DEVELOPMENT OF COATINGS/RING FORMATION IN THE PYRO PROCESS SYSTEM

Coating formation/build-ups either in the Calciner, Kiln Smoke Chamber or Ring formation in the Kiln, all are basically the consequences, arising mainly due to volatilization of the Alkali, Sulphates and Chlorides present in the raw materials and Fuels. Careful balancing of these components is required to ensure sustainable operation of the Pyro process system. Apart from the input materials chemical characteristics, stable & optimized control of the key variables also plays a major role in preventing such abnormal conditions of the Pyro process system.

To avoid coating formation / blockages in Preheater cyclones and ring formation in a cement kiln, one need to monitor several parameters that influence deposits/buildup. The key parameters are mentioned as below:

1. Alkali (Na_2O & K_2O)

Alkalis (Na_2O, K_2O) react with Sulphate (SO_3) and Chlorine (Cl) to form alkali sulphates and alkali chlorides. These compounds have low melting points and can cause build-up in preheater cyclones and rings in Kiln as well. Further, high chloride (Cl) content accelerates the formation of sticky alkali chlorides.

Control:

Keep alkali levels within the acceptable range by adjusting raw mix composition
Maintain an optimal alkali-sulphur ratio (Na_2O+K_2O/SO_3 between 0.8 and 1.2).
Use an alkali bypass system if Cl content exceeds 0.015%.
Avoid raw materials and fuels with high alkali or sulphur content.

2. Sulphate (SO_3)

High SO_3 levels (from fuel, raw materials, or alternative fuels) lead to the formation of alkali sulphates, contributing to deposits. These compounds condense and deposit in comparatively cooler section in Preheater/ Kiln zones (~900–1100°C). Further, improper fuel combustion increases the chances of SO_2 retention in the kiln.

Control:

Maintain alkali-sulphur (Na_2O+K_2O/SO_3) ratio, ideally between 0.8 and 1.2, to prevent excess sulphate buildup.
Optimize kiln combustion to ensure complete sulphur oxidation.
Maintain a proper oxidizing atmosphere to prevent SO_2 condensation.
Use low-sulphur fuels or blend fuels to dilute SO_3 input

3. Chlorine (Cl)

Chlorides (from alternative fuels, raw materials, or Petcoke) evaporates 100% and further influence the evaporation of Alkalies and Sulphates. Chlorine combines with alkalis to form low-melting alkali chlorides, causes severe build-ups in preheater cyclones.

Control: Keep Cl below 0.015% in Kiln feed and use alkali bypass system, in case the value exceeds from this threshold limit.

4. Raw Meal Composition

High levels of free silica (SiO_2) and alumina (Al_2O_3) can affect the melting behaviour and viscosity of clinker liquid phase, leading towards build-ups on the surface of the refractory lining
Control: Maintain an optimal raw mix with proper LSF (Lime Saturation Factor), SM (Silica Modulus), and AM (Alumina Modulus).

5. Fuel Composition

Fuels containing high sulphur, alkalis, or heavy metals (e.g., vanadium, lead, zinc) contribute to coating formation
High ash content in coal or alternative fuels leads to excess silica (SiO_2), alumina (Al_2O_3), and iron oxide (Fe_2O_3). These components form low-melting compounds that deposit on kiln walls.
Further, high fuel volatility and incomplete combustion aggravate the problem.
Deposition of fuel ash during the kiln startup period can cause ash ring in upper transition zone in the kiln. Hence, starting fossil fuel firing during kiln light-up should be carefully administered
Control: better to use low-sulphur fuels and monitor heavy metal inputs in case of higher Alternate Fuels usage

6. Kiln Inlet and Preheater Exit Gases

CO, CO_2, O_2, NO_x, SO_2, HCl levels should be monitored to detect process imbalances leading to deposits.
High CO indicates incomplete combustion, which can lead to local overheating and increased coating formation.

7. Kiln and Preheater Temperatures

Kiln inlet temperature should be around (1000–1100°C), an optimized operating range
Precalciner temperature should be in the range of (875–900°C) (to avoid higher DOC in hot meal)
Too high or too low temperatures can aggravate coating formation in the sensitive Kiln zones.

8. Volatile Eléments (Zn, Pb, Cd, etc.)

Heavy metals can create sticky deposits in the preheater.
Control: Monitor and limit their input from raw materials and alternative fuels.

Preventive Actions

- Optimize alkali/sulphur balance
- Minimize chlorine input and use a chlorine bypass if needed
- Usage of low-sulphur and low-alkali fuels is desirable
- Control raw mix chemistry
- Control Kiln feed and Fuel uniformity
- Maintain proper oxygen level in the Kiln and Calciner
- Maintain proper temperature profile in the Kiln and Preheater
- Effective control on alternate fuels firing
- Regularly inspect and clean critical areas

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