Limestone Calcined Clay Cement LC3
www.LC3.ch

LOW CARBON LOW COST LOW CAPITAL HIGH PERFORMANCE

Update on the progress of the work of LC3 TRC in Latin America

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CIDEM

Universidad Central de las Villas

CUBA

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Sustainable habitat

Collaboration with Prof. Karen Scrivener

2005-2008
SDC-SNSF Project
Calcined clays for pozzolans

2009-2012
SDC-SNSF Project
Ternary blend cement calcined clay-limestone

2013-2020
SDC-Climate Change
Low Carbon Cement

The pursuit of sustainable alternatives to replace Clinker with Supplementary cementitious Materials

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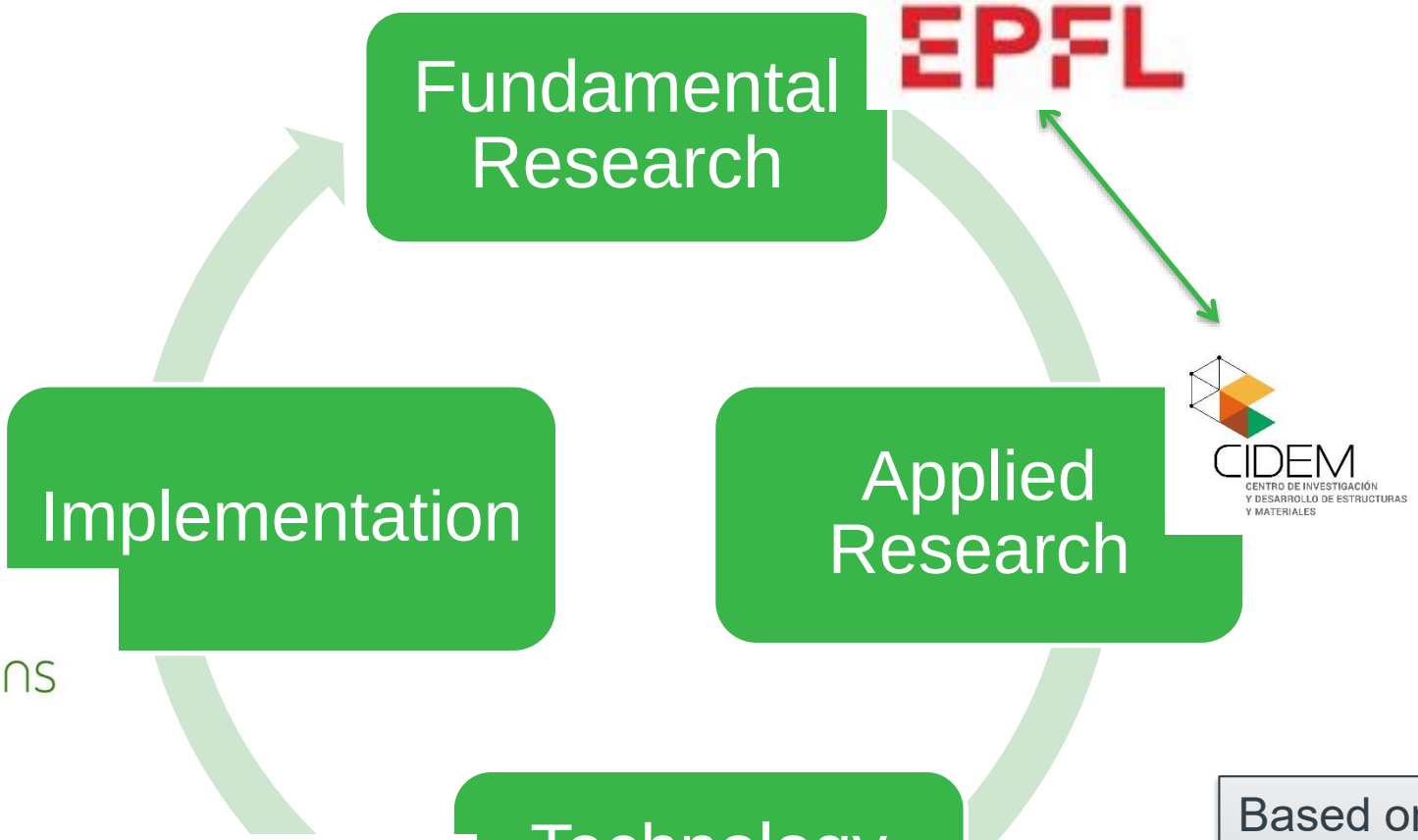
The idea of the collaboration



EPFL

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sinoma 中材叶片

Based on KFPE's 11 principles for partnerships between Swiss institutions and institutions in developing countries…

Current situation of cement production in Latin America

- Large availability of suitable clays in vast regions of the continent
- Scarce supply of Supplementary Cementitious Materials
- Cement industry expanding despite economic downturns (especially Central America and the Caribbean)
- Great interest in US for LC3 product (Especially in Florida with Department of Transportation)
- Several countries supporting COP 21's INDC to mitigating Climate Change

Main obstacles for LC3 dissemination in Latin America

Capital cost. Economic feasibility needs to be demonstrated

Availability of good quality natural pozzolan (volcanic ashes and tuffs) in certain regions

