

Handbook on Production, Recycling of Lithium Ion and Lead-Acid Batteries (with Manufacturing Process, Machinery Equipment Details & Plant Layout) (2nd Edition)

Author:- P.K. Tripathi

Format: paperback

Code: NI330

Pages: 544

Price: Rs.2999US\$ 250

Publisher: NIIR PROJECT CONSULTANCY SERVICES

Usually ships within **5** days

Handbook on Production, Recycling of Lithium Ion and Lead-Acid Batteries
(with Manufacturing Process, Machinery Equipment Details & Plant Layout)

India is one of the world's largest battery manufacturers. Furthermore, there is an increase in global demand for batteries, and Indian battery producers are preparing to satisfy this need. The Indian battery sector has grown by 25% year over year and is expected to increase even more in the future. Batteries, such as Sealed Maintenance Free (SMF), lead-acid, or lithium-ion batteries, now power virtually everything else on the world.

The global battery market was worth USD 108.4 billion and is predicted to increase at a CAGR of 14.1%. The increasing demand from the automotive application is responsible for the market's rise. Rechargeable batteries are utilised in non-rechargeable batteries and electric vehicles in the automobile industry. The rising global popularity of consumer electronics is expected to increase the use of lithium-ion batteries as a product category. Portable electronics, such as LCD displays, smartphones, tablets, and wearable devices like fitness bands, are in high demand, increasing market growth. Because of technical developments in terms of increased efficiency, cost-effectiveness, and product innovation, the market is predicted to rise significantly. Battery demand is likely to be driven by strict emission requirements imposed by government agencies in industrialized countries such as the United States and the United Kingdom, as well as an increasing focus on fuel efficiency.

The demand for lithium-ion batteries is predicted to increase by more than 500 percent in the future. Many predictions suggest that demand will outpace supply, virtually assuring a price increase. All of the businesses in this field have unique opportunities to invest in the future of energy storage and transportation.

The global lithium-ion battery market size was valued at USD 53.6 billion and is expected to grow at a compound annual growth rate (CAGR) of 19.0%. The market's expansion can be ascribed to the rising demand for lithium-ion batteries in electric vehicles (EVs) and grid storage, since they provide high-energy density and lightweight solutions. The market size is expected to grow due to an increase in the registration of electric vehicles.

The global lead-acid battery industry is growing significantly across the globe and it is likely to register a CAGR of 5.2% during the forecast period. Growing SLI applications in the automobile sector, increase in renewable energy output, and rising demand for energy storage devices are some of the causes driving up demand for lead-acid batteries. As the telecom industry expands in nations like the United States, Brazil, India, and the United Kingdom, there is a growing

demand for UPS systems as a backup power source, resulting in a higher usage of lead–acid batteries as a cost-effective energy source.

The book covers a wide range of topics connected to Batteries, as well as their manufacturing processes. It also includes contact information for machinery suppliers, as well as images of equipments.

A complete guide on Production, Recycling of Lithium Ion and Lead-Acid Batteries manufacture and entrepreneurship. This book serves as a one-stop shop for everything you need to know about the Battery manufacturing industry, which is ripe with opportunity for manufacturers, merchants, and entrepreneurs. This is the only book that covers Production, Recycling of Lithium Ion and Lead-Acid Batteries in depth. From concept through equipment procurement, it is a veritable feast of how-to information.

