting
4. Defects in Metallic Casts and Method to eliminate them
5. Faults in Bearing Joints and Ways to eliminate them
6. Faults in Motor Vehicle Units and Assemblies and Methods of Removing them

**Nonlinear Deformation and Fracture Mechanics for Engineering Approaches in Design of Structures**

N.A. Makhutov, Department of Strength and Engineering Safety of Materials and Constructions, Mechanical Engineering Research Institute, Russian Academy of Sciences, Moscow, Russia
M.M. Gadenin, Department of Strength and Engineering Safety of Materials and Constructions, Mechanical Engineering Research Institute, Russian Academy of Sciences, Moscow, Russia

1. General Load Conditions for Engineering Structures
2. Deformation Fracture Criteria under Static and Low Cyclic High Temperatures Loading
3. Stress-Strain Fracture Criteria under High Cyclic Loading
4. Stress-Strain Fracture Criteria under Two-Frequency Cyclic Loading
5. Life Time Prediction in Cycle Loading Condition
6. Elasto-Plastic Strain at the Crack Initiation in the Notch Affected Area
7. The Crack Propagation at Low Cycle Loading
8. The Generalized Effects of Stress and Strain Concentration for Substantiation of Constructions Safety
9. Engineering Approaches to Design of Structures

**Industrial and Manufacturing Engineering**

Berman Cilingir Kayis, *The School of Mechanical and Manufacturing Engineering, University of New South Wales, Sydney, Australia*

1. Introduction
2. Background
3. System-Wide Approach
   3.1. Real-World Relevance
      3.1.1. It Is About People
      3.1.2. Educate Beyond Manufacturing
4. Fundamentals of Industrial and Manufacturing Engineering
5. Definitions and Key Concepts
6. Management of Operations
7. System Models for Management of Manufacturing Operations
   7.1. Objectives of the Management of Manufacturing Operations
   7.2. Examples of System Models in Manufacturing Operations
8. Human Factors and Ergonomics in Industrial Engineering
   8.1. Technology-Oriented Systems
   8.2. Human and Organization-Oriented Systems
9. Production and Distribution Systems
10. Manufacturing
   10.1. Environmental Context
   10.2. Legal and Institutional Terrain
   10.3. Culture and Civil Society
   10.4. Economy and Technology
11. Management in Industrial and Manufacturing Engineering
12. Quality: a Management Philosophy
13. New Engineering Processes for the Twenty-First Century
14. Conclusion

Index

About EOLSS
5.3. Ventilation and Acoustical Comfort
   5.3.1. Acceptable Noise Levels
   5.3.2. Noise from HVAC Systems
   5.3.3. Noise Attenuating Measures

6. Indoor Air Quality
   6.1. Ventilation and IAQ
      6.1.1. The VRP Procedure
      6.1.2. The IAQ Procedure
   6.2. Ventilation Control Strategies
   6.3. Humidity and IAQ

7. Energy Conservation

Mechanical Ventilation and Equipment
Constantinos A. Balaras, National Observatory of Athens, Hellas, Greece

1. Introduction
2. Systems
3. Equipment
   3.1. Controls
4. Air Distribution
   4.1. Ductwork
   4.2. Air Diffusion—Circulation

Pollution Control Technologies
B. Nath, European Centre for Pollution Research, London, United Kingdom.
G. St. Cholakov, Department of Organic Synthesis and Fuels, University of Chemical Technology and Metallurgy, Sofia, Bulgaria.

1. Introduction
2. Control of Particulate Matter in Gaseous Emissions
3. Control of Gaseous Pollutants
4. Pollution Control through Efficient Combustion Technology
5. Pollution Control in Industrial Processes
6. Pollution Control in Transportation

Modeling and Simulation of Dynamic Systems
Inge Troch, Vienna University of Technology, Austria
Felix Breitenecker, Vienna University of Technology, Austria

1. Introduction
2. Systems, Processes and Models
3. Simulation
4. Classification of Systems and Models
   4.1. Properties of Systems and Models
   4.2. Properties of Models only
   4.3. Some Additional Remarks on the Properties 'Static' and 'Dynamic'
5. Modeling
   5.1. Some General Considerations
      5.1.1. Modeling and Modeler
      5.1.2. Modeling and Modeling Goals
      5.1.3. Model Structure
      5.1.4. Model Complexity
   5.2. Verification and Validation
   5.3. Numerical Aspects
   5.4. System Structure and Model Structure
5.5. System Descriptions and Relations between Models
6. A Short History of Simulation
   6.1. Continuous-time Simulation
   6.2. Discrete-event Simulation

**Combustion Research and Computer Fluid Dynamics**

A. Buekens, *Department of Chemical Engineering - CHIS 2, Vrije Universiteit Brussel, Belgium*

1. Combustion Research
   1.1. Phenomena and Processes
   1.2. Combustion Conditions
2. Combustion Research
   2.1. Survey
   2.2. Mathematical Modeling
   2.3. Experimental
   2.4. Turbulence
3. Basic Types of Flames
   3.1. Mixing is Burning
   3.2. Premixed Flames
      3.2.1. Modeling Laminar Premixed Flames
   3.3. Diffusion Flames
      3.3.1. Survey
      3.3.2. Modeling
      3.3.3. Internal Combustion Engines
   3.4. Liquid and Solid Particles Burning-off
4. Combustion Fundamentals: Chemical Aspects
   4.1. Thermodynamic State Functions
   4.2. The First Law of Thermodynamics
   4.3. Chemical Reactions
   4.4. The Second Law - Reversibility – Entropy
   4.5. Equilibrium Data
   4.6. Equilibrium Composition
5. Practical Problems
   5.1. Survey
   5.2. Complete Combustion
   5.3. Computer Fluid Dynamics
   5.4. Case Study: Fluidized Bed Incineration
   5.5. Theory and Practice
6. Conclusions

**Thermal to Mechanical Energy Conversion: Engines and Requirements**

Oleg N. Favorsky, *Division of Physical-Technical Problems of Energetics, Russian Academy of Sciences, Russia*

1. Introduction: Brief Historical Review
2. General Information on Heat Cycles
3. Combustion of Fuel
4. Steam Engines and Machines
5. Piston Engines
6. Bladed Engines: Steam Turbines
7. Gas Turbines
8. Aircraft Gas Turbine Engines
9. Space Engines
10. Conclusion
Yuri M. Pchelkin, Department of Gas Turbine Plants, Bauman Moscow State University, Russia

1. Industrial fuel
2. Fuel combustion
3. Organic fuels and problem of toxic combustion products

Fundamentals of the Heat Transfer Theory
B.M. Galitsevsksiy, Department of the - Aviation Space Thermotechnics, Moscow Aviation Institute, Russia

1. Types of Heat Transfer
2. Investigation Method of Heat Transfer
3. Differential Equations and Uniqueness Conditions
4. Simplified Equations
5. Transition from Laminar to Turbulent Flow
6. Heat Transfer Coefficient and Friction Resistance
7. Similarity and Modeling of Heat Transfer Processes
8. Criterial Equations for Convective Heat Transfer in the Boundary Layer
9. Criterial Equations for Convective Heat Transfer in Channels
10. Heat Conduction Process
11. Radiative Heat Transfer

Thermodynamic Cycles of Reciprocating and Rotary Engines
R.S. Kavtaradze, Moscow Bauman State Technical University, Russia.