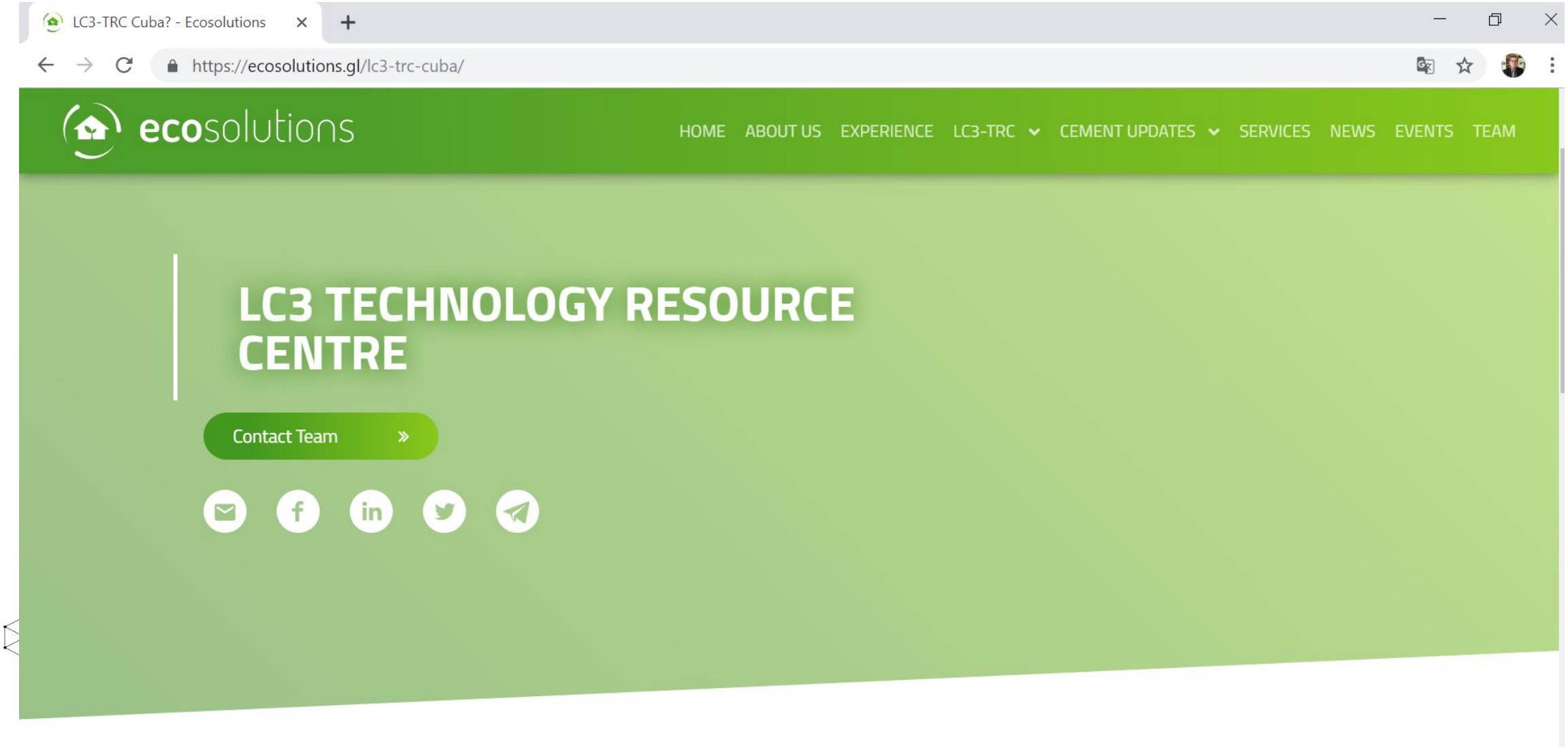
Few econnomic incentives for innovation at the cement industry level

Scarce knowledge of production of calcined clays (except Brazil)

WHAT'S NEEDED?

- Clear protocols for clay exploration
- Availability of advisory service
- Suitable and affordable equipment for clay calcination
- Clear recognition of the new product in standards
- Economic and fiscal incentives for the industry

Technical Resource Center Cuba (TRC Cuba)



Objectives of the TRC Cuba

To **provide advisory service and information** to all parties interested in introducing LC3 as cementitious materials

To **act as interface between the academia and the industry** for a swift introduction of the new developments in the area of LC3

To **interact with technology providers** in order to further develop equipment and machinery for the production of LC3

To **facilitate training** for the industry to assimilate the new technologies for the manufacture of LC3

Protocol to assist companies introduce LC3

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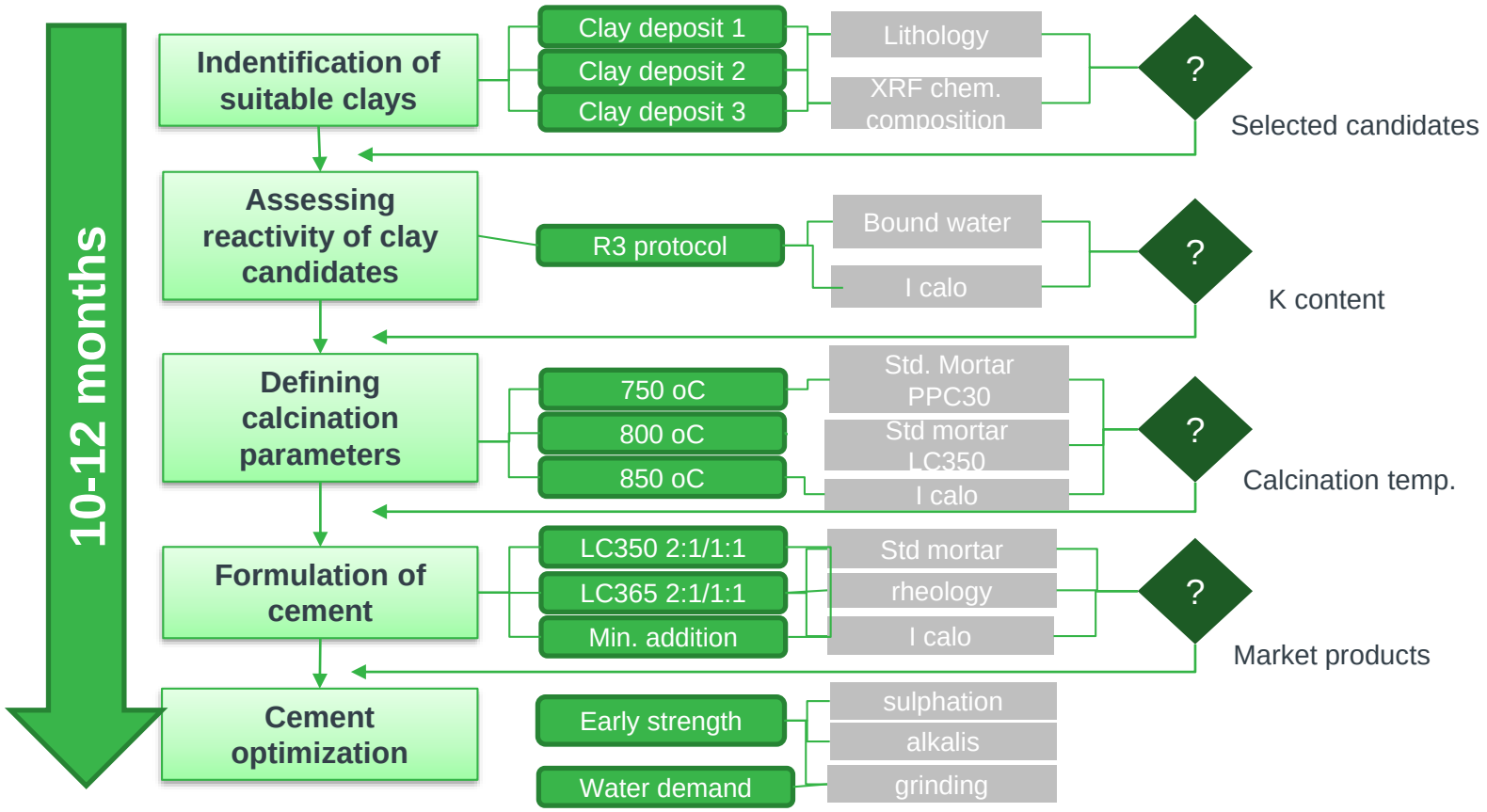
Non-profit company registered in Switzerland, with the goal of providing advisory service to companies in the cement sector (www.ecosolutions.gl)



