The Complete Technology Book on Hot Rolling of Steel

Author: NIIR Board of Consultants & Engineers Format: Paperback ISBN: 9788190568586 Code: NI147 Pages: 656 Price: Rs. 1,575.00 US\$ 150.00 Publisher: NIIR PROJECT CONSULTANCY SERVICES Usually ships within 5 days

The hot rolling technology is the most widely used method of shaping metals and is particularly important in the manufacture of steel for use in construction and other industries. In metalworking, rolling is a metal forming process in which metal stock is passed through a pair of rolls. Rolling is classified according to the temperature of the metal rolled. If the temperature of the metal is above its re crystallization temperature, then the process is termed as hot rolling. The hot mills using plain rolls were already being employed by the end of the seventeenth century. But the industrial revolution in the nineteenth century saw a new horizon in steel making process, with the considerably expanded markets for rods, rails and structural section, provided further impetus to the development of hot rolling. The basic use of hot rolling mills is to shape up the larger pieces of billets and slabs into narrow and desired forms. These metal pieces are heated over their re crystallization temperature and are then moved between the rollers so as to form thinner cross sections. Hot rolling mill thus helps in reducing the size of a metal thereby molding it into the desired form and shape. Rolling mills perform the function to reform the metal pieces such as billet and ingot whilst maintaining its well equipped micro structure into bar, wire, sheet, strip, and plate. Hot rolled products are frequently categorized into plain carbon, alloy, high strength alloy, dual phase, electrical and stainless steels.

This book provides a descriptive illustration of pre treatment of hot metal, the basic principles of heat treatment, types of hot rolled products, principles of measurement of rolling parameters, steel making refractories, performance characteristics of transducers, causes of gauge variation, main factors affecting gauge performance, gauge control sensors and actuators, automatic gauge control systems, strip tension control system in cold mills, flat rolling practice cold rolling, pack rolling, steelmaking refractories, refining of stainless steels, special considerations in refining stainless steels etc.

This book is a unique compilation and it draws together in a single source technical principles of steel making by hot rolling process up to the finished product. This handbook will be very helpful to its readers who are just beginners in this field and will also find useful for upcoming entrepreneurs, engineers, personnel responsible for the operation of hot rolling mills, existing industries, technologist, technical institution etc.

Contents

 Pre-Treatment of Hot Metal Introduction Desiliconization and Dephosphorization Technologies Desulfurization Technology Process Chemistry Transport Systems

Process Venue Slag Management Lance Systems Cycle Time Hot Metal Sampling and Analysis **Reagent Consumption Economics** Process Control Hot Metal Thermal Adjustment 2. Heat Treatments for Hot-Rolled Products Introduction The Basic Principles of Heat Treatment Quenching and Tempering Annealing Normalizing Grain Refinement Carbon Restoration and Carburizing Heat Treatments for Stainless Steels Facilities for Heat Treating Bars The Heat Treating of Tubular Products Equipment for Heat Treating Plates The Heat Treatment of Structural Shapes, Rails and Wheels 3. Types of Hot-Rolled Products Introduction Plain-carbon Steels Allov Steels High-Strength Low-Alloy (HSLA) Steels **Dual-phase Low-alloy Steels Electrical Steels** Stainless Steels Slabs, Blooms and Billets Rails and Joint Bars Structurals and Other Shapes Wheel Small Sections, Bars and Narrow, Flat-rolled Products Rods **Tubular Products** Hot-Strip-Mill Products 4. Principles of Measurement of Rolling Parameters Process of Measurement **Basic Methods of Measurement** Direct comparison method Indirect comparison method Nature of Measured Parameters in Rolling Mills Purpose and Classification of Transducers Purpose and Classification of Sensors Performance Characteristics of Transducers Static characteristics Dynamic characteristics **Environmental characteristics Reliability characteristics** Theoretical characteristics Noise characteristics

Static Characteristics of Transducers Error of measurement Repeatability Precision Sensitivity Linearity **Hysteresis** Threshold Dead band Resolution (Discrimination) Drift (Creep) Zero drift Zero stability Backlash Static friction Error band Static Calibration of Measuring Systems Dynamic Characteristics of Transducers Zero order instrument First order instrument Second order instrument Analysis of Errors Systematic errors Random errors Propagation of Errors Addition of values containing errors Subtraction of values containing an errors Multiplication of values containing errors Division of values containing errors Compatibility of Tolerances with Measurement Technology Signal sensing errors Data transmission errors Signal recovery errors 5. Causes of Gauge Variation Analysis of Gauge Variation Effect of roll gap setting Effect of entry thickness Effect of mill stiffness Effect of workpiece stiffness Main Factors Affecting Gauge Performance Disturbances from mill mechanical and hydraulic equipment Disturbances from mill control systems Distributions from incoming rolled product Gauge Variation in Hot Strip Mills Effect of Strip Tension on Gauge Effect of Mill Speed on Gauge Effect of Mill Chatter on Gauge Torsional mode Third-octave vertical mode Fifth-octave vertical mode Definition and Causes of Roll Eccentricity