1. INTRODUCTION

1.1. Principles of Operation

1.2. Primary Batteries

1.2.1. Zinc–Manganese Dioxide Systems

1.2.2. Zinc–Mercuric Oxide Battery

1.2.3. Zinc–Silver Oxide Battery

1.2.4. Lithium Batteries

1.2.5. Air-Depolarized Batteries

1.2.6. Other Primary Battery Systems

1.2.7. Storage Batteries

1.2.8. Lead-Acid Batteries

1.2.9. Alkaline Storage Batteries

1.2.10. Lithium Storage Batteries

1.3. Development of Batteries

2. BATTERY DESIGN AND FUNCTION

2.1. Lithium Ion Battery Electrochemistry and Function

2.1.1. Anode and Cathode Material Consideration

2.1.2. Cylindrical vs Prismatic Cell Design Tradeoffs

2.2. Battery Module Design Approach

2.3. Safety Considerations

3. INDUSTRIAL BATTERY OUTLOOK

3.1. The Lead-Acid Segment Expected to Dominate the Market

3.2. Asia-Pacific to Dominate the Industrial Battery Market

4. FUTURE SCOPE OF LITHIUM ION BATTERIES

4.1. Present Day Lithium Ion Batteries

4.2. Deficiencies of Present Lithium Ion Batteries and Likely Improvements

4.3. Li-Ion Batteries are Amazing Energy Storage Devices

4.4. The Future of Li-Ion Energy Storage

4.5. A Finite Resource

4.6. Early Li-Ion Battery Development

5. FUTURE OF LITHIUM-ION BATTERIES AND ELECTRIFICATION

5.1. Major Trends

5.2. Technological Trends

5.3. Future Trends in Battery Technology

5.4. Conclusion

6. LITHIUM ION BATTERY

6.1. General Characteristics

- 6.2. Advantages
- 6.3. Classification
- 6.4. Chemistry
 - 6.4.1. Lithium
 - 6.4.2. Cathode Materials
 - 6.4.3. Electrolytes
 - 6.4.4. Cells Couples and Reaction Mechanisms
- 6.5. Characteristics of Lithium Primary Batteries
 - 6.5.1. Summary of Design and Performance Characteristics
 - 6.5.2. Soluble-Cathode Lithium Primary Batteries
 - 6.5.3. Solid-Cathode Lithium Primary Cells
- 6.6. Safety and Handling of Lithium Batteries
 - 6.6.1. Factors Affecting Safety and Handling
- 6.7. Safety Considerations
- 6.8. Lithium/Sulfur Dioxide (Li/SO₂) Batteries
 - 6.8.1. Chemistry
 - 6.8.2. Construction
 - 6.8.3. Performance
- 6.9. Cell and Battery Types and Sizes
- 6.10. Use and Handling of Li/SO₂ Cells and Batteries—Safety Considerations
- 6.11. Applications
- 6.12. Lithium/Thionyl Chloride (Li/SOCl₂) Batteries
 - 6.12.1. Chemistry
 - 6.12.2. Bobbin-Type Cylindrical Batteries
 - 6.12.3.
 - 6.12.4. Li/SOCl₂ Cells, Flat or Disk-Type
- 7. LITHIUM-ION BATTERY APPLICATIONS
 - 7.1. Personal Transportation Applications
 - 7.2. Automotive Applications
 - 7.3. Microhybrid Electric Vehicles
 - 7.4. Hybrid Electric Vehicles
 - 7.5. PHEVs and EREVs
 - 7.6. Battery Electric Vehicles
 - 7.7. Fuel Cell EVs
 - 7.8. Bus and Public Transportation
 - 7.9. HD Truck Applications
 - 7.10. Industrial Applications
 - 7.11. Robotics and Autonomous Applications
 - 7.12. Marine and Maritime Applications
 - 7.13. Grid and Stationary Applications
 - 7.14. Bulk Energy Storage
 - 7.15. Ancillary Services
 - 7.16. Transmission and Distribution Infrastructure Services
 - 7.17. Customer Energy Management Services
 - 7.18. Community Energy Storage
 - 7.19. Aerospace Applications
- 8. LITHIUM BATTERY MANUFACTURING
 - 8.1. Electrode Coating
 - 8.2. Cell Assembly
 - 8.2.1. Prismatic Cells
 - 8.2.2. Cylindrical Cells