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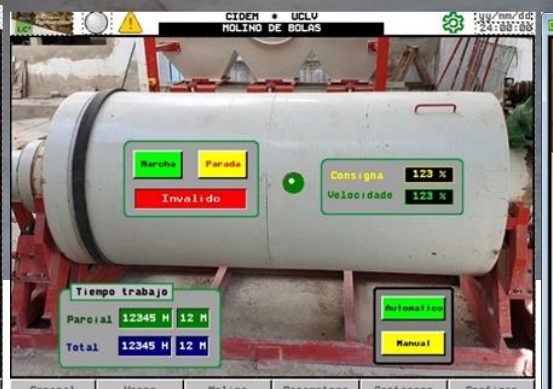
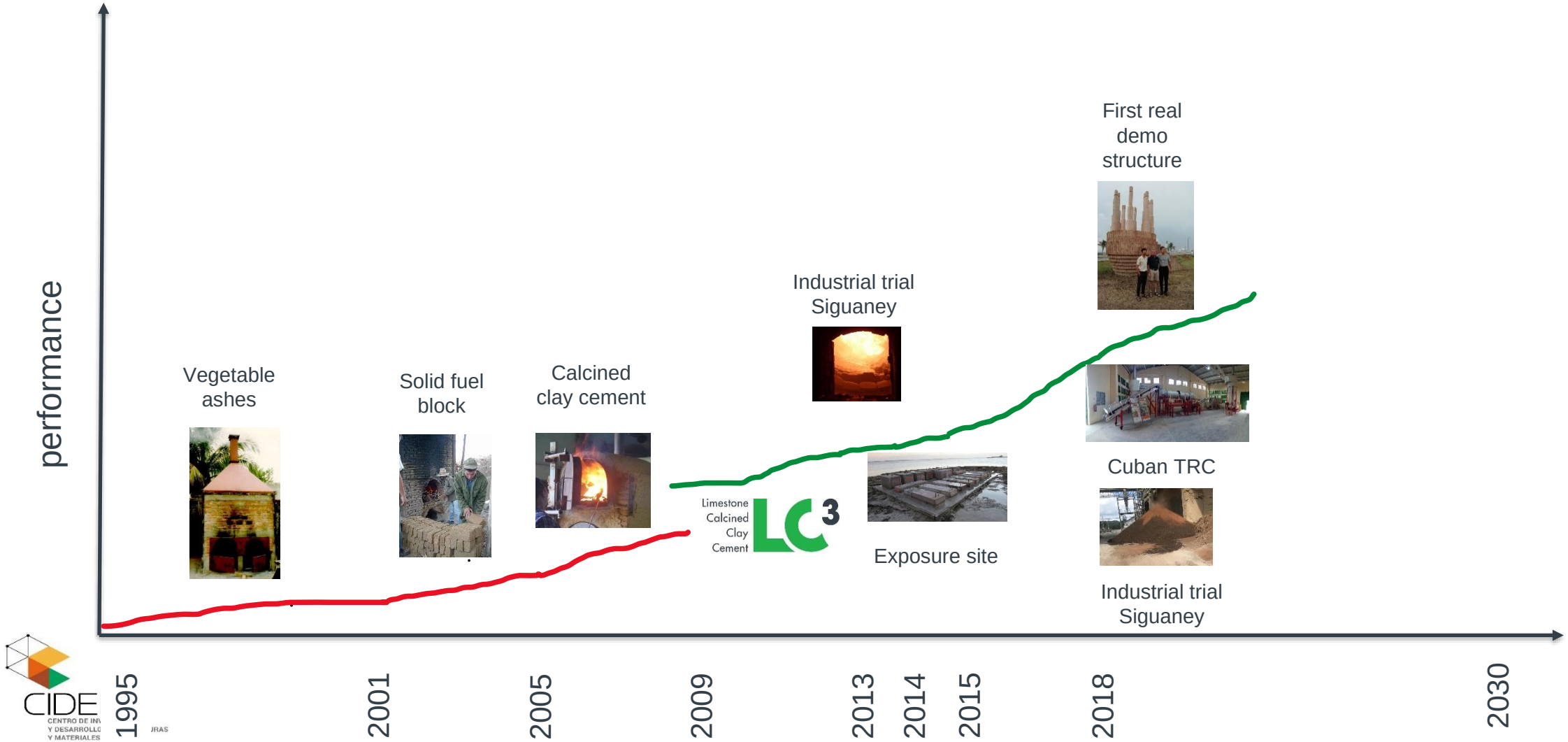
Cuban TRC. LC3 Pilot Plant (5 tpd)



Equipment for calcination & grinding LC3

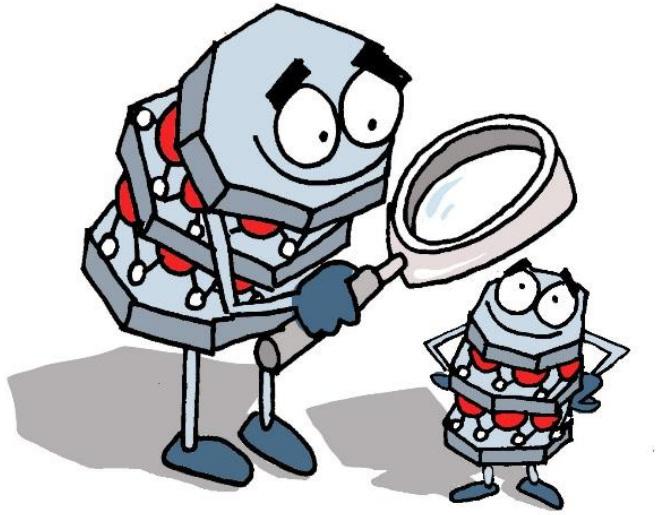
S-curve for LC3 Latin America



Stumbling blocks for industrial applications

- Geologists in cement companies are not used to look for OUR clays (1:1)
- Choice of calcination technology
- People (customers) do not like “red cement”
- Some standards do not include LC3 composition (minimum clinker content, water demand)
- Grinding ternary binders can be complex
- Calcined clays increase water demand in cement & concrete

Which are the suitable clays?



Threshold for good reactivity:
60% Quartz
40% Kaolinite

- % Al_2O_3 = 15,8
- % Al_2O_3 / % SiO_2 = 0,2
- % OH^- = 5,6

Suitable clays must comply with

- % Al_2O_3 > 18
- % Al_2O_3 / % SiO_2 > 0,3
- % LOI > 7,0

- % CaO < 3,0 (Low contents of calcite/gypsum)
- % SO_3 < 2,0 (Low contents of pyrite/alunite/gypsum)
- % Fe_2O_3 < 10,0 (?) (If red color is undesirable, also depending on calcination technology)

