Activating Clay to Help Achieve CO_2 Emissions Goals by 2050

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Tech Director

Topics

- ✓ CO_2 reduction with green cement
- ✓ Options
- ✓ Making the right decision

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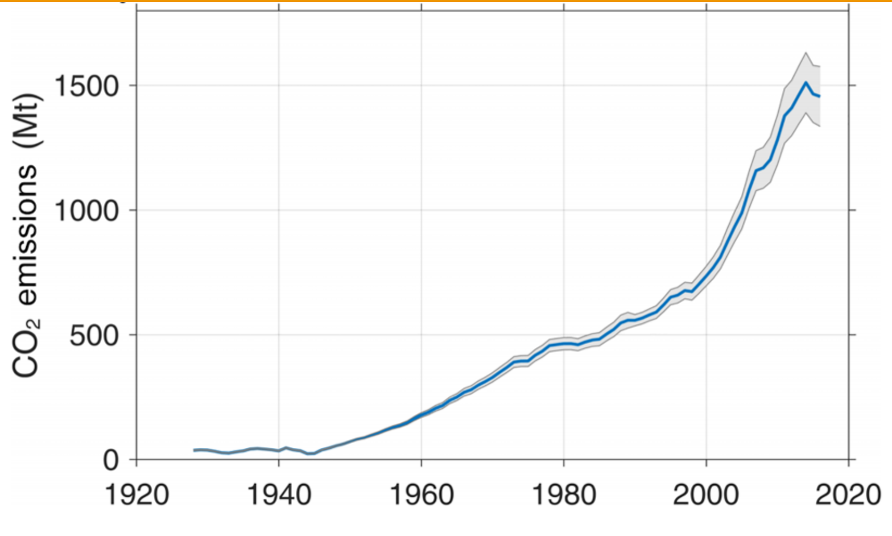
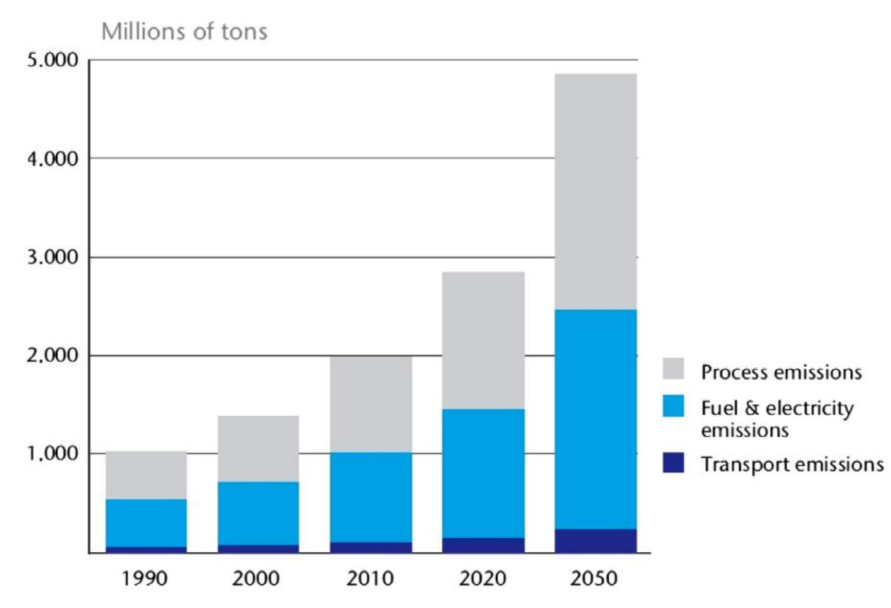
CO_2 Emission

Cement production is responsible for around **8%** of man-made CO_2 emissions



Global CO_2 emissions from rising cement production over the past century (with 95% confidence interval)[1].



Projected global cement industry reference CO_2, million metric tonnes

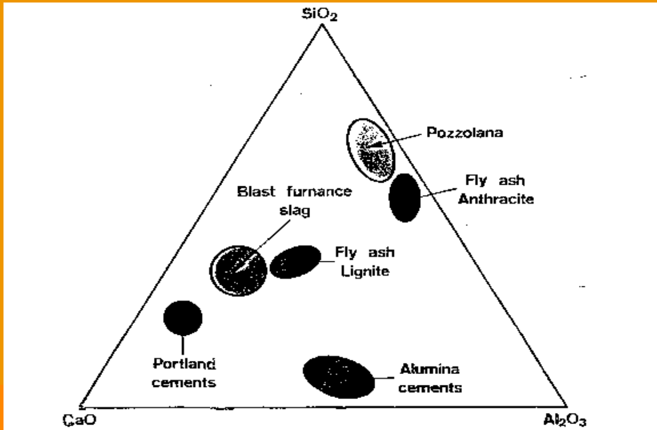
Several countries are adopting strict policies for greenhouse emission reductions