- 8.3. Formation
- 8.4. Process Control
- 8.5. Support Services
- 8.6. Lithium ion Battery Pack Assembly Line Making Machine
 - 8.6.1. Battery Cell Tester
 - 8.6.2. Auto Paper Pasting Machine
 - 8.6.3. Auto Sorting Machine
 - 8.6.4. Spot Welding Machine
 - 8.6.5. Integrated Tester
 - 8.6.6. Charging Discharging Aging Machine
- 9. RECYCLING OF LITHIUM-ION BATTERIES
 - 9.1. Repairing and Remanufacturing
 - 9.2. Refurbishing, Repurposing, and Second Life
 - 9.3. Second Life Partnerships
 - 9.4. Recycling
 - 9.5. Manufacturing Process
 - 9.6. Manufacturing Equipments
 - 9.6.1. Filter Press–Removal of the Black Mass
 - 9.6.2. Filter Press–Removal of the Lithium Carbonate
 - 9.6.3. Features
 - 9.7. Evaporation and Heated Tank System
 - 9.8. Clarifier
 - 9.8.1 Features
 - 9.9. Sludge Dryer
 - 9.9.1. Features and Benefits
 - 9.10. Thermal Evaporators
 - 9.10.1. Benefits of Evaporators
 - 9.11. Reverse Osmosis (RO)
 - 9.11.1. Applications
 - 9.12. Ultrafiltration
 - 9.12.1. Attributes
 - 9.13. Atmospheric Evaporators
- 10. ALUMINIUM–AIR BATTERY
 - 10.1. Electrochemistry
 - 10.2. Materials and Methods
 - 10.2.1. Materials
 - 10.2.2. Hydrogen Evolution and Half-Cell Test
 - 10.2.3. Full-Cell Test
 - 10.3. Results and Discussion
 - 10.4. Aluminium-Air Battery: Discovery, Commercial Alloys and State of The Art
 - 10.5. Discovery and Production
 - 10.6. Commercial Aluminium Alloys
- 11. ALKALINE BATTERY
 - 11.1. Electro-Chemical Description
 - 11.2. Temperature Effects on Performance
 - 11.3. Voltage and Capacity
 - 11.4. Discharge Types
 - 11.5. Shelf Life
 - 11.6. The Shelf Life is influenced by Temperature, Humidity and Internal Construction
 - 11.7. Testing / Care / Warnings
 - 11.7.1. Testing
 - 11.7.2. Warnings

- 11.8. Current
- 11.9. Construction
- 11.10. Recharging of Alkaline Batteries
 - 11.10.1. Leaks
 - 11.10.2. Disposal
 - 11.10.3. Alkaline Battery Recycling Industry
- 11.11. HOW ARE BATTERIES MADE?
- 12. METAL-AIR BATTERY
 - 12.1. Anodes for Metal-Air Batteries
 - 12.1.1 Lithium
 - 12.1.2. Magnesium
 - 12.1.3. Iron
 - 12.1.4. Zinc
 - 12.2. Cathodes for Metal-Air Batteries
 - 12.3. Catalyst for Air Cathodes
- 13. LEAD-ACID BATTERIES
 - 13.1. Introduction
 - 13.2. Lead Batteries in Applications
 - 13.2.1. Types of Lead-Acid Batteries
 - 13.2.2. Typical Commercially Available Battery Units
 - 13.2.3. Use Pattern of Lead-Acid Batteries
 - 13.2.4. Charge–Discharge Procedures of Lead-Acid Batteries
 - 13.3. Non automobile Applications of Lead-Acid Batteries
 - 13.3.1. Stationary Applications of Lead-Acid Batteries
 - 13.3.2. Standby Applications of Lead-Acid Batteries
 - 13.3.3. Backup Power Applications of Lead-Acid Batteries
 - 13.4. Automobile Applications of Lead-Acid Batteries
 - 13.4.1. Automobile Starting-Lighting-Ignition Applications
 - 13.4.2. Electric and Hybrid Electric Vehicle Applications of Lead-Acid Batteries
- 14. LEAD-ACID BATTERIES FUNDAMENTALS, TECHNOLOGIES, AND APPLICATIONS
 - 14.1 Introduction
 - 14.2 Materials and Properties
 - 14.2.1. Porosity, Pore Size, and Pore Shape
 - 14.2.2. Ionic Resistance
 - 14.2.3. Electrochemical Compatibility
 - 14.2.4. Acidic and Oxidation Stability
 - 14.2.5. Puncture Resistance
 - 14.2.6. Surface Area
 - 14.3. Separator Synthesis
 - 14.3.1. Polyethylene Separator
 - 14.3.2. Absorptive Glass Mat Separator
 - 14.3.3. Separator
 - 14.3.4. Rubber Separators
 - 14.4. Separator Structure Design and Fabrication
 - 14.4.1. Positive Ribs
 - 14.4.2. Negative Ribs
 - 14.4.3. Embossed/Corrugated
 - 14.4.4. Compression/Resiliency
 - 14.4.5. Fabrication