Design imperfections Assembling imperfections Roll and bearing distortions Grinding imperfections Roll gap control imperfections Effect of Roll Eccentricity on Roll Force Effect of Roll Eccentricity on Rolled Material Thickness Roll force mode Position mode Gaugemeter mode Effect of Roll Eccentricity on Gauge Variation in Tandem Cold Mills 6. Gauge Control Sensors and Actuators **Classification of Thickness Gages Optical Thickness Gages** Comparison method Shifting images method Isotope Thickness Gages X-ray Thickness Gages Methods of Measurement of Roll Gap **Digital Induction Position Transducers** Magnetostrictive Position Transducers Measurement of Roll Separating Force **Roll Separating Force Transducers** Load cells Extensiometers Pressure transducers Measurement of Strip Tension Measurement of Strip Velocity Signal processor error Fringe flare error Temperature error of diode laser Actuators for Roll Gap Control 7. Automatic Gauge Control Systems: **Close-Loop Control of Hydraulic Actuators Dynamic Characteristics of Automatic Control Systems** Step-function response Frequency response Phase shift Gaugemeter Control Gauge Deviation Control Strip Tension Control System in Cold Mills Roll Gap and Strip Tension Decoupling Control Interstand Tension Control in Hot Strip Mills with Loopers Interaction of Strip Tension and Roll Gap Control Looperless Tension Control Three-Stage AGC for Tandem Cold Mills Three-Stage AGC for Tandem Hot Strip Mills Feedforward AGC for Tandem Cold Mills Flow-Stress Feedforward AGC for Tandem

Cold Mills Non-Interactive AGC for Tandem Cold Mills Automatic Tension and Gauge Control Systems Mass flow gauge calculating system Gauge and tension control system Dynamic gauge control system High/Low Frequency AGC Effect of Roll Speed Control Response on AGC Performance Feedforward AGC for Hot Tandem Mills Feedforward Head-End Gauge Control System Features of Advanced Gauge Control Systems **Roll Eccentricity Control Methods** Passive roll eccentricity control methods Active roll eccentricity control methods Preventive roll eccentricity control methods Dead Band Method **Roll Force Method** Fourier Analyzer of Roll Eccentricity (FARE) Method Flying Gauge Change 8. Rolling Introduction Flat Rolling Frictional forces Roll force and power requirement Example: Calculation of roll force and torque **Roll deflections** Spreading **Flat-Rolling Practice** Cold rolling Pack rolling Defects in rolled plates and sheets Other characteristics **Residual stresses** Tolerances Surface roughness Gage numbers **Rolling Mills** Rolls Lubricants Shape-Rolling Operations Ring rolling Thread rolling Production of Seamless Tubing and Pipe Rotary tube piercing Continuous Casting and Rolling Minimills 9. Steelmaking Refractories Refractories for Oxygen Steelmaking Furnaces Introduction Balancing Lining Wear **General Considerations**

Areas of Severe Wear Wear-Rate Measurements Zoned Linings by Brick Type and Thickness **Refractory Construction** Furnace Burn-In Wear of the Lining Considerations of Slag Formation Other Factors Affecting Lining Life Hot Metal Differences Scrap Variations **Tap Temperature Requirements Reblows and Heat Times** Lance/Tuyere Design and Practices **Production Rates** Lining Life and Costs BOF Slag Coating and Slag Splashing Slag Coating Philosophy Magnesia Levels and Influences Material Additions Equilibrium Operating Lining Thickness **Other Refractory Maintenance Practices** Laser Measuring Slag Splashing Lance Buildup Slag Splashing Augmented by Gunning Refractories for Electric Furnace Steelmaking Electric Furnace Design Features Electric Furnace Zone Patterns Hearth Slagline Upper Sidewall **Taphole Refractories** Roof Electric Furnace Refractory Wear Mechanisms Corrosion Oxidation Erosion Melting Hydration Spalling Conclusion Refractories for AOD and VOD Applications Background **AOD Refractories** Life and Wear Rates AOD Lining Construction and Zoning Safety Lining Working Lining Bottoms Tuyere Zoneâ€"Knapsacks Walls and Slagline Vessel/Cone Flange and Seal Cone

