

Steel Making - Video course

COURSE OUTLINE

Introduction; The Science Base of Iron and Steelmaking; Modern Steelmaking I: Oxygen Steelmaking; Modern Steelmaking II: Electric Arc Furnace Steelmaking; Steelmaking: Additional Topics; Deoxidation, Ladle and Tundish Metallurgy Operations; Solidification and Casting Processes; Modeling and Measurements; Iron and Steelmaking in India.

COURSE DETAIL

Sl. No	Topic	Lectures
1.	Introduction (DM) <ol style="list-style-type: none"> 1. Introductory Remarks. 2. A Historical Perspective. 3. An Overview of Modern Iron and Steelmaking. 4. Energy in Iron and Steel Industry. 5. Environmental, Health and Safety (EHS) Issues - Environmental Issues - Health and Safety Issues. 6. Iron and Steel: Yesterday, Today and Tomorrow. 7. Concluding Remarks. 	2
2.	The Science Base of Iron and Steelmaking (DM) <ol style="list-style-type: none"> 1. Introductory Remarks. 2. Metallurgical Thermodynamics - Chemical Equilibrium - Activity and Equilibrium Constant - ΔG^0 for Oxides - Activity Composition Relationships - Concentrated Solutions - Dilute Solutions - Chemical Potential and Equilibrium. 3. Fluid Dynamics - Inference of Fluid Flow in steelmaking - Force Balance Expressions and Momentum Conservation Equations - Boundary Conditions - Laminar and Turbulent Flows - Calculation of Turbulent Flows in Steelmaking. 4. Heat Transfer - Mechanism of Heat Transfer - Heat Conduction - Convective Heat Transfer - Radiation. 5. Mass Transfer and Metallurgical Kinetics - Mechanism of Mass Transfer - Molecular Diffusion - Convective Mass Transfer - Chemical Reaction Kinetics. 6. Concluding Remarks. 	4
3.	Modern Steelmaking I: Oxygen Steelmaking (SCK)	7



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Metallurgy and Material Science

Pre-requisites:

1. Metallurgical Thermodynamics
2. Metallurgical Kinetics

Additional Reading:

1. Szekeley, J., Metallurgical Transaction, 19B, 525, 1988.
2. MacLean, A., Materials and Metallurgical Transactions, 37B, 319, 2006.

Hyperlinks:

1. Online Materials Information Resources: MatWeb, <http://www.matweb.com>.
2. International Iron and Steel Institute: <http://www.worldsteel.org>

Coordinators:

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	<ol style="list-style-type: none"> 1. Introductory Remarks. 2. Historical Perspectives: Steelmaking Processes and their Developments. 3. Pre - treatment of Hot Metal. 4. Classification of Steels and the Role of Impurity Elements. 5. Steelmaking Fundamentals - Chemical Reactions Equilibria - Carbon - Oxygen Reaction - Phosphorous - Oxygen Reaction - Manganese - Oxygen Reaction - Silicon - Oxygen Reaction - Sulphur - Oxygen Reaction (Desulphurization) - Iron-Oxygen Reaction - Slag Formation - Role of Slag - Basicity - Foaming Tendency - Oxidizing/Reducing Potential of Slag. 6. The LD Steelmaking (Practice) process - The LD Converter - Lance - LD Shop Layout - Charge Calculations - Feed Materials - Physico - Chemical Characteristics of LD Steelmaking - Description of a Typical Heat - Exit Gases - Tapping - Modern Trends - Post Combustion - Slag Splashing. 7. Bottom Blown Steelmaking. 8. The Evolution of Combination Blown Steelmaking and its Distinctive Features. 9. Concluding Remarks. 		
<p>4.</p>	<p>Modern Steelmaking II: Electric Arc Furnace Steelmaking (SCK)</p> <ol style="list-style-type: none"> 1. Introductory Remarks. 2. Electric Steelmaking. 3. Steelmaking in Electric Arc Furnaces (EAF) - Construction of an Arc Furnace - Operation - Steelmaking in EAF - Eccentric Bottom Tapping - Comparison with Oxygen Steelmaking - Environmental issues in Arc Furnace Steelmaking. 4. Developments in EAF steelmaking Technology - Oxygen lancing including Co jet - Gas injection through bottom - Post Combustion - Automation and Process control. 5. Alloy Steelmaking in EAF with Some Examples. 6. Concluding Remarks. 	<p>4</p>	
<p>5.</p>	<p>Steelmaking: Additional Topics (SCK)</p> <ol style="list-style-type: none"> 1. Introductory Remarks. 2. Other Steelmaking Processes - EOF (Energy Optimizing Furnace) Process - CONARC Process. 3. Refractory in steelmaking - Requirements of refractory Material - Various Refractory Materials - Fabrication and Types of Refractory Products - Emerging Trends. 4. Clean steel - Cleanliness Assessment - 	<p>4</p>	