1. The main kinds of reciprocating engines
2. Work Done by a Working Fluid in the Cylinder of a Reciprocating Engine
3. Working Process and Indicator Diagram of a Four-stroke Engine
5. Main Concepts of Thermodynamics
6. Main Distinctions Between Actual and Thermodynamic Cycles and Efficiency of a Cycle
7. Carnot cycle
8. Generalized Thermodynamic Cycle of Piston and Combined Engines
9. Otto cycle
10. Diesel cycle
11. Trinkler cycle
12. Comparative analysis of thermodynamic cycles of piston engines
13. Combined internal combustion engines (CICE)
14. Thermodynamic cycle of CICE with the impulse turbine
15. Thermodynamic Cycle of CICE with Constant Pressure in Front of the Turbine
16. Thermodynamic cycle of CICE with intermediate cooling of a working fluid
17. Stirling cycle
18. About the thermodynamic cycles of rotary internal combustion engines (ICE)

Noise Problem
Valeri G. Nesterenko, Faculty "Engines of aircraft", Moscow aviation institute (engineering university), Russia.

1. Physical fundamentals of noise and sound
   1.1. Concepts about noise and sound
   1.2. Basic parameters and performances
2. Effect of noise on the human being
   2.1. Action of a noise
   2.2. Correction of a level of sound pressure
2.3. Level of a perceived noise
2.4. Effective level of a perceived noise
3. Norms on admissible level of environmental aircraft noise and noise of ground GTE
   3.1. Noise of AC’s
   3.2. Noise of helicopters
   3.3. Noise in cabins
   3.4. Noise of ground GTP
4. Sources of a noise of AJE
   4.1. Total characteristic of sources of noise.
   4.2. PROP of TPE
      4.2.1. Component of a noise of propeller
      4.2.2. Methods of calculation of noise level of propeller
   4.3. Fan TFE, compressor GTE
      4.3.1. Sources and level of noise
      4.3.2. Lowering of a noise of the compressor
   4.4. Combustion chamber of GTE
   4.5. Turbine of GTE
   4.6. Jet nozzle of AJE
      4.6.1. Acoustic power and level of a force of a sound
      4.6.2. Application of noise mufflers
   4.7. Sound-absorbing constructions and their application
5. Tests for the definition of acoustic performances of GTE
   5.1. Acoustic performance of GTE
   5.2. Measuring of a noise of engine
   5.3. Muffling of a noise at tests
6. Factors, influencing to restriction of an aviation noise
7. Acoustic influence of transport, problem of slackening of a noise
8. Noise of power plants of a ground transport
   8.1. Radiants of a noise and their relative significance
   8.2. Radiants of a noise of internal combustion engine
   8.3. Methods of lowering of a noise of engine
9. Vibroacoustic diagnostics

Index

About EOLSS

VOLUME III

Turbines
E.A. Manushin, Professor, Doctor of Technical Sciences, Department of Power Engineering, Moscow State Technical University named after Bauman, Russia

1. Introduction
   1.1. Hydraulic and Steam Turbines
   1.2. Gas turbines
   1.3. Terms 'turbine' and 'unit'
2. The common information on work of turbines of various types
   2.1. Principles of the turbine work
   2.2. Classification of turbines
   2.3. Thermodynamic and kinematic parameters of the one-stage turbine
      2.3.1. Change of parameters in a stage
      2.3.2. Degree of reaction of a stage
      2.3.3. Specific work and efficiency of the turbine
3. Multistage turbines
3.1. Velocity stages and pressure stages
3.2. Change of parameters on height of a flow passage of the turbine
4. Feature of a radial flow (centripetal) turbines
5. Characteristics of turbines
6. Steam turbines and steam turbine units
   6.1. Steam turbines
      6.1.1. Main parameters of steam turbines
      6.1.2. Main types of steam turbines
      6.1.3. Basic thermodynamic parameters of steam turbine units
7. Ways of increase of efficiency of steam turbine units
8. Gas turbines and gas turbine units
   8.1. Features of gas turbines
   8.2. Basic thermodynamic parameters of gas turbine units
   8.3. Ways to increase the efficiency of gas turbine units
9. Multi-modal units with gas turbines
10. Gas turbine units working on a closed thermodynamic cycle
11. Combined units with steam and gas turbines
   11.1. Feature of the combined turbine units
   11.2. Basic schemes and thermodynamic cycles of the combined turbine units
12. Cooling of gas turbines

Compressors
V. S. Beknev, Department of Power Engineering, Moscow Bauman State Technical University, Moscow, 107005, Russia

1. Compressor Definition, Types of Compressors
   1.1. Axial flow compressor (AFC)
      1.1.1. AFC stage
      1.1.2. Stage parameters
      1.1.3. Multistage axial flow compressor (MAFC)
   1.2. Radial flow compressor (RFC)
      1.2.1. RFC stage
      1.2.2. RFC stage parameters
      1.2.3. Multistage RFC (MRFC), its parameters
   1.3. Combined compressors (CC)
      1.3.1. Turbine compressor (TC)
      1.3.2. Parameters and the fields of application of the CC
2. Basic equations for the gas dynamic compressor design
   2.1. Basic equations of the fluid mechanics
      2.1.1. Flow rate equation
      2.1.2. Impulse equations (L. Euler)
      2.1.3. Energy equation (Bernoulli). The gas dynamic functions.
   2.2. Basic thermodynamic equations
      2.2.1. First law equation
      2.2.2. Second law equation
      2.2.3. Processes of the compression and the expansion
   2.3. Diagrams T-s and p-v for these processes
      2.3.1. Loss coefficients interconnection for the flow in the channel
3. Gas dynamic compressor design
   3.1. Axial flow compressor stage design
      3.1.1. Plane cascade. Joukovski’s formulas
      3.1.2. Plane cascade performance
      3.1.3. Untwisted straight blade cascade. The endwall losses
      3.1.4. MAFC stage design
   3.2. Radial flow compressor stage design
      3.2.1. RFC rotor design
      3.2.2. Vaneless diffuser (VLD) design
3.2.3. Vaned diffuser (VD) design
3.3. Inlet and outlet duct design
4. Blade (vane) and duct design
   4.1. Axial flow compressor rotor and stator design. The chord estimation
   4.2. RFC stage itself design
   4.3. Duct design
5. Gas dynamic compressor performance, modeling and control

**Lubrication Systems**

Valeri G. Nesterenko, Faculty "Engines of Aircraft", Moscow Aviation Institute (Engineering University), Russia.