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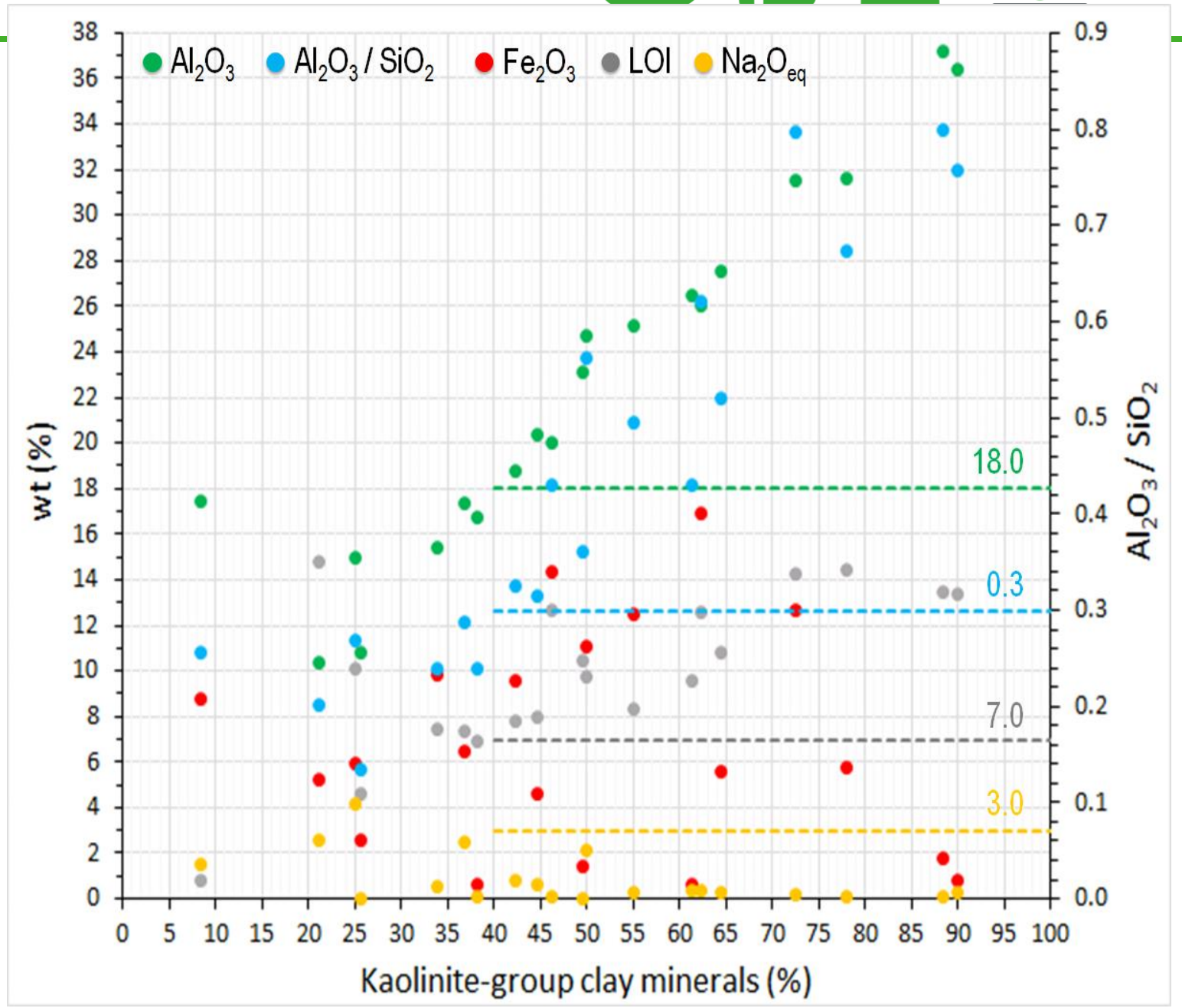
Chemical and mineralogical composition

- Clays used in Clinker production have low Al and high Si (contrary to what is needed for LC3)
- High alkalis values indicate not completed weathering process (low kaolinite content)
- Presence of Fe only has implications in color



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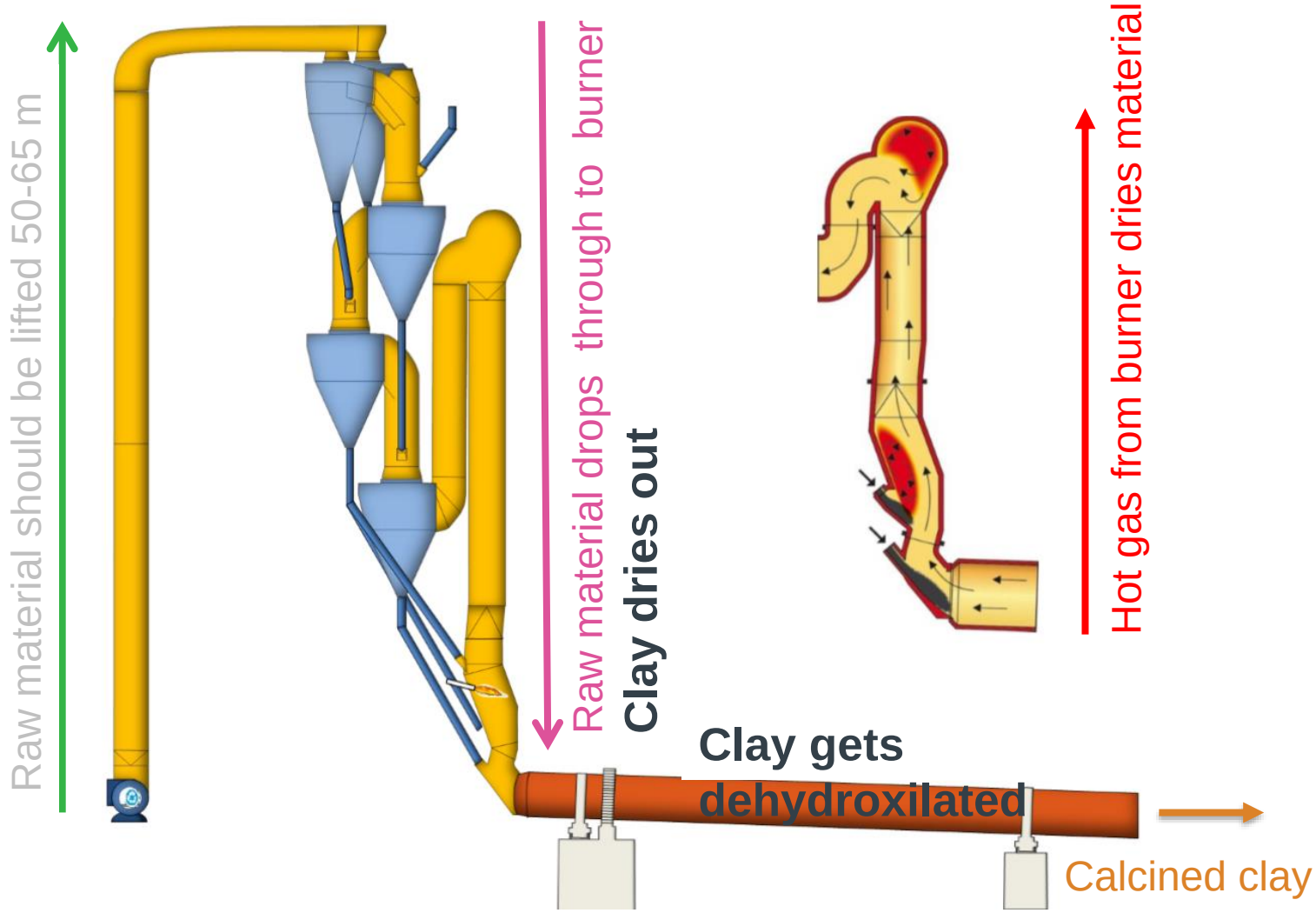
Technology for calcination: flash calciner coupled to rotary kiln