	<p>Inclusions and Mechanical Properties - Sources of Inclusion in steel - Types of Inclusions - Properties of Inclusions - Inclusion Engineering.</p> <p>5. Process Control and Automation in Steel Industry - BOF - EAF.</p> <p>6. Concluding Remarks.</p>	
6.	<p>Deoxidation, Ladle and Tundish Metallurgy Operations (DM)</p> <p>1. Introductory Remarks.</p> <p>2. slag Carry-over: Impact on Ladle Metallurgy.</p> <p>3. Deoxidation - Techniques of Deoxidizer Addition - Physical and Chemical Interaction between Solid Additions and Steel Melt - Types of Deoxidation - Deoxidation Kinetics and Products.</p> <p>4. Ladle Metallurgy Steelmaking Operations - Construction of Steelmaking ladles; Ladle Refractory, Preheating and Recycling - The Method of Inert Gas Stirring in Ladles - Temperature and Composition Control in Ladles - The Ladle Furnace - Injection Metallurgy - Miscellaneous Issues in Ladle Metallurgy.</p> <p>5. Vacuum Degassing - Principles - Degassing Techniques - Stream Degassing - Tank Degassing - Circulation Degassing - Thermodynamics and Kinetics of Hydrogen and Nitrogen Removal under Vacuum - Water Capacity of Ladle Slags.</p> <p>6. Flow sheet for Production of Clean Steel - Transfer Operations.</p> <p>7. Tundish Metallurgy - Tundish Design and Operations - Temperature and Cleanliness Control in Tundish - Sequence Casting and Grade Transition - Residual Metal loss in Ladles and Tundish.</p> <p>8. Concluding Remarks.</p>	7
7.	<p>Solidification and Casting Processes (SCK)</p> <p>1. Introductory Remarks.</p> <p>2. Fundamental Aspects of Solidification.</p> <p>3. Casting Processes - Ingot Casting - Continuous Casting - Process description - Continuous Casting Products and Casting Defects - Emerging Trends in Continuous Slab Casting - EM stirring and EM braking - Gas Injection in Mold - High Speed Slab Casting - Thin Slab casting - Strip Casting.</p> <p>4. Final Finishing Operations - Surface Treatment - Heat Treatment - Shaping and Secondary Product Manufacturing (Including Deformation Processing).</p> <p>5. Concluding Remarks.</p>	5
8.	<p>Modeling and Measurements (DM)</p>	4

	<ol style="list-style-type: none"> 1. Introductory Remarks. 2. The role of Modeling in Iron and Steelmaking - Physical Modeling - Geometrical Similarity - Mechanical Similarity - Thermal Similarity - Chemical Similarity - Scaling Equations - Mathematical Modeling - Developing a Mathematical Model - The Role of Flow Modeling in Steelmaking - The Role of Commercial Software Packages - Sources of Uncertainty in Mathematical Model Predictions. 3. Physical and Mathematical Modeling: Case Studies - Blast Furnace - Oxygen Steelmaking - Argon Stirred Ladles - Continuous Casting. 4. Measurements and Measuring Devices in Iron and Steelmaking. 5. Concluding Remarks. 	
9.	<p>Iron and Steelmaking in India (DM)</p> <ol style="list-style-type: none"> 1. Introductory Remarks. 2. Raw Materials - Availability, Distribution and Reserve - Characteristics of Indian Raw Materials and their Impact on Iron and Steelmaking. 3. Iron and Steelmaking in India - Early years - Steelmaking in Modern India - Integrated and Mini Mills - Layout of an Integrated Iron and Steel Plant - Future. 4. Problems Facing the Domestic Steel Producing Sectors - Mini Mills - Integrated Mills. 5. Steel Education and Research in India. 6. Concluding Remarks. 	3
	<ul style="list-style-type: none"> • DM: Dipak Mazumdar • SCK: Satish Ch. Korla 	

References:

1. Turkdogan, E.T., A Text Book of Steelmaking, Academic Press, London, 1997.
2. Ghosh, A. and Chatterjee, A., Principles and Practices in Iron and Steelmaking, Prentice Hall of India, New Delhi, 2008.
3. Making, Shaping and Treating of Steel (Steelmaking and Refining), 10th Edition, 1985, AISE, Pittsburgh.
4. Ghosh, A., Secondary Steelmaking, CRC Press, Boca Raton, 2000.