1. Introduction
2. General information on friction and lubrication
3. Aviation oils, requirements and service properties
4. Purpose, structure and functioning of oil systems
5. Kinds of lubrications of aircraft engines friction units. Scavenging of heat by oil and required oil circulation
6. Friction and lubrication of ball and roller bearings in aviation GTEs
   6.1. Friction and Magnitude of Friction Coefficient in Rolling-element Bearings
   6.2. Purposes and Tasks of Oil Circulation
   6.3. Rated Estimation of GTE Compressor Roller Bearings’ Thermal Mode
   6.4. Procedure of Calculation of GTE Compressor Ball Bearings’ Thermal Mode
   6.5. Procedure of Calculation of GTE Turbine Supports Roller Bearings’ Thermal Mode
   6.6. Calculation of TPE’s Reduction Gears Bearings’ Thermal Mode
7. One-shot lubrication system of a GTE with short service life
8. Sealing of GTE rotor support bearings oil chambers
9. Lubrication and cooling of plain bearings
   9.1. Construction and Calculation of Supports with Plain Bearings
   9.2. Calculation of Oil Consumption through the Plain Bearing
      9.2.1. The Radial Bearings
      9.2.2. The Axial Plain Bearings
10. Circulation of oil and capacity of a lubrication system of aircraft GTEs
    10.1. Requirements to Circulation of Oil in GTE
    10.2. Quantity of Heat, going into Oil in GTE Rotor Supports
11. The schemes of lubrication systems and systems of aircraft GTEs breathing
    11.1. The Schemes of Lubrication Systems
    11.2. Systems of Breathing
12. Peculiarities of maintenance of aircraft GTEs OS
13. Compressor station and GPA: oil-supply systems, oil cleaning machines and system of oil cooling
    13.1. Systems of Oil–supply of Compressor Station and of GPA
    13.2. Oil Cleaning Machines
    13.3. System of Oil Cooling
14. Lubrication systems of PE
    14.1. Kinds of Lubrication Systems
    14.2. Adjusting and Controlling Devices
    14.3. Additional devices of a lubrication system

**Heat Exchangers**

V.L. Ivanov, Power Engineering Department, Moscow Bauman State Technical University, Moscow, Russia

1. Introduction
2. Heat exchanger role in gas turbine units
3. Types of heat exchangers. Principle of operation
4. Heat exchanger pressure drop influence on the efficiency and the capacity of gas turbine installations
5. Heat exchanger pressure drop
6. Heat transfer surface types of heat exchangers
7. Heat transfer through heat transfer surface
8. Design of recuperative-type heat exchangers
   8.1. Heat Exchangers with Predetermined Magnitude of Working Fluid Pressure Drops
   8.2. Heat Exchangers with Fixed Gabarit
   8.3. Cross-flow Heat Exchanger with Predetermined Heat Transfer Surface Area $F$
   8.4. Liquid Coupled Indirect Type Heat Exchangers
9. Design of regenerative-type heat exchangers
   9.1. Regenerative Heat Exchanger with Rotating Matrix
   9.2. Regenerative Heat Exchanger with Stationary Matrix
10. Temperature expansion compensation system
11. Fouling problem
12. Conclusion
8.3. Environmental Constraints

9. Safety and Risk
   9.1. Safety Implications
   9.2. Risk of Power Generation
   9.3. Nuclear Safety
   9.4. Engineered Safeguards

10. Future Prospects
    10.1. Controlling Factors
    10.2. Electricity Demand
    10.3. Fuel Availability
    10.4. Financial Resources
    10.5. Environmental Controls
    10.6. Electrical Grid System
    10.7. Combined Cycles
    10.8. Life Extension

11. Renewable Resources
    11.1. Relative Importance and Feasibility

12. Energy Technologies
    12.1. Magnetohydrodynamics
    12.2. Fuel Cells
    12.3. Nuclear Fusion

---

Power Plant Technology

Robin Anthony Chaplin, Department of Chemical Engineering, University of New Brunswick, Canada

1. Technological Decisions
   1.1. Scope of Topic
   1.2. Scientific Knowledge
   1.3. Engineering Experience

2. Fundamental Requirements
   2.1. Common Principles
   2.2. Capital Cost
   2.3. Fuel Cost
   2.4. Efficiency
   2.5. Availability
   2.6. Reliability
   2.7. Unplanned Maintenance
   2.8. Planned Maintenance
   2.9. Maintenance Costs

3. Environmental Considerations
   3.1. General Scope
   3.2. Plant Safety
   3.3. Environmental Safety
   3.4. Sustainability

4. Thermodynamic Cycles
   4.1. Basic Concepts
   4.2. Now-Flow Gas Cycles
      4.2.1. Otto cycle (Spark Ignition)
      4.2.2. Diesel Cycle (Compression Ignition)
      4.2.3. Dual Cycle
   4.3. Steady-Flow Gas Cycles
      4.3.1. Brayton Cycle
      4.3.2. Actual and Modified Cycles
      4.3.3. Regenerating Cycle
      4.3.4. Intercooling Cycle
      4.3.5. Reheating Cycle or Afterburning Cycle
      4.3.6. Turbojet Cycle
4.4. Steady-Flow Steam Cycles
   4.4.1. Saturated Rankine Cycle
   4.4.2. Superheated Rankine Cycle
   4.4.3. Superheated-Reheated Rankine Cycle
   4.4.4. Saturated-Reheated Rankine Cycle
   4.4.5. Regenerative Cycle
   4.4.6. Actual and Modified Cycles

4.5. Combined and Hybrid Cycles
   4.5.1. Combined Cycles
   4.5.2. Steam Injected Gas Turbine
   4.5.3. Pressurized Fluidized Beds
   4.5.4. Nuclear Gas Turbines

5. Applications of Thermodynamic Cycles
   5.1. Governing Factors
       5.1.1. Plant Capacity
       5.1.2. Fuel Availability
       5.1.3. Plant Duty

   6.1. Thermal Cycle Efficiency
   6.2. Heat Transfer
   6.3. Energy and Exergy Flows
   6.4. Thermo-economic Analysis

7. Fuels and Efficiency
   7.1. Calorific Value
   7.2. Combustion Calculations
   7.3. Efficiency Determination
       7.3.1. Input-output Method
       7.3.2. Heat Loss Method
   7.4. Gaseous Effluents
   7.5. Nuclear Fuel