Clay Activation

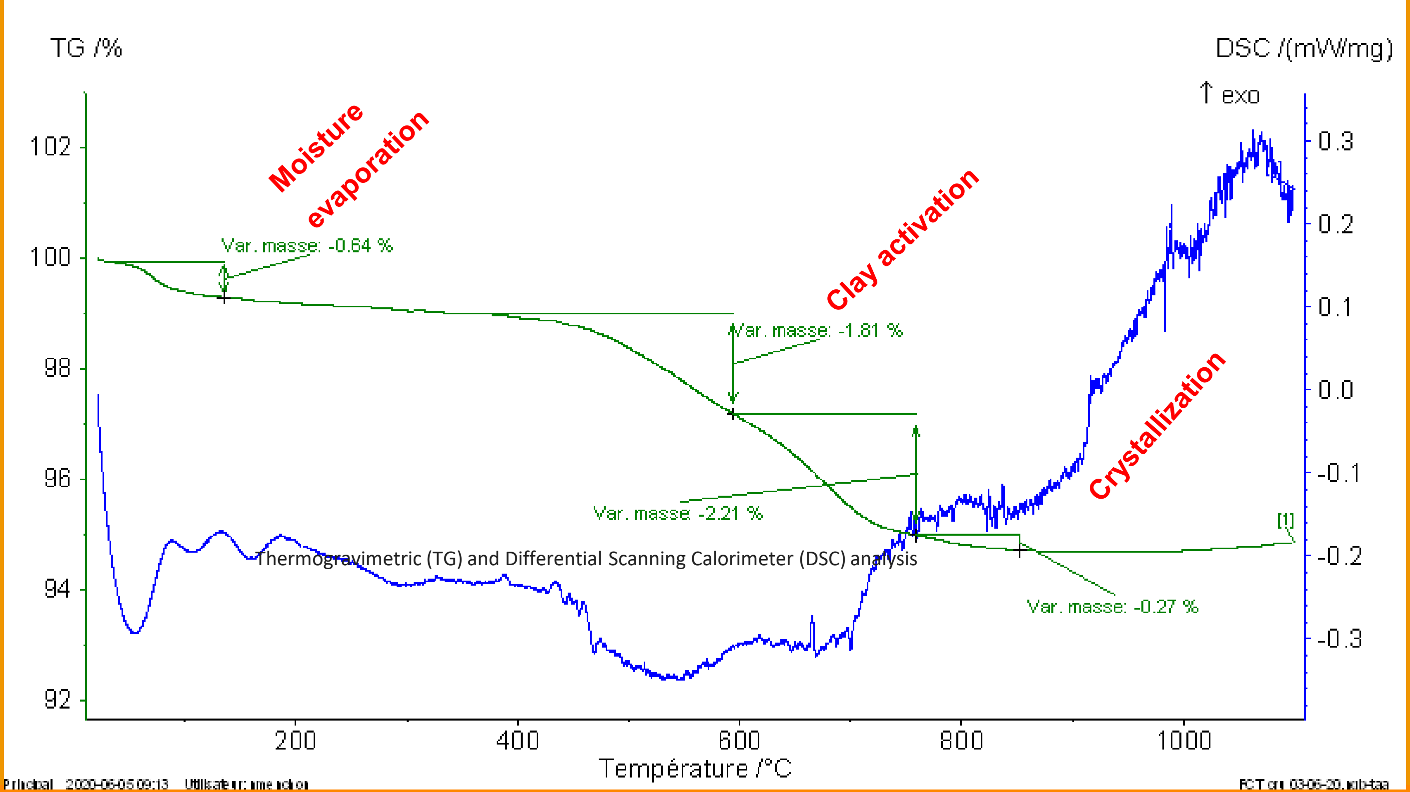
Pozzolanic activity due to the amorphous structure of the aluminosilicate obtained from the heat treatment of clays, in temperatures ranging from 600 to 900 °C, lower than the 1450°C needed for clinker