14.5. Effects of Material Composition, Morphology, and

Synthesis Conditions on Battery Performance

14.5.1. Antimony Poisoning and Water Loss

14.5.2. Low Electrical Resistance

14.6. Effect of Battery Operating Conditions on Separator Performance

14.6.1. Basic Condition/Extreme Shrinkage

14.6.2. Hydration Shorts

14.6.3. Extreme Oxidation

14.7. Technical Challenges, Mitigation Strategies, and Perspectives

14.7.1. High-Power Starter Batteries

14.7.2. Deep-Cycle Batteries

15. LEAD-ACID BATTERY MANUFACTURING EQUIPMENT

15.1 Casting in a Grid

15.1.1 Grid Caster

15.1.2.Strip Expansion Grid

15.1.3 Continuous Grid Caster

15.2. Production of Lead Oxide

15.2.1. Barton Pot Process

15.2.2. Ball Mill process

15.3. Paste Mixing

15.3.1. Batch Paste Mixer

15.4. Pasting

15.5. Curing

15.6. Formation

15.6.1. Formation of Positive Plates

15.6.2. Formation of Negative Plates

15.6.3. Tank Formation

15.6.4. Case Formation

15.7. Battery Assembly

15.7.1.Group Stacking

15.7.2. Alignment

15.7.3. Group Burning

15.7.4. Group Alignment

15.8. Group Insertion

15.8.1. Inspection and Terminal Alignment

15.8.2. Short Circuit Testing

15.8.3. Intercell Welding

15.8.4. Shear Testing

15.8.5. Case Cover Sealing

15.8.6. Leak Testing

15.8.7. Terminal (Post) Burning

15.8.8. Aluminum Foil Sealing

15.8.9. Acid Filling

15.8.10. Packing

15.8.11. Quality Assurance and Control

16. RECYCLING OF LEAD-ACID BATTERY

16.1. Battery Breaking

16.1.1. Historical Background of Battery Breaking

16.1.2. Modern Battery Breaking Process

16.1.3. Battery Breaking: Potential Sources of

- Environmental Contamination
- 16.2. Lead Reduction
 - 16.2.1. Pyrometallurgical Methods
 - 16.2.2. Hydrometallurgical Methods
 - 16.2.3. Lead Reduction: Potential Sources of Environmental Contamination
- 16.3. Lead Refining
 - 16.3.1 Pyrometallurgical Refining
 - 16.3.2 Lead Refining: Potential Sources of Environmental Contamination
- 16.4. Lead Battery Recycling Plant
 - 16.4.1. Scope
- 16.5 Manufacturing Equipment:
 - 16.5.1. Battery Cutting Machines / Battery Breakers
 - 16.5.2. Rotary Furnace
 - 16.5.3. Pollution Control Plant
 - 16.5.4. Refining and Alloying Pots
 - 16.5.5. Ingotting Systems
- 17. ZINC-CARBON BATTERY
 - 17.1. General Characteristics
 - 17.2. Chemistry
 - 17.3. Types of Cells and Batteries
 - 17.3.1. Leclanche´ Batteries
 - 17.3.2. Zinc Chloride Batteries
 - 17.4. Construction
 - 17.4.1. Cylindrical Configuration
 - 17.4.2. Inside Out Cylindrical Construction
