Advanced Thermal Properties of Refractories: Course Outline

Gain an in-depth understanding of the thermal properties of refractories.

This course is an intensive combination of classroom lectures and live laboratory demonstrations that address the thermal properties of refractories, both theoretically and experimentally. The individual sessions are titled in the accompanying outline of the daily topics. The lectures are taught on the undergraduate senior/graduate level. The fundamentals, along with application to refractories, are emphasized. The live laboratory demonstrations are designed to give the participants experience with common thermal property tests.

The primary objective of this course is to provide the participants with an in depth understanding of the thermal properties of refractories. The live laboratory demonstrations are designed to provide the participants with direct experience in fabricating test specimens and the application of standard ASTM test methods.

Lecture Number	Topics / Activities During Class

Lecture 1	• Thermal Stability
	  • Definition
	  • Thermodynamic Principles
	  • Chemical Bonding
	  • Application to Refractories
	  • Melting Temperature vs. Free Energy of Formation Diagrams
	• Heat Capacity
	  • Definition
	  • Dulong and Petit Model
	  • Einstein Model
	  • Debye Model
	  • Electronic Contributions
	  • Structural Aspects of Heat Capacity
	  • Application to Refractories
	  • Measurement Technique and Laboratory Demonstration
	  • ASTM E1269 Heat Capacity by Differential Scanning Calorimetry

Lecture 2	• Thermal Conductivity
	  • Definition
	  • Phonon Conductivity
	  • Structural Aspects of Phonon Conductivity
	  • Photon Conductivity
	  • Structural Aspects of Photon Conductivity
	  • Application to Refractories
	  • Measurement Techniques and Laboratory Demonstrations
	  • ASTM C201 Thermal Conductivity of Refractories by Water Calorimeter

	• ASTM C1113 Thermal Conductivity of Refractories by Hot Wire • ASTM E1461 Thermal Diffusivity and Conductivity by Laser Flash

Lecture 3	• Thermal Expansion
	  • Definition
	  • Bonding and Potential Energy
	  • Equation of State of Solids
	  • Structural Aspects of Thermal Expansion
	  • Application to Refractories
	  • Reversible Changes
	  • Irreversible or Permanent Changes
	  • Thermal Conductivity-Thermal Expansion Relations
	  • Measurement Technique and Laboratory Demonstration
	  • E228 Thermal Linear Analysis

Lecture 4	• Thermal Shock
	  • Definition
	  • Thermal Stresses
	  • Thermal Expansion Mismatches
	  • Temperature Gradients
	  • Thermal Shock Theory
	  • Thermoelastic Theory
	  • Damage Resistance Theory
	  • Application to Refractories
	  • Measurement Technique and Laboratory Demonstration
	  • ASTM C1171 Quantitatively Measuring the Effect of Thermal Cycling on Refractories