$$Al_2Si_2O_5(OH)_4 \xrightarrow{450-650°C} Al_2O_3.2SiO_2 + 2H_2O$$

metakaolin

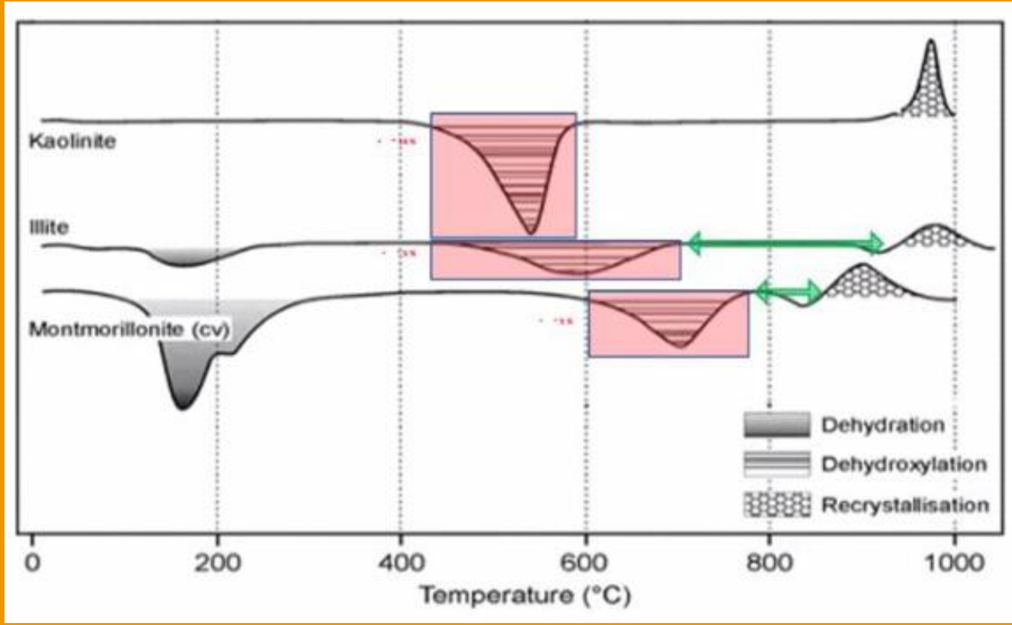


Clay Activation

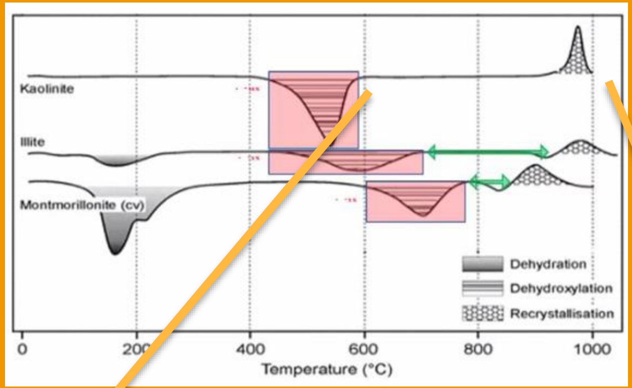


Clay Activation

Temperature ranges for activation and recrystallization



Clay Activation



Topics

- ✓ CO_2 reduction with green cement
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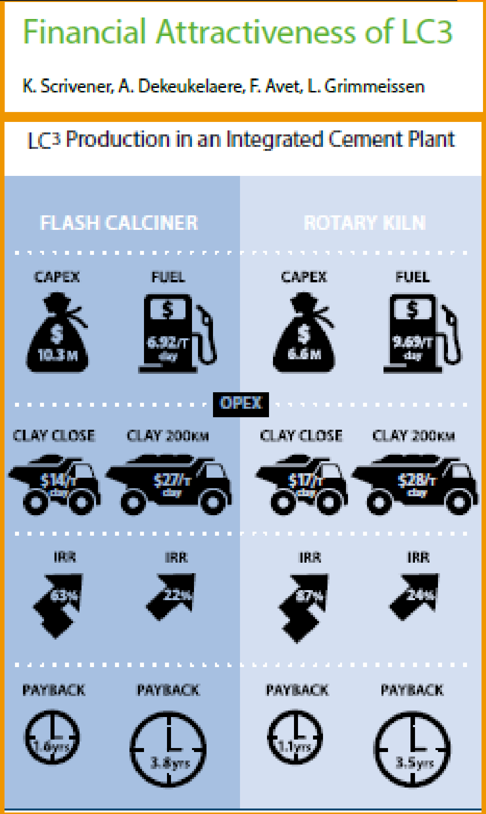
Rotary vs. Flash

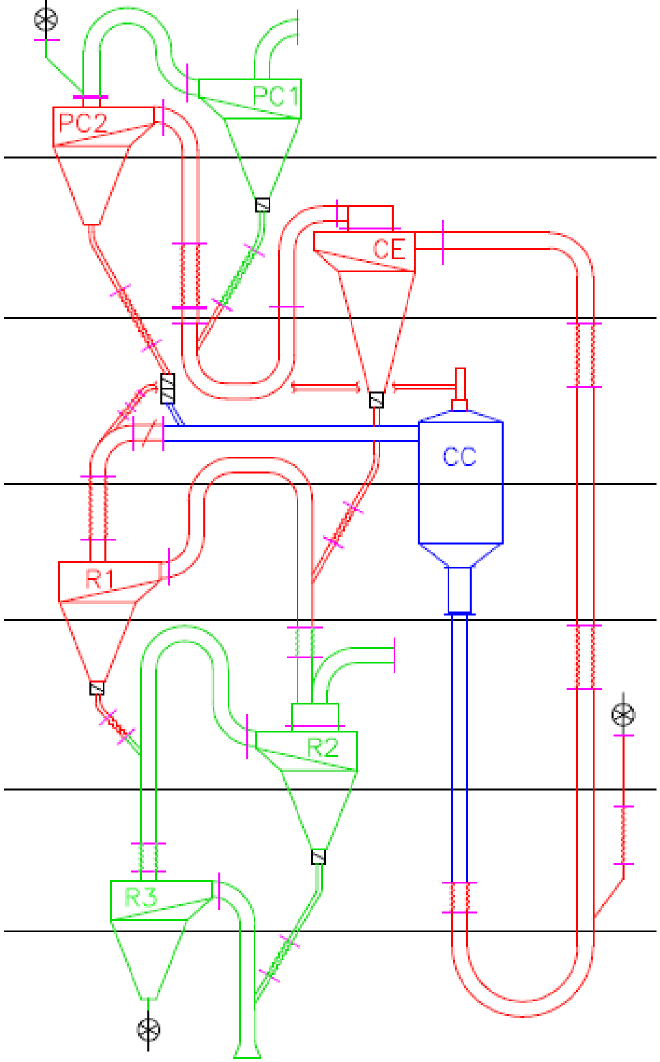
- **The solution to a specific site depends on the types of fuel, available capex, existing equipment, raw material characteristics**