8. Metallurgy and Chemistry
   8.1. Material Selection
   8.2. Carbon Steel
       8.2.1. Carbon
       8.2.2. Manganese
       8.2.3. Molybdenum
       8.2.4. Chromium
       8.2.5. Nickel
   8.3. Other Metals
       8.3.1. Copper
       8.3.2. Titanium
       8.3.3. Nickel
       8.3.4. Zirconium
   8.4. Material Damage
       8.4.1. Fatigue Failure
       8.4.2. Creep Rupture
       8.4.3. Thermal Fatigue
       8.4.4. Overheating Damage
       8.4.5. Corrosion Damage
       8.4.6. Erosion Damage
       8.4.7. Radiation Damage
   8.5. Material Inspection
       8.5.1. Liquid Penetrant Testing
       8.5.2. Magnetic Particle Inspection
       8.5.3. Eddy Current Testing
       8.5.4. Ultrasonic Testing
       8.5.5. Radiography
   8.6. Water Chemistry
Thermal Fluid Theory
Robin Anthony Chaplin, Department of Chemical Engineering, University of New Brunswick, Canada

1. Introduction
1.1. Heat Transfer
1.2. Fluid Flow
2. Conduction
2.1. General Conduction Equation
2.2. Heat Generation and Conduction
2.3. Heat Conduction through Cylindrical Walls
2.4. Contact Resistance
2.5. Composite Heat Transfer Paths
3. Convection
3.1. General Convection Equation
3.2. Empirical Formulae for Convection
   3.2.1. Nusselt Number \( Nu \)
   3.2.2. Grashof Number \( Gr \)
   3.2.3. Reynolds Number \( Re \)
   3.2.4. Prandtl Number \( Pr \)
4. Radiation
4.1. Radiation Equation for Black Bodies
4.2. Radiation Equation for Grey Bodies
4.3. Radiation from Gases
5. Boiling and Condensing
5.1. Phase Change Phenomena
5.2. Pool Boiling
5.3. Flow Boiling
5.4. Boiling Heat Transfer
5.5. Condensing Heat Transfer
6. Heat Exchangers
6.1. Classification
6.2. Heat Exchanger Heat Transfer
7. Two Phase Flow
7.1. Flow Patterns
7.2. Mass and Volume Fractions
7.3. Slip Ratio
8. Fluid Friction
8.1. Single Phase Flow
8.2. Two Phase Flow
9. Fluid Circulation
9.1. Natural Circulation
9.2. Forced Circulation
9.3. Average Density

Thermodynamic Theory
Robin Anthony Chaplin, Department of Chemical Engineering, University of New Brunswick, Canada

1. Introduction
2. Fundamental Equations
   2.1. Equation of State
   2.2. Continuity Equation
   2.3. Energy equation
   2.4. Momentum Equation
3. Thermodynamic Laws
   3.1. The Laws of Thermodynamics
   3.2. Heat Engine Efficiency
   3.3. Heat Rate
   3.4. Carnot Cycle
   3.5. Available and Unavailable Energy

4. Thermodynamic Cycles
   4.1. The Carnot Cycle
   4.2. The Rankine Cycle
   4.3. The Brayton Cycle
   4.4. Entropy Changes
   4.5. Thermodynamic Processes
      4.5.1. Constant Pressure Process
      4.5.2. Constant Temperature Process
      4.5.3. Constant Entropy Process
      4.5.4. Constant Enthalpy Process
   4.6. Thermodynamic Diagrams

5. Steam Turbine Applications
   5.1. Introduction
   5.2. Turbine Processes
   5.3. Turbine Efficiency
   5.4. Reheating
   5.5. Feedwater Heating

---

Power Plant Steam Cycle Theory
Robin Anthony Chaplin, Department of Chemical Engineering, University of New Brunswick, Canada

1. Cycle Efficiencies
   1.1. Introduction
   1.2. Carnot Cycle
   1.3. Simple Rankine Cycles
   1.4. Complex Rankine Cycles

2. Turbine Expansion Lines
   2.1. T-s and h-s Diagrams
   2.2. Turbine Efficiency
   2.3. Turbine Configuration
   2.4. Part Load Operation

---

Exergy Analysis
Robin Anthony Chaplin, Department of Chemical Engineering, University of New Brunswick, Canada

1. Introduction
   1.1. Theoretical Thermodynamic Cycle Concepts
   1.2. Practical Modifications to Cycle Concepts
   1.3. Reversible and Irreversible Processes
      1.3.1. Mixing of Fluids of Different Temperatures
      1.3.2. Heat Transfer Across a Temperature Difference
      1.3.3. Friction in a Flowing Fluid
   2. Available Energy and Availability
      2.1. Available Energy Principles
      2.2. Availability as a Property
   3. Heat Exchangers
      3.1. Application of Available Energy Principles
      3.2. Heat Exchanger Analysis
   4. Steam Turbines
      4.1. Transfer of Available Energy
4.2. Change of Heat Rejection Temperature
5. Complete Steam Cycle
   5.1. Exergy Analysis
   5.2. Example of Exergy Analysis
   5.3. Energy and Exergy Flow Diagrams
6. Thermo-economic Analysis
   6.1. Development of Exergy Concept
   6.2. Example of Thermo-economic Analysis
   6.3. Application of Thermo-economic Analysis

**Power Plant Materials**

Derek H. Lister, *Department of Chemical Engineering, University of New Brunswick, Canada*

1. Introduction
2. Metals and their Properties
   2.1. Steels
   2.2. Nickel Alloys
   2.3. Zirconium Alloys
   2.4. Magnesium Alloys
   2.5. Copper Alloys
   2.6. Titanium Alloys
3. Conclusion

**Fossil Fuel Plant Materials and Chemistry**

Derek H. Lister, *Department of Chemical Engineering, University of New Brunswick, Canada*

1. Introduction: A Typical Plant
2. Materials Applications
   2.1. Boiler Plant
   2.2. Turbine Plant
3. Chemistry Considerations
   3.1. Fire/Combustion Side
   3.2. Steam/Water Side
      3.2.1. System Makeup Water Treatment
      3.2.2. Boiler Feedwater Treatment
4. Conclusion

**Gas Turbine Fundamentals**

H.I.H. Saravanamuttoo, *Department of Mechanical and Aerospace Engineering, Carleton University, Canada*

1. Gas Turbines for Electric Power Generation: Introduction
2. Basics of gas turbine operation
3. Ideal Cycles
   3.1. Simple Gas Turbine Cycle
   3.2. Modifications to the Simple Cycle
      3.2.1. Heat Exchange Cycle
      3.2.2. Reheat Cycle
      3.2.3. Intercooling
      3.2.4. Heat Exchange, Reheat and Intercooling
4. Real Cycles
   4.1. Typical Performance Results
5. Combined Cycles
6. Cogeneration Plant
7. Off-design Performance
Solid Wastes for Power Generation
Swietenbank J, Sheffield University Waste Incineration Centre, UK
Nasserzadeh V, Sheffield University Waste Incineration Centre, UK
Goh R, Sheffield University Waste Incineration Centre, UK