 - 17.4.3. Flat Cell and Battery
 - 17.4.4 Special Designs
 - 17.5. Cell Components
 - 17.5.1. Zinc
 - 17.5.2. Bobbin
 - 17.5.3. Manganese Dioxide (MnO_2)
 - 17.5.4. Carbon Black
 - 17.5.5. Electrolyte
 - 17.5.6. Corrosion Inhibitor
 - 17.5.7. Carbon Rod
 - 17.5.8. Separator
 - 17.5.9. Seal
 - 17.5.10. Jacket
 - 17.5.11. Electrical Contacts
 - 17.6. Performance Characteristics
 - 17.6.1. Voltage
 - 17.6.2. Discharge Characteristics
 - 17.6.3. Effect of Intermittent Discharge
 - 17.6.4. Comparative Discharge Curves—Size Effect Upon Heavy Duty Zinc-chloride Batteries
 - 17.6.5. Comparative Discharge Curves—Different Battery Grades
 - 17.6.6. Internal Resistance
 - 17.6.7. Effect of Temperature
 - 17.6.8. Service Life
 - 17.6.9. Shelf-Life

- 17.7. Special Designs
 - 17.7.1. Flat-Pack Zinc/Manganese Dioxide P-80 Battery
- 17.8. Battery Parameters
- 17.9. Types and Sizes of Available Cells and Batteries
- 18. ENVIRONMENTAL ISSUES FOR BATTERIES
 - 18.1. Lifecycle Analysis (LCA)
 - 18.2. Material Issues
 - 18.2.1. Resource Availability
 - 18.3. Environmental Impacts
 - 18.3.1. Electrode Materials
 - 18.3.2. Electrolyte Risks
 - 18.3.3. Binders
 - 18.4. Material Issues: Going Forwards
 - 18.4.1. Energy Density
 - 18.4.2. Alternative Materials
 - 18.4.3. Non-Fluorinated Binders
 - 18.4.4. Cobalt Substitution
 - 18.5. Energy Issues: Production and Charging
 - 18.5.1. Source Of Energy for Production
 - 18.5.2. Roundtrip Efficiency
 - 18.6. Lifespan
 - 18.7. End-of-Life (EoL) treatment
 - 18.7.1. Recycling
 - 18.7.2. Re-Use
 - 18.7.3. Design for Recycling and Re-Use
- 19. INTERNATIONAL STANDARDS AND TESTING APPLICABLE TO BATTERIES
 - Standards and Safety Testing Organisations
 - General Battery Standards
 - Lithium Battery Standards
 - Nickel Metal Hydride Battery Standards
 - Nickel Cadmium Battery Standards
 - Lead Acid Battery Standards
 - Photovoltaic Battery Standards
 - Safety Standards
 - Automotive Battery Standards
 - Aircraft Battery Standards
 - Military Standards for Batteries, Software, EMC/RFI, Safety & Quality
 - Radio Battery Standards
 - Standby Power Systems Standards
 - Software Standards
 - EMC/RFI Standards
 - Ingress Protection (IP) Standards
 - Battery Monitoring Standards
 - Battery Recycling and Disposal Standards
 - Other Related Electrical Standards
 - Quality Standards
- 20. BIS SPECIFICATIONS
- 21. PLANT LAYOUT AND PROCESS FLOW CHART & DIAGRAM
- 22. AUTOMATED MANUFACTURING EQUIPMENT
 - 22.1. Equipment Specifications