Flash Calciner

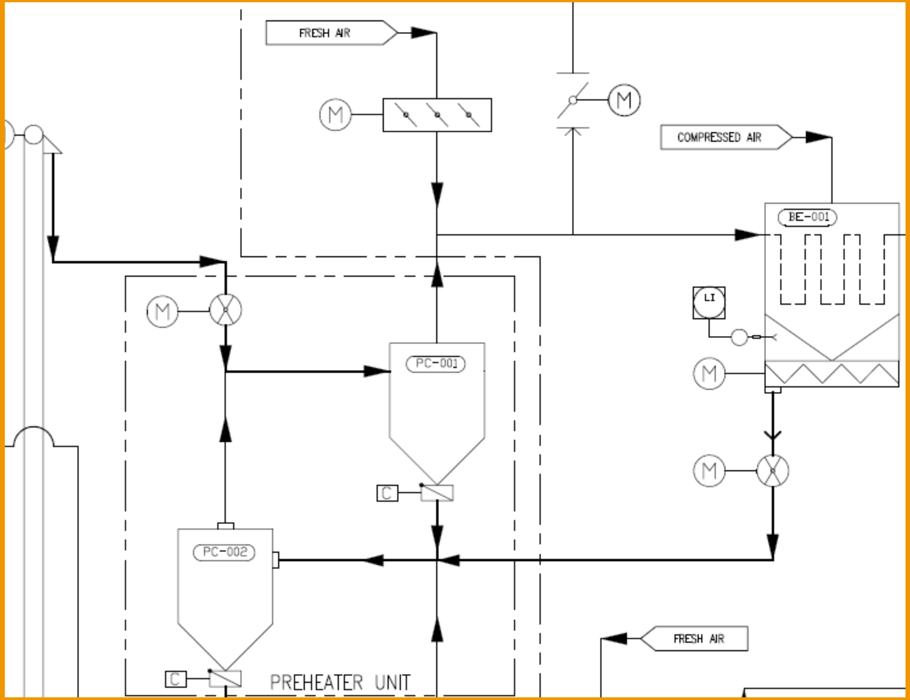
- **Steps**
  - **Feed and Preheating**
  - **Calcination**
  - **Cooling**

- **Enhanced heat recovery**



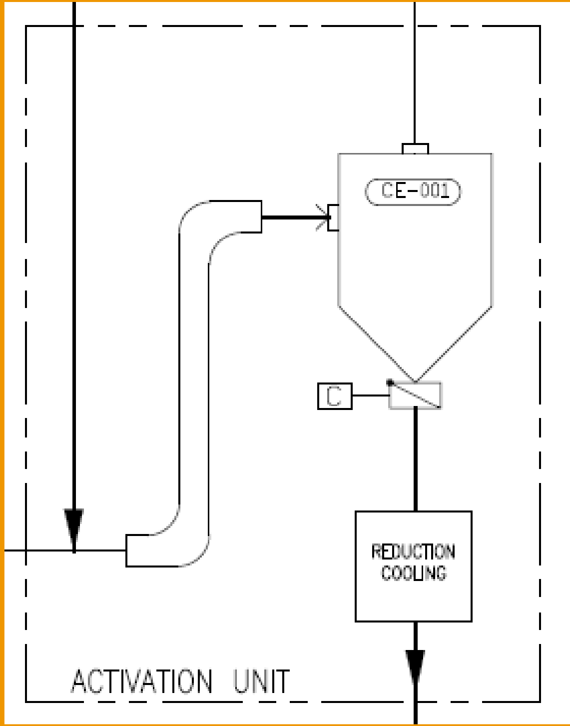
Flash Calciner

- **Feed and Preheating**
  - **Exhaust gas used for drying**
  - **Bucket elevator with recirculation**