Two stage process:

1. Removal of absorbed water (calcination tower)
2. Removal of chemically bound water(rotary kiln)



Graph taken from CEMCAP Report “Status Report on Calciner Technology”, EU Horizon

Example: ARGOS plant Rio Claro, Columbia (rotary claciner coupled to a drier tower)

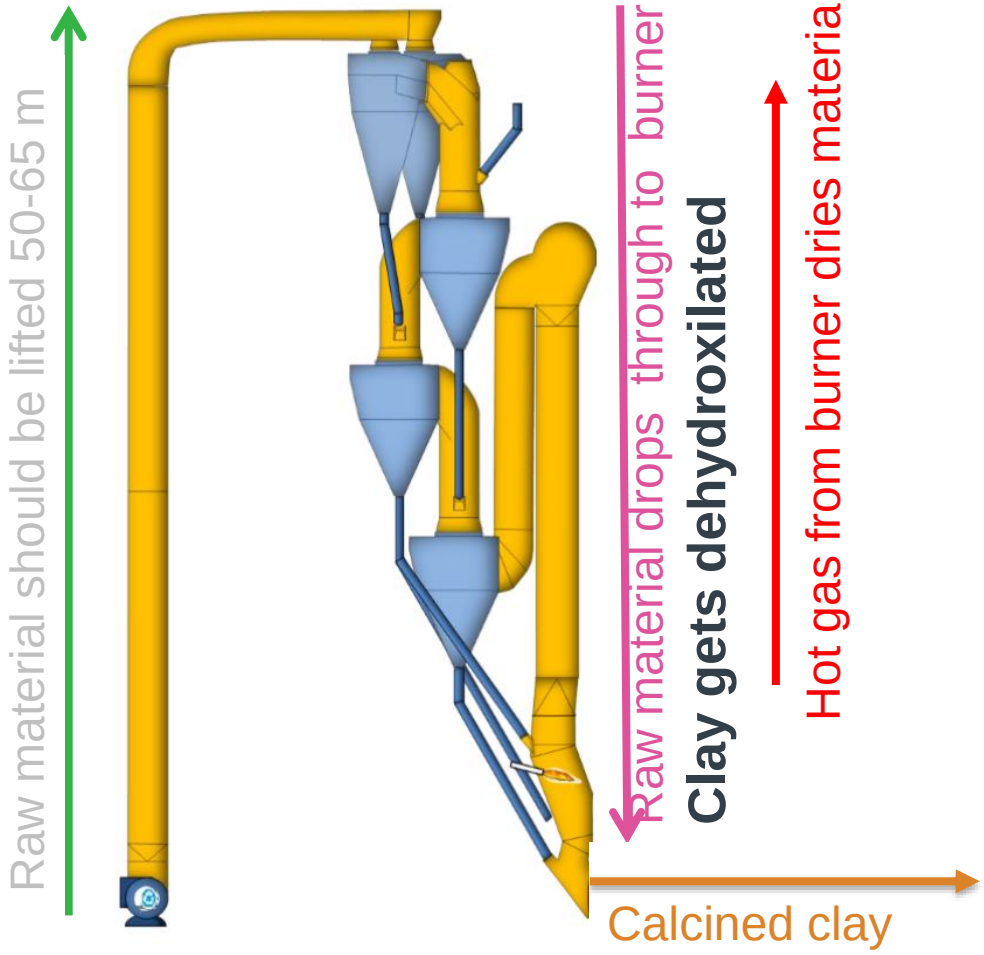
Main parameters:

- 1500 ton calcined clay per day (500 K ton x year)
- Project total cost: 76 millones USD
- OPEX ≤ 20 USD/ton AC
- Thermal consumption: 550 kcal/kg CCL
- Power consumption: 33 kw/ton CCL

Technoology for calcination: flash calciner

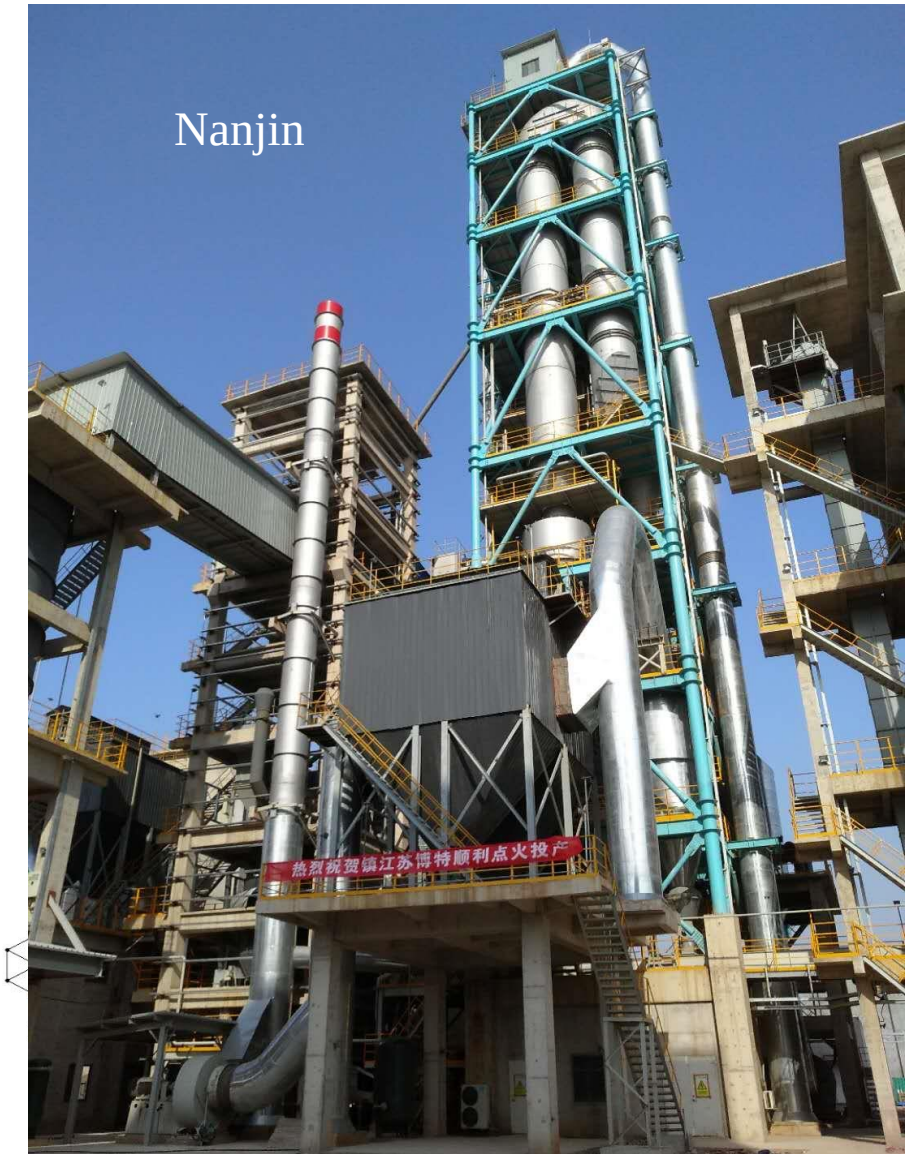
Two stage process:

1. Removal of absorbed water (calcination tower)
2. Removal of chemically bound water(calcination tower)



Graph taken from CEMCAP Report “Status Report on Calciner Technology”, EU Horizon

Example: Sobute plant. Nanjing (flash calcination tower). China



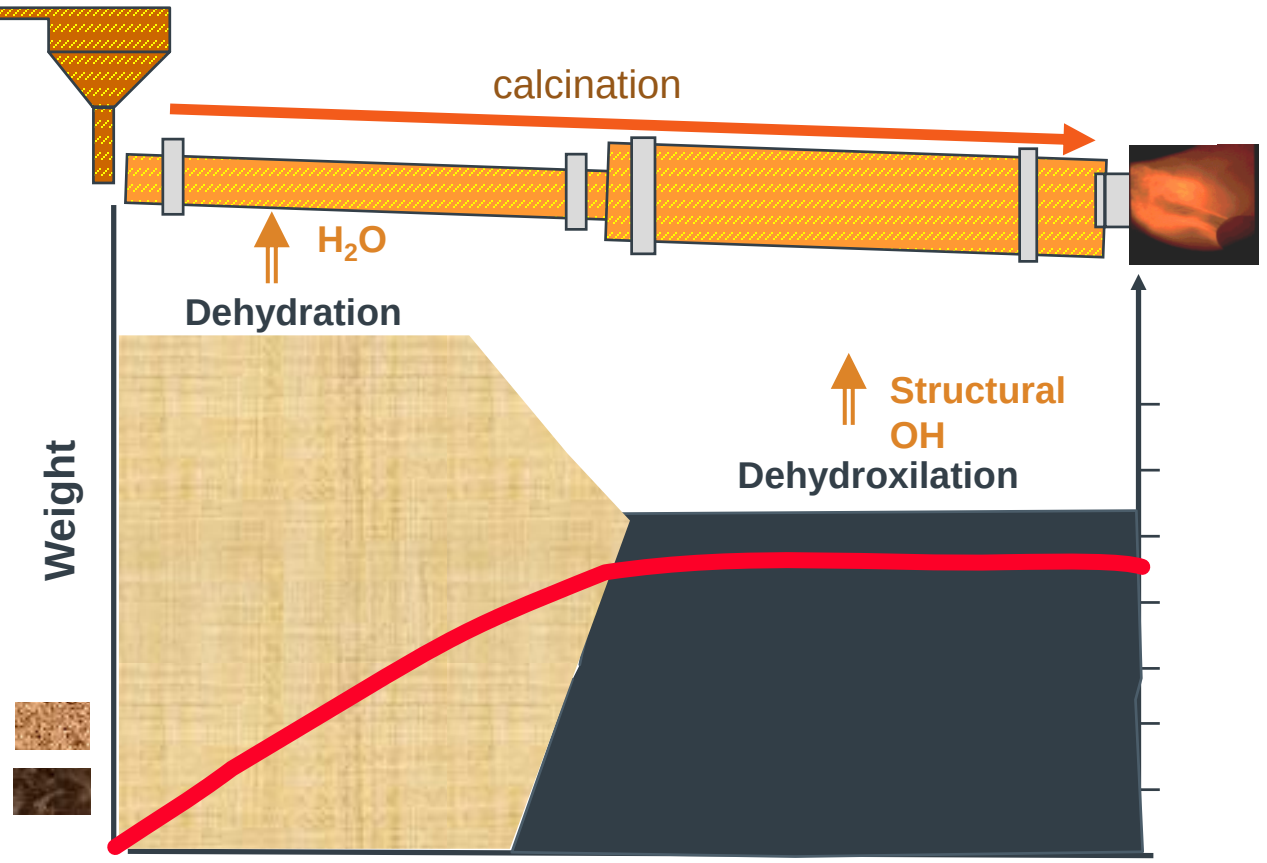
Main parameters:

- 600 ton calcined clay per day (200 K ton x year)
- Estimated cost project: 30 Mio USD Thermal consumption: 620-660 kcal/kg CCL
- Power consumption: 78-89 kw/ton AC

Technology for calcination: double shaft rotary kiln

Two stage process:

1. Removal of absorbed water (first shaft)
2. Removal of chemically bound water(second



Example: CEMTECH Ivory Coast (double shaft rotary kiln)

Main parameters:

- 720 ton calcined clay per day (200 K ton x year)
- Cost equipment: 6 millones USD; total: 12 Mio USD
- Thermal consumption: 529 kcal/kg; AC
- Power consumption: 18 kW/ton AC

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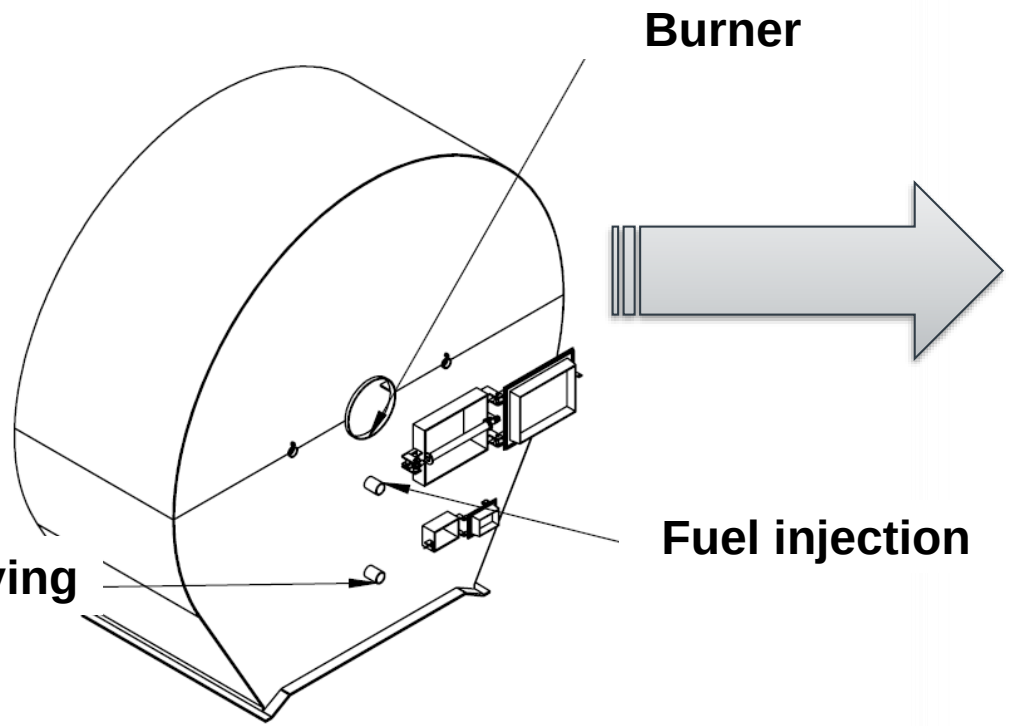
IPIAC, 2019