1. Introduction
2. Waste as Fuel
3. The Energy Content of Waste
4. Incineration Principles
   4.1. Mathematical Modeling of the Gas and Particle Flow
   4.2. Modeling of the Burning Refuse Bed in a Traveling Grate Incinerator
   4.3. Freeboard Combustion
5. Pollution Control
6. Power Generation Principles and Concepts (Thermodynamic Cycles)
   6.1. City Waste Factors
      6.1.1. Superheating the Incinerator Steam with Supplementary Fuel
      6.1.2. Integration of the Incinerator Steam with a Combined Cycle
      6.1.3. Ultra High Temperature Heat Exchanger Application
      6.1.4. Some Novel Thermodynamic Systems
      6.1.5. Co-Gasification Systems
      6.1.6. Small-Scale Units for Developing Countries
      6.1.7. Coincineration
      6.1.8. Other Considerations
      6.1.9. Incentives and Human Factors
7. Future Opportunities for Waste, Energy, and Pollution Control for Sustainable Cities
8. Economic Factors
9. Conclusions

Steam Generators and Steam Distribution Networks
Reinhard Leithner, Technische Universität Braunschweig, Germany

1. Steam Generators
   1.1. Types and Technologies
   1.2. Operating Modes
   1.3. Furnaces and Heat Sources
2. Steam Distribution Networks
3. Laws, Regulations, Guidelines, and Standards
4. Main Control Systems
   4.1. Fuel and Air Control
   4.2. Feedwater Control
   4.3. Steam Temperature Control
   4.4. Nuclear Reactor Control
   4.5. (Programmable) Logic Control
   5.1. Advanced Control Methods
   5.2. Monitoring, Analysis, and Diagnosis
      5.2.1. Monitoring
      5.2.2. Analysis
MECHANICAL ENGINEERING, ENERGY SYSTEMS AND SUSTAINABLE DEVELOPMENT

5.2.3. Diagnosis
5.2.4. Diagnosis Programs
5.3. Validation
5.4. Expert Systems
5.5. Power Plant Management
6. Experience and Practical Suggestions

Gas Turbines
Hans-Kaspar Scherrer, ABB Switzerland, Power Technologies Division, Switzerland
Christopher Ganz, ABB Switzerland, Power Technologies Division, Switzerland
Wolfgang Weisenstein, ABB Switzerland, Power Technologies Division, Switzerland

1. Power Plant Setups
2. Gas Turbine Components
   2.1. Air Intake
   2.2. Compressor
   2.3. Combustor
      2.3.1. Gas Turbine Combustion Basics
      2.3.2. The Classic Gas Turbine Combustor
      2.3.3. Dry Low Emission Combustors
   2.4. Turbine
      2.4.1. Auxiliary Systems
3. The Ideal Gas Turbine Cycle
   3.1. Gas Turbine Cycle with Losses
4. Gas Turbine Control
5. Turbine Control System
   5.1. Open Loop Control
   5.2. Gas Turbine Start-up
   5.3. Closed Loop Control
   5.4. Protection System

Exergetics
Göran Wall, Independent researcher, Mölndal, Sweden

1. The Exergy Concept
   1.1. Thermodynamics and Thermostatics
   1.2. Energy and Exergy
   1.3. Calculation of Exergy
   1.4. Reference States
   1.5. Exergy and Work
   1.6. Exergy of Pressure
   1.7. Exergy of Heat and Cold
   1.8. Exergy of Light
   1.9. Exergy of Material Substances
   1.10. Exergy of Nuclear Fuel
   1.11. Exergy of Information
   1.12. Exergy Losses
   1.13. Exergy Efficiencies
   1.15. Exergy Utility Diagrams
2. Exergy and Life Cycle Analysis
   2.1. Exergy Analysis
   2.2. Life Cycle Analysis or Assessment
   2.3. Life Cycle Exergy Analysis
3. Exergetics and Economics
   3.1. Exergetics and Macroeconomics
3.2. Exergetics and Microeconomics
   3.2.1. Thermoeconomic Accounting
   3.2.2. Thermoeconomic Optimization
3.3. Exergy of Emissions and Pollution

Exergy, Energy System Analysis, and Optimization
Christos A. Frangopoulos, National Technical University of Athens, Greece

1. Introduction
2. Historical Evolution of Exergy Analysis
   2.1. The Early Years (1824 - 1900)
   2.2. The Period of Development (1930 - 1980)
   2.3. The Concepts of Exergy and Irreversibility
3. Thermoeconomics in the Design and Operation of Energy Systems
4. Optimization in Energy Systems
   4.1. Definition of Optimization
   4.2. The Need for Optimization
   4.3. A Brief Historical Overview
      4.3.1. Development of Optimization Techniques
      4.3.2. Introduction of Optimization to Energy Systems
   4.4. Formulation of the Optimization Problem
      4.4.1. Mathematical Statement of the Optimization Problem
      4.4.2. Objective Functions
      4.4.3. Independent Variables
      4.4.4. Equality and Inequality Constraints
   4.5. Levels of Optimization of Energy Systems
   4.6. Methods for Solution of the Optimization Problem
   5.1. Design, Knowledge, and Artificial Intelligence
   5.2. Definition of Artificial Intelligence
   5.3. Expert Systems
6. Energy Systems and Sustainability
   6.1. The General Social Framework
   6.2. Sustainability Considerations in Energy Systems Analysis
   6.3. Global Implications of the Second Law of Thermodynamics
7. Future Work

Pinch Analysis
Francois Marechal, Ecole Polytechnique Federale de Lausanne, Switzerland

1. Introduction
2. Energy-Capital Trade-off for Heat Recovery by a Heat Exchanger
3. Defining the Minimum Energy Requirement of a Process
   3.1. The Composite Curves
   3.2. The Pinch Point
   3.3. The Heat Cascade
   3.4. The Problem Table Method
   3.5. The Grand Composite Curve
4. Consequences of the Pinch Point Location
   4.1. Heat Sink and Heat Source
   4.2. The More In, The More Out
   4.3. Penalizing Heat Exchangers
      4.3.1. Exchangers using Hot Utility below the Pinch Point
      4.3.2. Exchangers using Cold Utility above the Pinch Point
      4.3.3. Exchangers that do exchange heat across the pinch point
5. Utility Integration
6. Targeting the Investment
   6.1. The Minimum Number of Connections Target
   6.2. Total Area Target
   6.3. Capital Cost Estimation
   6.4. Optimal $\Delta T_{\text{min}}$ Value
   6.5. Physical Meaning of the $\Delta T_{\text{min}}$

7. Summary of the Targeting Method

8. Heat Exchanger Network (HEN) Design
   8.1. Representing a Heat Exchanger Network
   8.2. The HEN Design Target

9. The Pinch Design Method
   9.1. Feasibility Rules
      9.1.1. Number of Streams Rule
      9.1.2. The $c_p$ Rule
   9.2. Heuristic Rules
      9.2.1. Tick-off Rule
      9.2.2. Remaining Problem Analysis
      9.2.3. Driving Force Plot and Splitting Factors
      9.2.4. Other Heuristics
      9.2.5. A Synthesis Method

10. Mathematical Programming Approach
   10.1. Heat Load Distribution

11. Optimizing the Heat Exchanger Network Design
   11.1. Loops and Path for Reducing the Number of Heat Exchangers
   11.2. Using Mixed Integer Non Linear Programming Methods

12. Final Remarks Concerning the Heat Exchanger Network Design

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The Thermodynamic Process of Cost Formation

Antonio Valero, Center of Research for Energy Resources and Consumption, Centro Politécnico Superior, Universidad de Zaragoza, Spain.