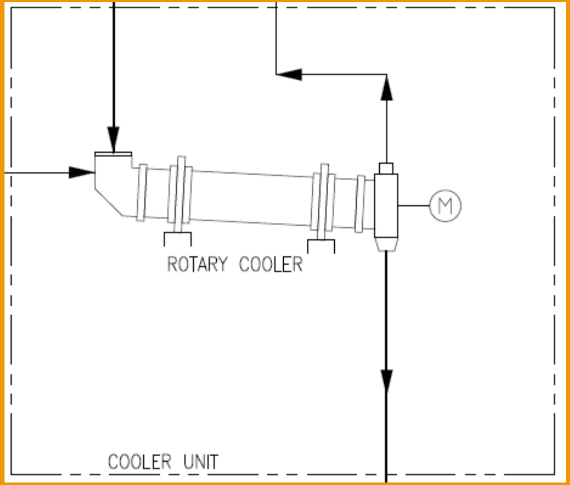
Flash Calciner

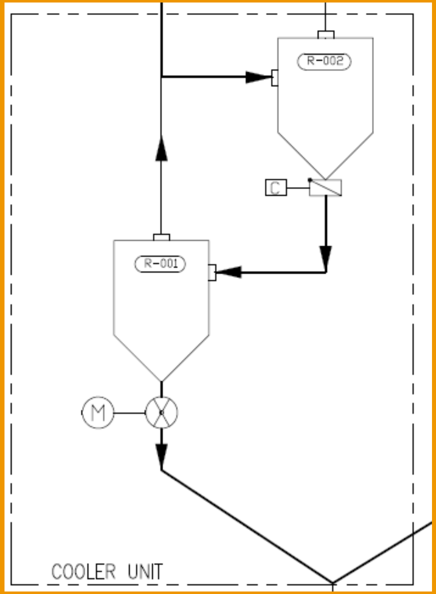
- **Calcination**
  - **In-Line or Separate-Line Calciner**
  - **Optional color management feature**



