

Proposed Outline

PCA Kiln Training

1. Raw material design and chemistry
 - 1.1. Introduction
 - 1.1.1. Chemical requirements for Portland Cement
 - 1.1.2. Cement types
 - 1.1.3. Clinker compounds
 - 1.2. Typical raw materials used for cement manufacture
 - 1.2.1. Limestones
 - 1.2.2. Argillaceous materials
 - 1.3. Mix design factors and their meaning
 - 1.3.1. Lime saturation factor
 - 1.3.2. Silica modulus
 - 1.3.3. Alumina modulus
 - 1.4. Chemical impacts on operations
 - 1.4.1. Strength
 - 1.4.2. Set-time
 - 1.4.3. Minor element impacts
 - 1.5. Summary & conclusions
 - 1.6. Questions & answers
2. Kiln Systems, preheaters, & precalciners (Ove)
 - 2.1. Introduction
 - 2.2. Evolution of kiln, preheater & precalciner design
 - 2.2.1. Kilns
 - 2.2.2. Preheaters
 - 2.2.3. Precalciners
 - 2.3. Principles of operation of the preheater
 - 2.3.1. Heat transfer
 - 2.3.2. Dust collection efficiency
 - 2.4. Preheater Components
 - 2.4.1. Cyclone thimble / dip tube
 - 2.4.2. Material seal / flap valve
 - 2.4.3. Splash box
 - 2.5. Precalciner Basics
 - 2.5.1. Residence time and fuel burn-out
 - 2.5.2. Mixing effects
 - 2.5.3. Low NO_x designs & operation
 - 2.5.4. Build-ups & solutions
 - 2.6. Summary & Conclusions
 - 2.7. Questions & Answers
3. Kilns
 - 3.1. Introduction
 - 3.2. Chemical reactions taking place in the kiln

- 3.2.1. Kiln inlet
 - 3.2.2. Calcining zone
 - 3.2.3. Transition zone
 - 3.2.4. Burning zone
 - 3.2.5. Cooling zone
- 3.3. Coating
 - 3.3.1. Chemistry
 - 3.3.2. Stability
 - 3.3.3. Interaction with refractory
- 3.4. Common kiln operating strategies
 - 3.4.1. Start-Up
 - 3.4.2. Shut-Down
 - 3.4.3. Exceptions
- 3.5. Common operating problems and solutions
 - 3.5.1. Examples from attendees
- 3.6. Summary & Conclusions
- 3.7. Questions & Answers
- 4. Coolers
 - 4.1. Introduction
 - 4.2. Cooler evolution
 - 4.2.1. First generation
 - 4.2.2. Second generation
 - 4.2.3. Third generation
 - 4.2.4. Traditional & new players
 - 4.3. Basics of cooler operation
 - 4.3.1. Air to material ratio
 - 4.3.2. Bed depth considerations
 - 4.3.3. Cooling air velocity
 - 4.4. Typical cooler problems
 - 4.4.1. Uneven bed depths
 - 4.4.2. Over and under airing
 - 4.4.3. Snowmen & red rivers
 - 4.4.4. Overheating
 - 4.5. Options in clinker crushing
 - 4.5.1. Hammer crushers
 - 4.5.2. Roll crushers
 - 4.6. Summary & Conclusions
 - 4.7. Questions & Answers
- 5. Burners & Combustion
 - 5.1. Introduction
 - 5.1.1. Typical Fuels for cement kilns
 - 5.2. Combustion Reactions
 - 5.2.1. Volatiles
 - 5.2.2. Fixed carbon

- 5.2.3.Ash
- 5.3. Factors influencing speed of combustion
 - 5.3.1.Temperature
 - 5.3.2.Air fuel mixing
 - 5.3.3.Volatile content
 - 5.3.4.Char porosity
- 5.4. Kiln burner design
 - 5.4.1.Direct fired burners & evolution
 - 5.4.2.Indirect fired burners
 - 5.4.2.1. First generation burners
 - 5.4.2.2. Low-Nox burners
 - 5.4.2.3. Third generation burners
 - 5.4.3.Common burner controls
- 5.5. Calciner burner design
 - 5.5.1.Common calciner burners
 - 5.5.2.Staged combustion
 - 5.5.3.Down draft calciner burners
- 5.6. Common problems with burners and combustion
 - 5.6.1.Kilns
 - 5.6.2.Precalciners
- 5.7. Summary & Conclusions
- 5.8. Questions & Answers
- 6. Kiln System Emissions
 - 6.1. Introduction
 - 6.2. Overview of regulations
 - 6.2.1.NESHAP
 - 6.2.2.CISWI
 - 6.2.3.HWC
 - 6.2.4.Other (World Bank, general limits)
 - 6.3. Sources of emissions
 - 6.3.1.Combustion
 - 6.3.1.1. NO_x
 - 6.3.1.2. SO_x
 - 6.3.1.3. CO
 - 6.3.1.4. HCl
 - 6.3.2.Raw Materials
 - 6.3.2.1. SO_x
 - 6.3.2.2. CO
 - 6.3.2.3. THC
 - 6.3.2.4. Hg
 - 6.4. Overview of control technologies
 - 6.4.1.NO_x
 - 6.4.2.SO_x & HCl
 - 6.4.3.CO

- 6.4.4. THC & VOC
- 6.4.5. Hg
- 6.5. Summary & Conclusions
- 6.6. Questions & Answers
- 7. Volatile Cycles (Ove)
 - 7.1. Introduction
 - 7.1.1. Volatile compounds
 - 7.1.2. Sources of volatile elements
 - 7.2. Reactions
 - 7.2.1. Primary volatilization
 - 7.2.2. Secondary volatilization
 - 7.2.3. Volatilization temperatures
 - 7.3. Sulphur cycle
 - 7.4. Build-up
 - 7.4.1. Hot meal testing
 - 7.4.2. Surface temperature monitoring
 - 7.4.3. Record keeping
 - 7.4.4. Strategies to reduce build-up
 - 7.5. Rings
 - 7.5.1. Tail Rings
 - 7.5.2. Spurrite / sulphur rings
 - 7.5.3. Sinter Rings
 - 7.5.4. Nose Rings
 - 7.6. Balls
 - 7.7. Summary & conclusions
 - 7.8. Questions & answers
- 8. Heat Consumption
 - 8.1. Introduction
 - 8.2. Heats of Reaction
 - 8.2.1. Chemical drivers
 - 8.2.2. Physical drivers
 - 8.2.3. Tests to perform
 - 8.3. Heat recuperation in the preheater
 - 8.3.1. Determining the heat input
 - 8.3.2. Seeking and correcting inefficiencies
 - 8.3.3. Minimizing heat losses
 - 8.4. Heat recuperation in the cooler
 - 8.4.1. Heat loss in clinker
 - 8.4.2. Heat loss in cooler vent air
 - 8.4.3. Radiation losses
 - 8.4.4. Other losses
 - 8.4.5. Optimization
 - 8.5. Radiation losses
 - 8.5.1. Preheater

8.5.2. Cooler

8.5.3. Kiln

8.6. Raw mix chemical stability

8.7. Summary & Conclusions

8.8. Questions & Answers