1. Introduction
   1.1. Irreversibility and exergy cost

2. Definitions and concepts

3. Cost accounting and the exergy cost theory
   3.1. Calculation of average exergy costs
   3.2. Calculation of exergoeconomic costs
   3.3. External assessment and additional concepts
      3.3.1. Exergy Amortization
      3.3.2. Residues (Wastes)
      3.3.3. Assessment of the plant fuels
      3.3.4. Cumulative exergy cost or ecological cost

4. On the nature of costs
   4.1. Linearity of costs
   4.2. The process of cost formation

5. Conclusion

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Structural Theory of Thermoeconomics

Luis Serra, University of Zaragoza, Spain
Cesar Torres Cuadra, Universidad de Zaragoza, Spain

1. Introduction
2. Marginal Costs
   2.1. Characteristic Equations
   2.2. General Equation of Marginal Cost
2.3. Generalized Fuel Impact
2.4. Lagrange Multipliers and Marginal Costs
3. Structural Theory of Thermoeconomics
   3.1. Linear Model of Characteristic Equations
   3.2. Average and Marginal Costs
4. Structural Theory as Standard for Thermoeconomics
   4.1. Structural Theory and Exergy Cost Theory
      4.1.1. Structural Theory and the FuelProduct Model
   4.2. Structural Theory and Thermoeconomic Functional Analysis
5. Applications
   5.1. Local Optimization
6. Closure

Modeling, Simulation and Optimization in Energy Systems

Christos A. Frangopoulos, National Technical University of Athens, Greece
Enrico Sciubba, Università di Roma 1 “La Sapienza”, Italy

1. Introduction
2. Modeling and Simulation of Energy Systems
   2.1. Definition of Modeling and Simulation
   2.2. A Brief History of Energy Systems Design Procedures
   2.3. Modeling
   2.4. Simulation
      2.4.1. Simulation of Individual Processes and Components
      2.4.2. Simulation of Complex Processes and Plants
3. Optimization in Energy Systems
   3.1. Definition of Optimization
   3.2. The Need for Optimization
   3.3. A Brief Historical Overview
      3.3.1. Development of Optimization Techniques
      3.3.2. Introduction of Optimization to Energy Systems
   3.4. Formulation of the Optimization Problem
      3.4.1. Mathematical statement of the optimization problem
      3.4.2. Objective Functions
      3.4.3. Independent Variables
      3.4.4. Equality and Inequality Constraints
   3.5. Levels of Optimization of Energy Systems
   3.6. Methods for Solution of the Optimization Problem

Design Optimization of Power and Cogeneration Systems

Yehia M. El-Sayed, Advanced Energy Systems Analysis, California, USA

1. Introduction
2. The Optimal System Design for Time-independent Production
   2.1. The Interacting Resources of an Energy-conversion Device
      2.1.1. Quantification of the Making and Operating Resources
   2.2. Making and Operating Resources of a System of Devices
   2.3. A Decomposition Strategy
      2.3.1. Decomposition at the Discipline Level
      2.3.2. Decomposition at the Device Level
      2.3.3. The Updating Equation
      2.3.4. The Price of Exergy Destruction
      2.3.5. Global Decision Variables
3. An Application Example of Time-Independent Production
4. The Optimal System Design for Time-dependent Production
   4.1. Problem Complexity
   4.2. The Computation of System Off-design Performance
       4.2.1. The Performance Equations of Devices
       4.2.2. The Performance Equation of a System of Devices
   4.3. An Illustration of Off-design Computations
       4.3.1. Convergence
       4.3.2. Design and Off-design Results
       4.3.3. Overall System Performance Equation
   4.4. A Simplified Screening Method for Time-dependent Production
5. Application Examples of Time-dependent Production
   5.1. Power and Heat Cogeneration for Variable Demands
       5.1.1. The Investigation Made
   5.2. The Optimal Operating Mix of Power Plants
       5.2.1. The Condition of Optimality
       5.2.2. Illustrative Example
6. Concluding Remarks

**Electrical Network Optimization**
John Kabouris, Hellenic Transmission System Operator (HTSO), Greece
George C. Contaxis, National Technical University of Athens (NTUA), Greece

1. Introduction
2. Transmission System Optimal Expansion Planning
3. Transmission System Operational Requirements
4. Statement of the Optimization Problem
   4.1. Problem Statement
   4.2. Formulation
   4.3. Modelling of Planning Criteria
   4.4. Technical Planning Constraints
5. Optimization Methodologies
6. Conclusion

**Artificial Intelligence and Expert Systems in Energy Systems Analysis**
Enrico Sciubba, Università di Roma “La Sapienza”, Italy

1. Introduction
2. Is there a "universal" design paradigm?
   2.1. The "Universal Design Procedure": a possible Flowchart
       2.1.1. Definition of Needs and Objectives
       2.1.2. Preliminary Estimate of the Design Costs
       2.1.3. Feasibility Study
       2.1.4. Final Design
       2.1.5. Construction
       2.1.6. Testing and Customer’s Acceptance
       2.1.7. Modifications and Improvements
3. Application of the Universal Design Procedure to Process Synthesis
   3.1. Formulation and Position of a Process Engineering Design task
   3.2. Towards a General Process Synthesis Paradigm
4. Design and "Optimization"
5. Process Optimization
   5.1. The Classical Viewpoint
   5.2. Some Additional Remarks on the Optimization of Thermal Systems
   5.3. Optimization Criteria
   6.1. Deterministic Methods for Process Synthesis
6.1.1. The Connectivity Matrix Method
6.2. Process Synthesis based on AI Methods
   6.2.1. Expert Systems for Design
   6.2.2. General Knowledge Representation for Design Applications
   6.2.3. Example of Automatic Process Design
7. Application of the Universal Design Procedure to the Design of Component
8. Expert Assistants for Process Diagnostics and Prognostics
9. Conclusions