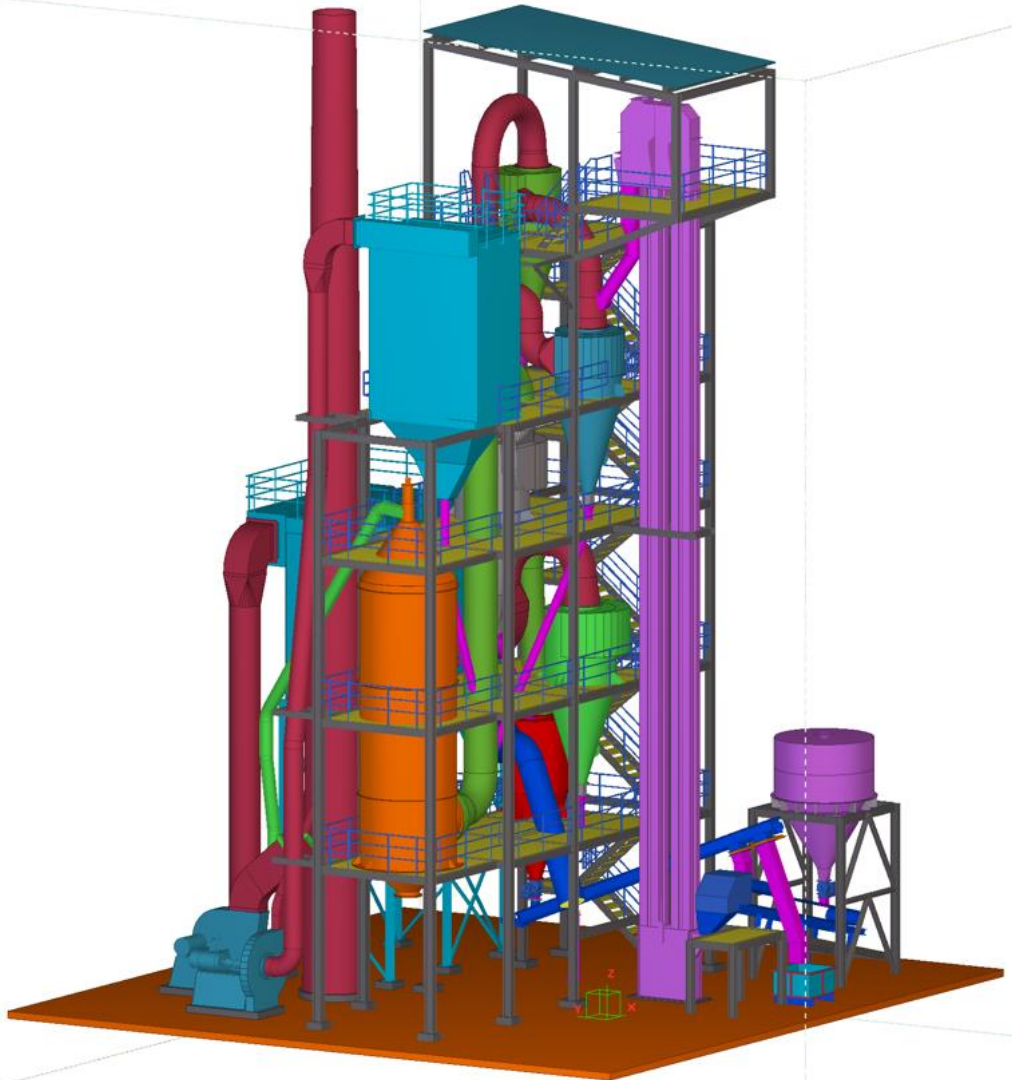
Flash Calciner

- **Cooling**
  - **Rotary or Suspension Cooler**





Flash Calciner



Flash Calciner

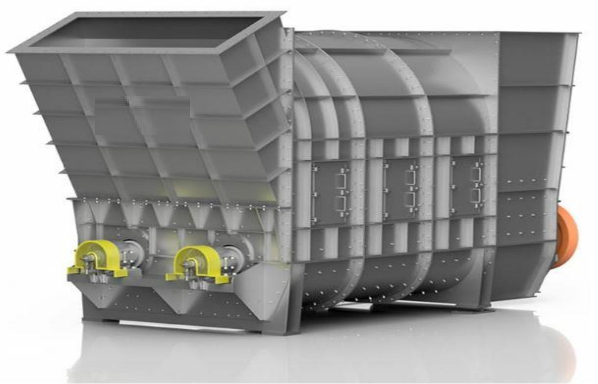
- **Refractory only applied in the combustion chamber, riser and calciner cyclone: quick heat-up**
- **No moving parts: low maintenance, light structure, high reliability installation.**
- **Precise temperature control, preventing melting and agglomeration of the clay, highly reactive pozzolan**

Why Flash?

- **High pozzolanic activity (allows for maximized use of pozzolan in Cement blends)**
- **No calcine grinding**
- **Quick start and easy operation**
- **Lower fuel consumption**
- **Lower maintenance cost**
- **Lower overall electrical consumption**

Drying

Rapid Dryer



VRM w/ sand removal

Rotary dryer

Hot Gas Generation

Fluidized bed for coarse and/or alternative fuels

Pulverized solid fuel

Gaseous or Liquid fuel

Rotary Kiln

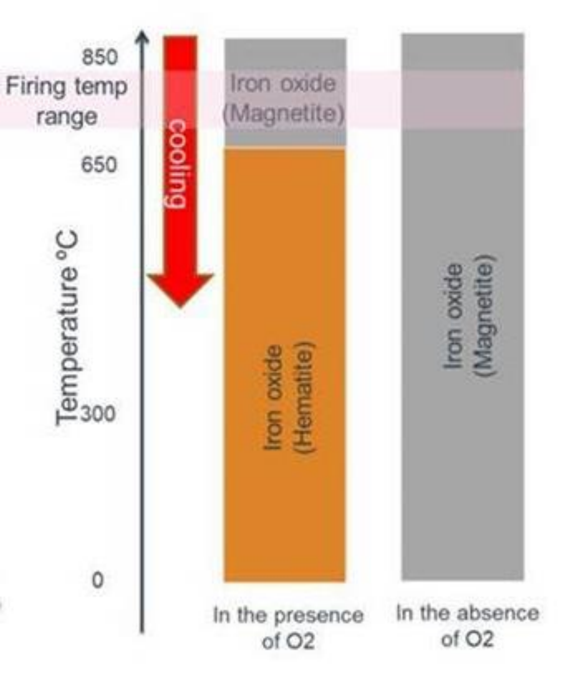
- Existing (or new) equipment
- Drying and calcination in a single equipment
- Burner or Combustion chamber
- Cooler

Clay Color Control

- **No correlation with Cement strength development**
- **Psychological influence on buyer's decision**

Hematite → Magnetite

Fe_2O_3 → Fe_3O_4



Clay Color Control

Hematite Fe_2O_3 → Magnetite Fe_3O_4

Method I: O_2 depletion

- **Rationale: Hematite is the most oxidized form of iron oxide**
- **Action: minimize O_2 in kiln operation**
  - **back end O_2 target < 1%**
  - **fuel injection in the vicinity of the kiln discharge**

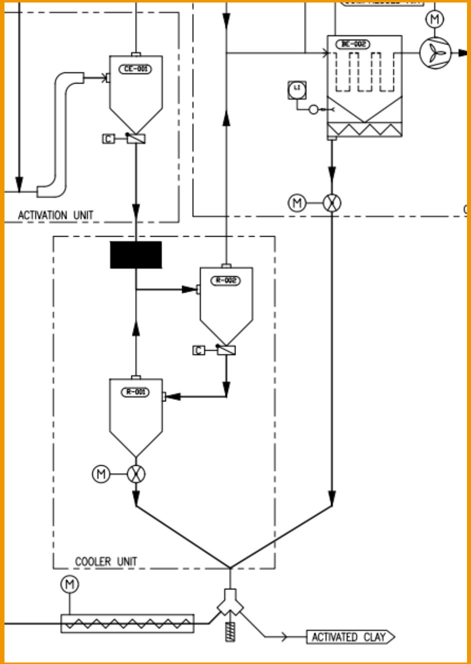
Clay Color Control

Hematite → Magnetite

Fe_2O_3 → Fe_3O_4

Method II: Quenching

- **Rationale: *Freezing* Fe in Magnetite form**
- **Action: promote quenching**
  - **Water spraying, and/or**
  - **Indirect cooling in inert environment**