Pour Spouts Preheating of Linings Process Variables Significantly Affecting life Slag Control Transfer Slag **Decarburization Slag** Reduction Slag Tuyere Knurdle Control Temperature Back Titt **VOD** Refractories Lives and Wear Rates VOD Lining Construction and Zoning Safety Lining Backfill Working Lining **Bottoms Bottom/Wall Impact Pads** Stir Plug/Blocks and Well Blocks Walls Main Slagline plus Sidewall and Slagline Stir Pads Upper Slaglines Freeboard Lip Rings Preheating of Linings Acknowledgments Refractories for Ladles Function of Modern Steel Ladle Ladle Design Ladle Refractory Design and Use Stream Impact Pad Bottom and Lower Barrel Refractories Barrel Slagline Ladle Refractory Construction **Refractory Stirring Plugs** Refractories for Degassers 10. Refining of Stainless Steels Introduction Special Considerations in Refining Stainless Steels Selection of a Process Route **Raw Materials** Melting Electric Arc Furnace Melting **Converter Melting Dilution Refining Processes** Argon-Oxygen Decarburization (AOD) Converter Process K-BOP and K-OBM-S Metal Refining Process (MRP) Converter Creusot-Loire-Uddeholm (CLU) Converter Krupp Combined Blowing-Stainless (KCB-S) Process Argon Secondary Melting (ASM) Converter Sumitomo Top and Bottom Blowing

Process (STB) Converter Top Mixed Bottom Inert (TMBI) Converter **Combined Converter and Vacuum Units** Vacuum Refining Processes **Direct Stainless Steelmaking** Equipment for EAF-AOD Process Vessel Size and Shape Refractories Tuyeres and Plugs Top Lances Gases Vessel Drive System **Emissions Collection** Vessel Operation Decarburization Refining Process Control Post-Vessel Treatments Summary 11. The Instrumentation and Computer Control of Hot Mills Introduction **Pyrometers** Thickness Gaging Monitoring the Profile of Hot-rolled Strip Measuring the Flatness of Hot-rolled Strip Width and Length Gaging of Rolled Products The Measurement of Rolling Force Automatic Control of Blooming and Slabbing Mills The Control of Billet, Rod and Bar Mills using Microcomputers Automatic Gage Control **Computer Control of Plate Mills** Hot-Strip-Mill Automation Finishing Mill Setup Finishing-Temperature Setup **Finishing-Temperature Control Ciling-Temperature Setup and Control** Roughing-Mill Setup Edger Setup Mill Pacing **Reheat-Furnace Control** 12. Overview of Steelmaking Processes and their Development Introduction Bottom-Blown Acid or Bessemer Process **Basic Bessemer or Thomas Process Open Hearth Process** Oxygen Steelmaking Electric Furnace Steelmaking 13 Structural Changes in Steel During Hot Rolling 414 Structural Changes During Reheating Grain Restoration Processes **Dynamic Restoration Process** Static Restoration Process

Effect of Initial Grain Size on Static Recrystallization Effect of Temperature and Microalloying Effect of Amount of Deformation Recovery Partial recrystallization Complete recrystallization Factors Affecting Critical Reduction for Recrystallization Grain Growth After Deformation Structural Changes in Steel During Cooling Effect of Steel Structure on Flow Stress 14. Steel Heating for Hot Rolling Purpose of Heating Process **Requirements for Heating Process** Heat Transfer in Ingots Mold Cooling Time Air Cooling Time Types Of Soaking-pit Furnaces **Regenerative Pits Continuous-fired Pits Electric Soaking Pits** Heat Transfer In Soaking Pits Batch-type Slab Reheating Furnaces **Continuous Reheating Furnaces** Fuel-firing on Continuous Reheating Furnaces Analysis of a Continuous Heating Process Hot Slab Charging Effects of Skid System on Heating 15. Heat Transfer During the Rolling Process Workpiece Temperature Change in Hot Strip Mill Temperature Loss due to Radiation Temperature Loss due to Convection Temperature Loss due to Water Cooling Temperature Loss due to Conduction to Work Rolls Temperature Rise due to Mechanical Work Intermediate Reheat Facilities Thermal Covers Heat Transfer in Reradiating Heat Covers Heat balance for metallic shield Heat transfer through Insulation Heat balance for outer metallic panel Heat Transfer in Coilbox 16. Thermomechanical Treatment Combined with Rolling Thermomechanical Treatment of Steel U.S. Classification of TMT Russian Classification of TMT Standard Heat Treatment (SHT) Thermomechanical Treatment (TMT) Low Temperature Thermomechanical Treatment High Temperature Thermomechanical Treatment (HTMT) Combined Thermomechanical Treatment (CTMT) Preliminary Thermomechanical Treatment (PTMT)