- 22.2. Kaido Winder
- 22.3. Hibar Equipment
 - 22.3.1. Module 1: Bottom Tab Welding System
 - 22.3.2. Module 2: Beading/Grooving System
 - 22.3.3. Module 3: Sealant Dispensing System
 - 22.3.4. Module 4: Electrolyte Filling System
 - 22.3.5. Module 5: Top Tab Welding and Taping System
 - 22.3.6. Module 6: Final Crimping System
- 22.4. Formation and Test Equipment
- 22.5. Machine Vision Approach and Implementation
 - 22.5.1. Part Serial Number / Bar Code Tracking
- 22.6. Manufacturing Equipment Installation
- 22.7. Operator Training
- 22.8. Manufacturing Equipment Validation
 - 22.8.1. Kaido Winder Validation
 - 22.8.2. Hibar Resistance Welding Module Validation
 - 22.8.3. Hibar Beading Module Validation
 - 22.8.4. Hibar Sealant Dispensing Module Validation
 - 22.8.5. Hibar Electrolyte Filling Module Validation
 - 22.8.6. Hibar Electrolyte Filling System Performance Validation
 - 22.8.7. Hibar Top Tab Welding and Taping Module Validation
 - 22.8.8. Hibar Crimping System Validation
- 23. PHOTOGRAPHS OF PLANT & MACHINERY WITH SUPPLIER'S CONTACT DETAILS

- Lead Battery Recycling Plant
- Battery Automatic Plate Pasting Machine
- Lead Battery Recycling Plant
- Lithium Ion Battery Machine
- Lithium Ion Battery Tester
- Vacuum Oven
- Vacuum Drying Oven for Lithium Ion Battery
- Planetary Mixer Vacuum Jacketed
- Battery Inter-cell Welding Machine
- Automatic Battery Assembling Plant
- Battery Breaking and Separation Ds Systems
- Electrode Coating Machine
- Battery Plate Enveloping Machine
- Lead Battery Breaking Plant
- Battery Cutting Machine
- Battery Cell Spot Welding Machine
- Semi-Auto Grooving Machine for Cylindrical Cell
- Battery Heat Sealing Machine
- Battery Laser Welding Machine
- Electric Battery Lead Melting Furnace

24. Plant Layout Description for Lithium-Ion and Lead-Acid Battery Manufacturing

About NIIR

NIIR PROJECT CONSULTANCY SERVICES (NPCS) is a reliable name in the industrial world for offering integrated technical consultancy services. NPCS is manned by engineers, planners, specialists, financial experts, economic analysts and design specialists with extensive

experience in the related industries.

Our various services are: Detailed Project Report, Business Plan for Manufacturing Plant, Start-up Ideas, Business Ideas for Entrepreneurs, Start up Business Opportunities, entrepreneurship projects, Successful Business Plan, Industry Trends, Market Research, Manufacturing Process, Machinery, Raw Materials, project report, Cost and Revenue, Pre-feasibility study for Profitable Manufacturing Business, Project Identification, Project Feasibility and Market Study, Identification of Profitable Industrial Project Opportunities, Business Opportunities, Investment Opportunities for Most Profitable Business in India, Manufacturing Business Ideas, Preparation of Project Profile, Pre-Investment and Pre-Feasibility Study, Market Research Study, Preparation of Techno-Economic Feasibility Report, Identification and Section of Plant, Process, Equipment, General Guidance, Startup Help, Technical and Commercial Counseling for setting up new industrial project and Most Profitable Small Scale Business.

NPCS also publishes various process technology, technical, reference, self employment and startup books, directory, business and industry database, bankable detailed project report, market research report on various industries, small scale industry and profit making business. Besides being used by manufacturers, industrialists and entrepreneurs, our publications are also used by professionals including project engineers, information services bureau, consultants and project consultancy firms as one of the input in their research.

Our Detailed Project report aims at providing all the critical data required by any entrepreneur vying to venture into Project. While expanding a current business or while venturing into new business, entrepreneurs are often faced with the dilemma of zeroing in on a suitable product/line.

NIIR PROJECT CONSULTANCY SERVICES, 106-E, Kamla Nagar, New Delhi-110007, India.
Email: npcs.india@gmail.com **Website:** NIIR.org

Sun, 28 Dec 2025 21:03:51 +0000