Clay Color Control

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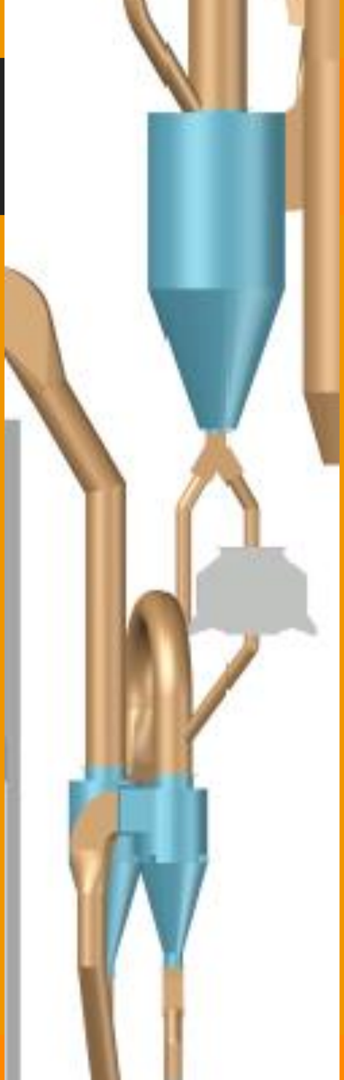

Clay Color Control

Method III: Inorganic Modifiers

- **Rationale: Fe structure-change**
- **Action: case by case analysis**
  - **NDA required**
  - **Assess feedstock and available resources**

Hematite Fe_2O_3 → Magnetite Fe_3O_4

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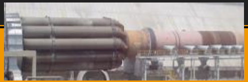
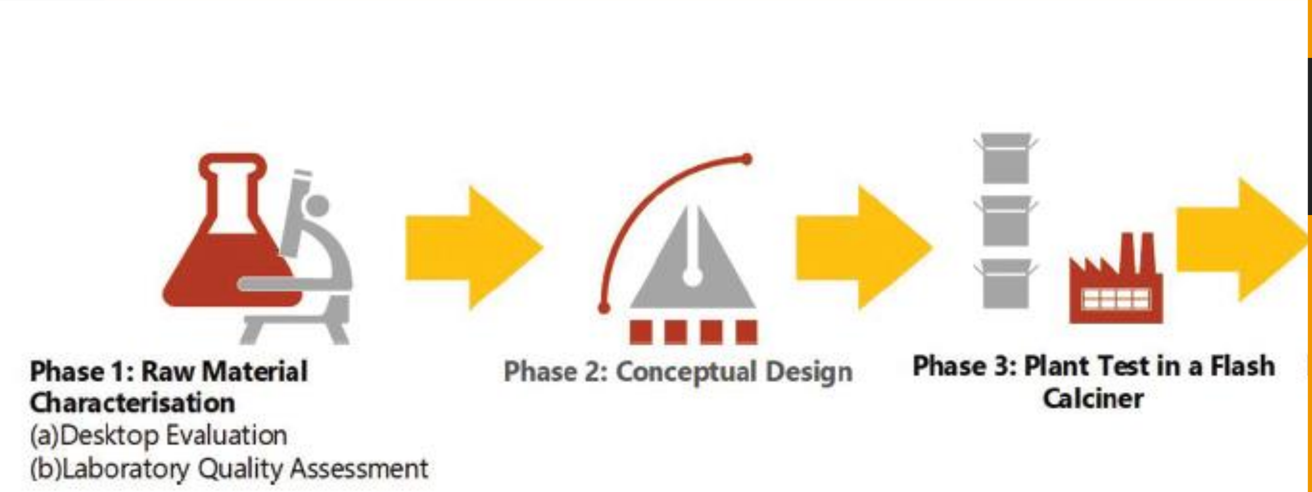
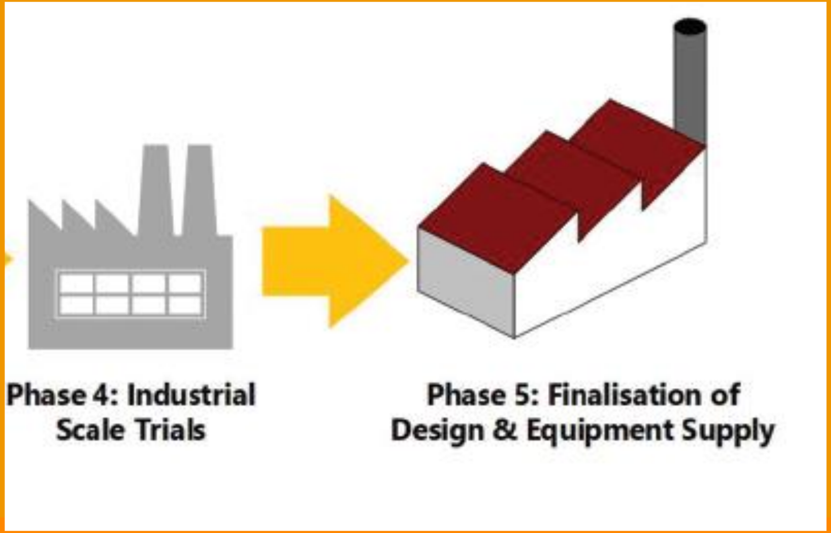
Rotary vs. Flash - Comparison