Simple system to control color



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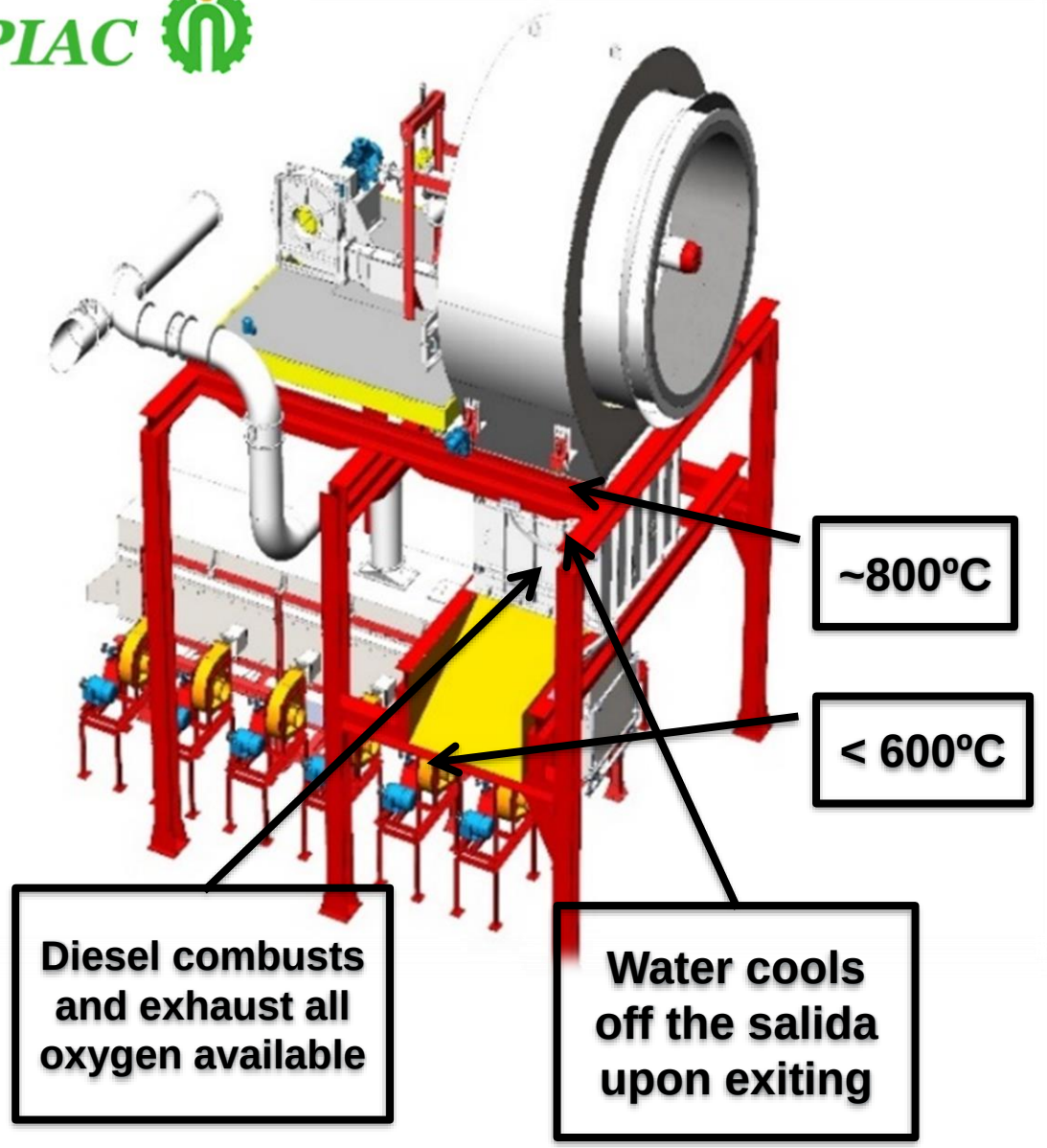

Fuel consumption for color control is less than 1%...

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Color control. IPIAC technology

IPIAC

Calcination takes place under reducing conditions

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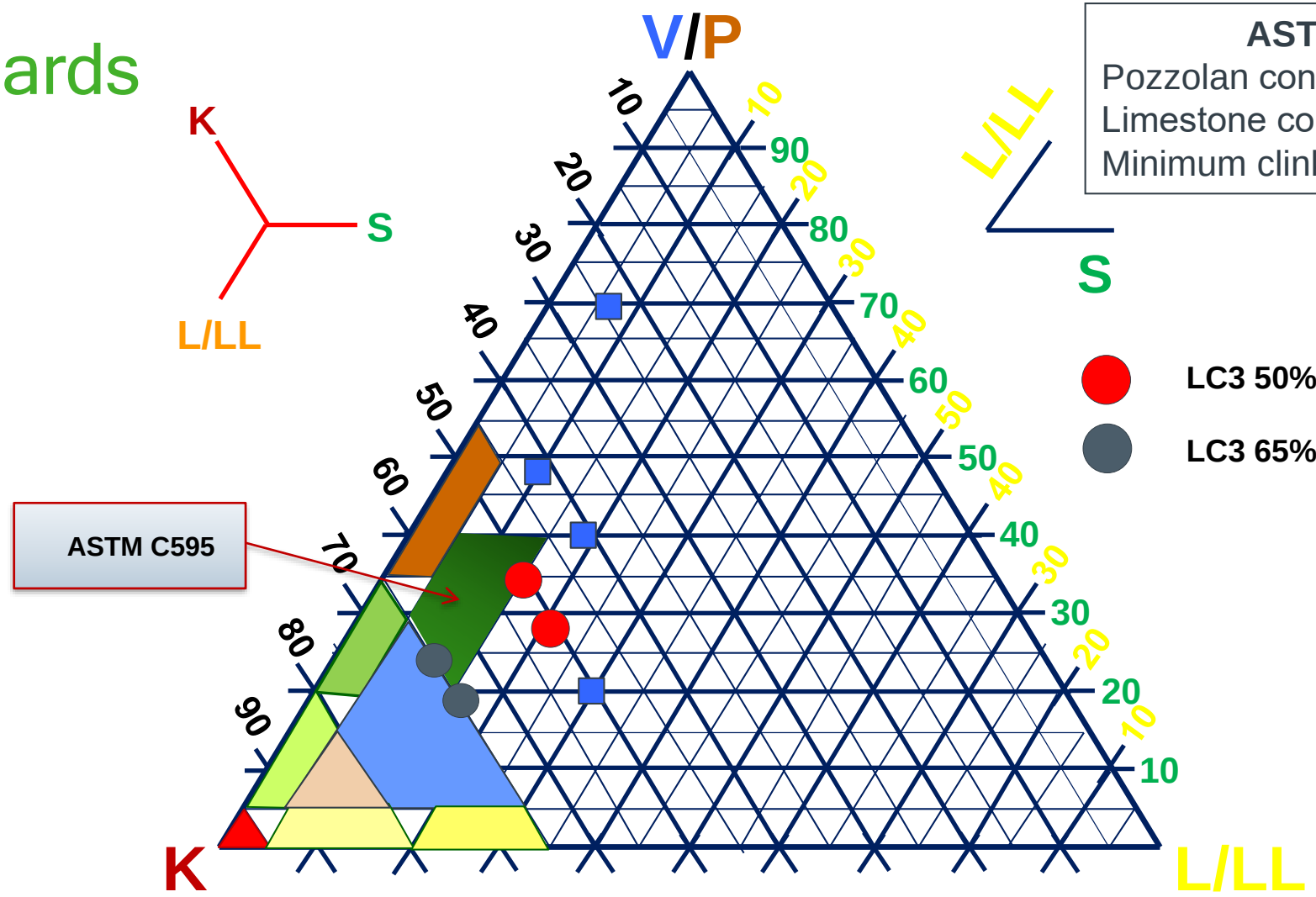
Standards