Sustainability Considerations in the Modeling of Energy Systems

Michael R. von Spakovsky, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA

1. Introduction
2. Expansion of the Meaning of "Optimal System" – Sustainability
3. Pollution and Resource-related Indices
5. Role of the Second Law of Thermodynamics
6. National and Global Exergy Accounting of Natural Resources
7. Conclusions

Life-Cycle, Environmental and Social Considerations - Sustainability

Enrico Sciubba, Università di Roma 1 “La Sapienza”, Roma, Italy
Paolo Frankl, Università di Roma 1 “La Sapienza”, Roma, Italy

1. Introduction
2. Extension of the concept of "Optimal System"
   2.1. Including the Effects of a Finite Plant Life
   2.2. Including the Effects of the Life-cycle of the Product
   2.3. The Environmental Externality
   2.4. The Social Externality
   2.5. Material cycles
      2.5.1. Non-Renewable Resources
      2.5.2. Renewable resources
3. The tools required for an extended analysis
   3.1. Embodied Energy Analysis, “EA”
   3.2. Life Cycle Assessment, “LCA”
      3.2.1. Methodology
      3.2.2. Key Features and Limits of LCA
      3.2.3. Examples of the application to energy systems
   3.3. Exergetic Life Cycle Assessment, ELCA
   3.4. The “Cumulative Exergy Content” Method, CEC
   3.5. A Critique of Neo-Classical Economics
   3.6. Emergy Analysis, EmA
   3.7. Extended Exergy Accounting, EEA
4. Application of the tools - Implementation issues and possible solutions
   4.1. Availability and Quality of Data
   4.2. Impact Assessment Indicators and their Evaluation
   4.3. The Single Value Indicator Problem
   4.4. Multi-criteria Methods for the Interpretation of the Results
   4.5. Asking the Right Question
5. Towards what kind of sustainable society?
   5.1. The "Spaceship Earth" Paradigm
   5.2. Strong and Weak Sustainability
   5.3. Resource Scarcity: Myth or Reality?
   5.4. Sustainable Use of Resources
Analysis and Optimization of Energy Systems with Sustainability Considerations

Michael R. von Spakovsky, Virginia Polytechnic Institute and State University, USA
Christos A. Frangopoulos, National Technical University of Athens, Greece

1. Introduction
2. The Environomic Optimization Problem
   2.1. Statement of the Problem and its Objective or Figure of Merit
   2.2. Pollution Measures, Penalties, and Costs
   2.3. Resource Scarcity Measures, Penalties, and Costs
4. Market-Based Approaches for Internalizing Environmental Externalities
5. Additional Considerations
6. Application Examples on Analysis and/or Evaluation
   6.1. Economic Analysis of a Gas-Turbine Cogeneration System
      6.1.1. Description of the System
      6.1.2. Net Present Cost of the System
      6.1.3. Unit Cost of SO\textsubscript{2} Abatement
      6.1.4. Critical Values of the SO\textsubscript{2} Penalty
      6.1.5. Numerical Application
   6.2. Evaluation of Alternative Systems
7. Application Examples on Optimization
   7.1. Optimization of a Gas-Turbine System with SO\textsubscript{2} Abatement
      7.1.1. Statement of the Optimization Problems
      7.1.2. Numerical Results and Comments
   7.2. Optimization of a Recuperative Gas-Turbine Cogeneration System
      7.2.1. Statement of the Optimization Problems
      7.2.2. Numerical Results and Comments
   7.3. Optimization of a District Heating Network with Centralized and Decentralized Heat Pumps, Cogeneration, and/or a Gas Furnace
      7.3.1. The DHN Super-Configuration for the Environomic Model
      7.3.2. Statement of the Optimization Problem
      7.3.3. Numerical Results and Comments
8. Closure
5. Equilibrium Conditions in Simple Systems
   5.1. Thermal Equilibrium
   5.2. Mechanical Equilibrium
   5.3. Chemical Equilibrium

6. Graphical Representation of Equilibrium States

7. Stability of Thermodynamic Equilibrium States

8. Eulero and Gibbs–Duhem Equations

9. Entropy and Transformation of Heat into Work
   9.1. The Carnot Cycle
   9.2. Common Thermodynamic Cycles

10. Entropy and its Absolute Value: Third Law of Thermodynamics

11. Other State Functions for Equilibrium Conditions in Chemical Systems: Enthalpy and Free Energies
    11.1. Free Energy at Constant Volume or Helmholtz Potential
    11.2. Free Energy at Constant Pressure or Gibbs Potential

12. Relationships among State Functions


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Composite Defects and Their Detection

Robert Alan Smith, Structural Materials Centre, QinetiQ Ltd, Cody Technology Park, Farnborough, UK

1. Introduction
   1.1. Scope
   1.2. Defects in Composites
   1.3. Significance of Defects in Composites
   1.4. Detection methods
      1.4.1. Detection methods
      1.4.2. Low-frequency Vibration Methods

2. Types of Defect in Composites
   2.1. Manufacturing Defects
   2.2. In-service Defects

3. Ultrasonic Inspection Methods
   3.1. Basic Ultrasonics
      3.1.1. Ultrasound
      3.1.2. Interaction with Materials
   3.2. Choice of Frequency
   3.3. Defect Detection and Characterization
      3.3.1. Detection
      3.3.2. Delamination Sizing
      3.3.3. Measurement of Bulk Attenuation
   3.4. Ultrasonic Imaging Techniques
      3.4.1. General Imaging Principles
      3.4.2. Ultrasonic A-scan
      3.4.3. Ultrasonic B-scan
      3.4.4. Ultrasonic C-scan
      3.4.5. Ultrasonic Depth Scan
      3.4.6. Pseudo-3D Imaging
   3.5. Production Inspection Techniques
      3.5.1. Immersion Testing
      3.5.2. Ultrasonic Jet Probes
   3.6. In-service Inspection Techniques
      3.6.1. Manual Single-point Inspection
      3.6.2. Manual Scanning and Imaging
      3.6.3. Automated Scanning and Imaging
      3.6.4. Roller Probes
      3.6.5. Multi-element Array Probes
   3.7. Specialist Ultrasonic Techniques
      3.7.1. Velocity Measurement
3.7.2. Full Ultrasonic Waveform Capture
3.7.3. Acoustic Backscattering
3.7.4. Polar Scans
3.7.5. Laser Ultrasound Techniques
3.7.6. Lamb Wave Propagation

4. Low-frequency Vibration Methods
4.1. Global Assessment
   4.1.1. Natural Frequency Measurement
   4.1.2. Damping Measurements
4.2. Local Assessment
   4.2.1. Tap Test
   4.2.2. The Mechanical Impedance Method
   4.2.3. Membrane Resonance Method
   4.2.4. Velocimetric and Other Pitch-catch Methods
   4.2.5. Choice of Local Technique