	Case 1 Existing preheater kiln 		Case 2 Energy Eff, Color Control 	Case 3 Mothballed long kiln 
Solutions	• Sizer, grizzly • Raw clay transport system • Combustion system evaluation		• short rotary dryer • 5-stage tower • fluidized bed HGG • quenching (or inorganic modifiers) for color control	• Sizer, grizzly • Raw clay transport system • Pre combustion chamber • Water spraying
	• With lifters	• Without lifters		
CAPEX	low	lowest	medium	low
OPEX	low	medium	lowest	high
Moisture	20%	20%	15%	10%
Heat Consumption	570 kcal/kg	610 kcal/kg	*570 kcal/kg with quenching* *510 without quenching*	720 kcal/kg
Production	1050 tpd	750 tpd	1000 tpd	450 tpd

Offer

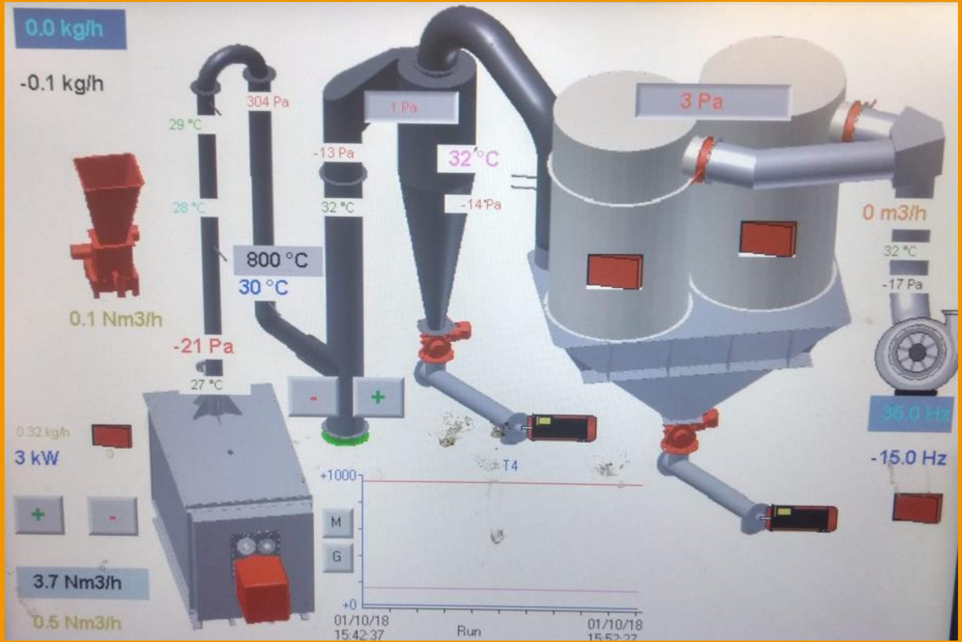


Phase 1: Raw Material Characterisation
(a)Desktop Evaluation
(b)Laboratory Quality Assessment
Phase 2: Conceptual Design
Phase 3: Plant Test in a Flash Calciner



Phase 4: Industrial Scale Trials
Phase 5: Finalisation of Design & Equipment Supply

Offer


0.0 kg/h
-0.1 kg/h
304 Pa
29 °C
28 °C
-13 Pa
32 °C
1 Pa
32 °C
-14 Pa
3 Pa
0 m3/h
32 °C
-17 Pa
800 °C
30 °C
0.1 Nm3/h
-21 Pa
27 °C
3 kW
T4
+1000
M
G
+0
-15.0 Hz
3.7 Nm3/h
0.5 Nm3/h
01/10/18
15:42:37
Run
01/10/18

Conclusion

- There are several grinding/drying/calcining solutions to produce calcined clay

  …trade-off studies have to be conducted

- Each project should be evaluated with its own specificities

- Transition to LC3 requires knowledge in mining, logistics, clinker and concrete technologies, thermo fluid dynamics, grinding

THANKS!

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