Mechanico-Thermal Treatment (MTT) Thermomechanical Treatment During Rolling Conventional hot rolling Controlled rolling Low finishing temperature rolling Types of Controlled Rolling Processes Structural Changes in Steel During Controlled Rolling Deformation in recrystallization region Deformation in non-recrystallization region Deformation in the gamma-alpha region Structural Changes in Steel During Continuum Rolling Structural Changes in Steel During Controlled Cooling Effect of Alloying Elements in Controlled Rolling Controlled Rolling in Hot Strip Mills Precipitation Strengthening Hot Rolling of Acicular Ferrite Steel Hot Rolling of Dual-Phase Steel Finish rolling temperature Intermediate temperature Coiling temperature Controlled Rolling of Arctic Grade Steel Effect of slab reheating and finishing temperatures Ferritic Rolling Accelerated Cooling Multipurpose Accelerated Cooling System On-Line Accelerated Cooling (OLAC) **Dynamic Accelerated Cooling RAC Process** Cold Rolling and Annealing of Steel Temper Rolling of Steel Tin mill products High-strength cold-rolled sheets Electrical sheets **Deep-drawing Sheet** 17. Oxygen Steelmaking Processes Introduction Process Description and Events Types of Oxygen Steelmaking Processes **Environmental Issues** Sequence of Operationsâ€"Top Blown Plant Layout Sequence of Operations Scrap Handling Hot Metal Pouring Hot Metal Treatment Charging the Furnace **Computer Calculations** Oxvgen Blow Flux Additions Final Oxygen Adjustments and Dynamic Sensors Turndown and Testing

Corrective Actions Quick Tap Procedures Tapping Slagging Off and Furnace Maintenance Shop Manning Hot Metal **Charging Crane** Scrap Furnace and Charging Floor Flux Handling Maintenance General Labor Chemistry Lab **Refractory Maintenance Relines and Major Repairs** Ladle Liners Management and Clerical Raw Materials Hot Metal Composition Determination of Carbon and Temperature Hot Metal Treatment Weighing Scrap High Metallic Alternative Feeds **Oxide Additions** Iron Oxide Materials Waste Oxides Fluxes Burnt Lime Dolomitic lime Limestone Fluorspar Oxygen Process Reactions and Energy Balance Refining Reactions in BOF Steelmaking Carbon Oxidation Silicon Oxidation Manganese Oxidation Phosphorus Oxidation Sulfur Reaction Slag Formation in BOF Steelmaking Mass and Energy Balances Determination of the Flux Additions Determination of Oxygen Requirements Determination of the Weight of Iron-Bearing Materials Determination of the Gases and Fumes Produced Determination of the FeO in the Slag **Tapping Practices and Ladle Additions Process Variations** The Bottom-Blown Oxygen Steelmaking or

OBM (Q-BOP) Process Plant Equipment **Raw Materials** Sequence of Operations **Process Characteristics** Product Characteristics Mixed-Blowing Processes **Bottom Stirring Maintenance Problems** Bottom Plug/Nozzle Configurations **Oxygen Steelmaking Practice Variations Post-Combustion Lance Practices High Scrap Melting Practices** Slag Splashing Refractory Maintenance Effects of Desulfurized vs. Non-Desulfurized Hot Metal Process Control Strategies Static Models Fundamentals of the Static Charge Model **Operation of the Static Charge Model** Statistical and Neural Network Models **Dynamic Control Schemes** Gas Monitoring Schemes **Optical and Lasser Based Sensors** Sensor or Sub-Lances Drop-in Thermocouples for Quick-Tap Sonic Analysis Lance Height Control Measurement of Lance Height **Environmental Issues Basic Concerns** Sources of Air Pollution Hot Metal Reladling Desulfurization and Skimming of Hot Metal Charging the BOF Blowing (Melting and Refining) Sampling and Testing Tapping Materials Handling Teeming Maintenance and Skull Burning Relative Amounts of Fumes Generated **Other Pollution Sources** BOF Slag BOF Dust and Sludge Summary 18. Alternative Oxygen Steelmaking Processes Introduction General Principles and Process Types Specific Alternative Steelmaking Processes Energy Optimizing Furnace (EOF) **AISI Continuous Refining IRSID** Continuous Steelmaking Trough Process **Other Steelmaking Alternatives**

About NIIR

NIR 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 varies 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

Tue, 30 Apr 2024 18:29:11 +0530