5. Acoustic Emission and Acousto-Ultronics

6. X-Radiography

7. Optical Methods

8. Thermal Methods
   8.1. Thermal Imaging
   8.2. Pulsed Thermography
   8.3. Lock-in Thermography

Earth's Available Energy And The Sustainable Development Of Life Support Systems 83
V. Brodianski, Moscow Power Institute, Russia

1. Introduction
2. The Problem of a "Universal Measure" for Matter and Energy Resources
   2.1. The Thermodynamic Basis of the Available Energy Concept
      2.1.1. The Fundamental Role of the Two Thermodynamic Laws
      2.1.2. The Role of Environment in Defining Available Energy
      2.1.3. Defining Exergy for Different Energy Forms
3. Exergy Balances and Efficiency of Artificial Life Support Systems
   3.1. Exergy Balances of Systems and Characteristics of their Sophistication
   3.2. Exergy Analysis of Engineering Systems and their Results
   3.3. Conclusion
4. The Available Energy and Resources of the Earth
   4.1. Introduction
   4.2. Three Forms of Earth’s External Energy Balances
      4.2.1. The Earth’s External Energy Balance
      4.2.2. Entropy Balance of the Earth
      4.2.3. Exergy Balance of the Earth
   4.3. Internal Material and Energy Balances of the Earth
      4.3.1. Inorganic Sphere
      4.3.2. Biosphere
      4.3.3. Human-engineered Sphere (LSS)
5. Two Approaches to Economics and LSS Development
   5.1. Economic Sciences and Natural Productive Forces
   5.2. Market Economy Science: What it Can and Cannot Do
   5.3. Natural Theory of Value
   5.4. Optimization of LSSs: Three Types of Goal Functions
6. Conclusion: The Approach to "Ecological Economy"
1. Significance of the Second Law of Thermodynamics
2. Dissipation of Energy
3. Influence of the Laws of Non-equilibrium Thermodynamics
4. Influence of Solar Radiation on the State of the Terrestrial Environment
5. Influence of the Emission of Deleterious Waste Products and Deforestation
6. Depletion of Non-renewable Natural Resources
7. Conservation of the Natural Environment
   7.1. Improvement of the Thermodynamic Imperfection of Processes
   7.2. Reduction of the CO₂ Emission
   7.3. Utilization of Renewable Energy Sources
   7.4. Utilization of Waste Products
   7.5. Mitigation of the Consumption of Final Products
8. Conclusions

Industrial Ecology 160
Lawrence K. Wang, United Nations Industrial Development Organization, Vienna, Austria

1. Introduction and Definitions of Industrial Ecology
2. Goal, Role and Objectives
3. Approach and Applications
4. Tasks, Steps and Framework for Implementation
5. Qualifications of Industrial Ecologists
6. Ways and Means for Analysis and Design
7. Sustainable Agriculture, Industry and Environment
8. Zero Emission and Related Terms
9. Case Studies of Successful Hazardous Waste Management through Industrial Ecology Implementation
   9.1. New Galvanizing Steel Technology Used at Delot Process SA Steel Factory, Paris, France
   9.2. Reduction of Hazardous Sulfide in Effluent from Sulfur Black Dyeing at Century Textiles, Bombay, India
   9.3. Replacing Toxic Solvent-based Adhesives with Non-toxic Water-based Adhesives at Blumenthorf Packaging Plant, Kent, UK
   9.4. Recovery and Recycling of Toxic Chrome at Germanakos SA Tannery near Athens, Greece
   9.5. Recovery of Toxic Copper from Printed Circuit Board Etchant for Reuse at Praegitzer Industries, Inc., Dallas, Oregon, USA
   9.6. Recycling of Hazardous Wastes as Waste-derived Fuels at Southdown, Inc., Houston, Texas, USA
10. Conclusions

Industrial Metabolism 175
Andreas Windsperger, Institute for Industrial Ecology, St. Pölten, Austria

1. Industrial Ecology and Sustainability
   1.1. Policy- and Material-related Developments
2. Basic Concepts of Industrial Ecology
   2.1. The Biological Analogy
   2.2. Types of Industrial Ecology
   2.3. Limits of the Analogy
   2.4. Shortcomings of Interlinked Systems and Strategies
3. Industrial Ecology and the Relation to Tools and Methods
   3.1. Life-cycle Approach
   3.2. Material Flow Analysis
      3.2.1. Draft IN-OUT Balance
      3.2.2. Adjusting the Balance
      3.2.3. Constructing Material-Flow-Chains
4. Examples for Applications

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4.1. Material-Flow Analysis and Life-cycle Thinking
   4.1.1. Assessing Waste Treatment
   4.1.2. Importance of Life-cycle Aspects for Environmental Management
4.2. Examples for Industrial Ecosystems
   4.2.1. Kalundborg: An Industrial Ecosystem in Denmark
   4.2.2. OMV–Austria, Schwechat
   4.2.3. The Houston Ship Channel
   4.2.4. Material Metabolism in Companies
5. How to Achieve Industrial Ecosystems—Potential Benefits
   5.1. Benefits to Industry
   5.2. Benefits to the Environment
   5.3. Benefits to Society
6. Conclusion
4.1. Continuous Rotating Gas Lift
4.2. Intermittent Gas Lift
5. Plunger Lift

Mechanics of Solids 339
Ramon Peralta Fabi, Facultad de Ciencias, Universidad Nacional Autonoma de Mexico (UNAM), México
1. Introduction
2. Historical Notes
3. General Considerations
4. Classical Theory of Elasticity
  4.1. Beams and Plates
  4.2. Body and Surface Waves
  4.3. The Navier Equations
5. Fracture
6. Finite Elasticity
7. Computational Mechanics
8. Granular Materials

Inverse Problems In Experimental Solid Mechanics 350
Fabrice Pierron, Arts et Métiers ParisTech (ENSAM), Châlons-en-Champagne, France
Stéphane Avril, Ecole Nationale Supérieure des Mines, Saint-Étienne, France
1. General Introduction to Inverse Problems in Solid Mechanics
   1.1. Significance and Importance
   1.2. Main Types of Practical Inverse Problems
2. Identification of Constitutive Behavior of Materials: Theory
   2.1. Statement of the Problem
   2.2. Principal Methods of Resolution
      2.2.1. Direct Inversion
      2.2.2. Model Updating Techniques
      2.2.3. The Virtual Fields Method
3. Identification of Constitutive Behavior of Materials: Applications
   3.1. Detailed Survey of Identification Problems in Linear Elasticity for Homogeneous Materials
      3.1.1. Vibration-Based Techniques
      3.1.2. Quasi-Static Tests
   3.2. Elasto-Plasticity
   3.3. Soft Materials
   3.4. Heterogeneous Materials
      3.4.1. Damaged Materials
      3.4.2. Materials with Gradients of Properties
   3.5. High Strain Rate Testing
   3.6. Microscale Applications
4. Conclusion and Perspectives

Index 389

About EOLSS 395