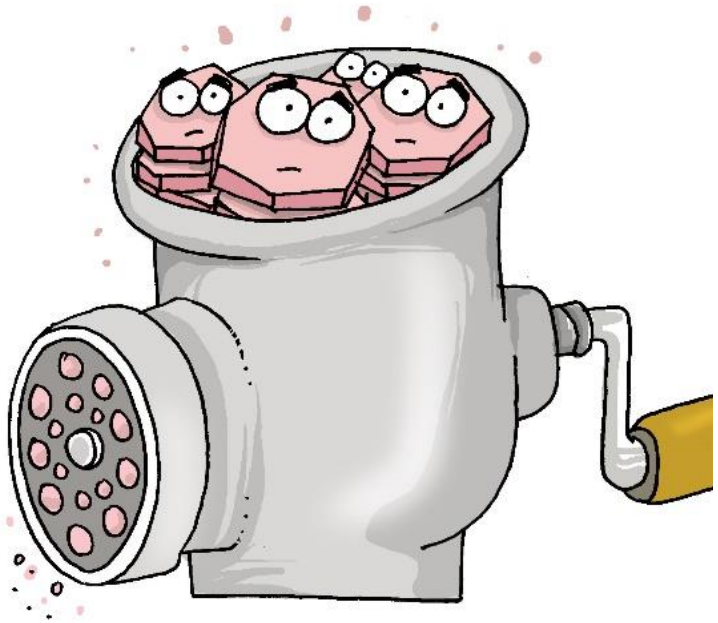
ASTM C595
Pozzolan content: ≤ 40%
Limestone content: ≤ 15%
Minimum clinker content: 45%

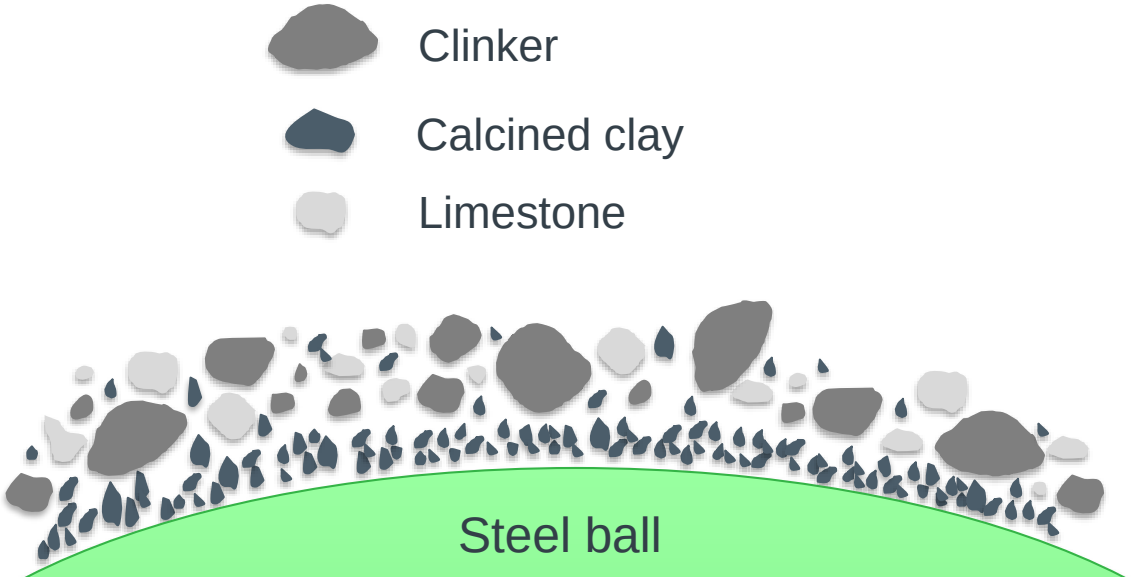


(**) tests carried out by Lafarge (France)

Problems during grinding multi-component cement

- Electrically charged particles coat the steel balls and the walls of the mill and affect clinker grinding
- Excess grinding of soft materials takes place





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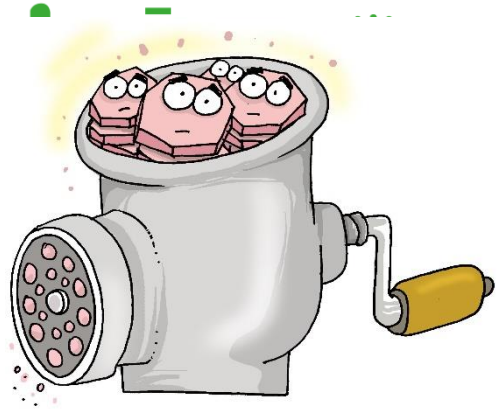
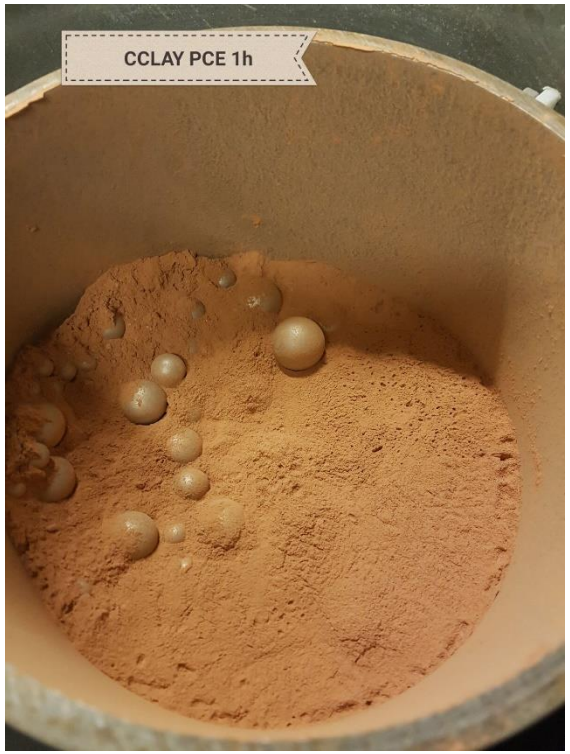
Impact of grinding aids

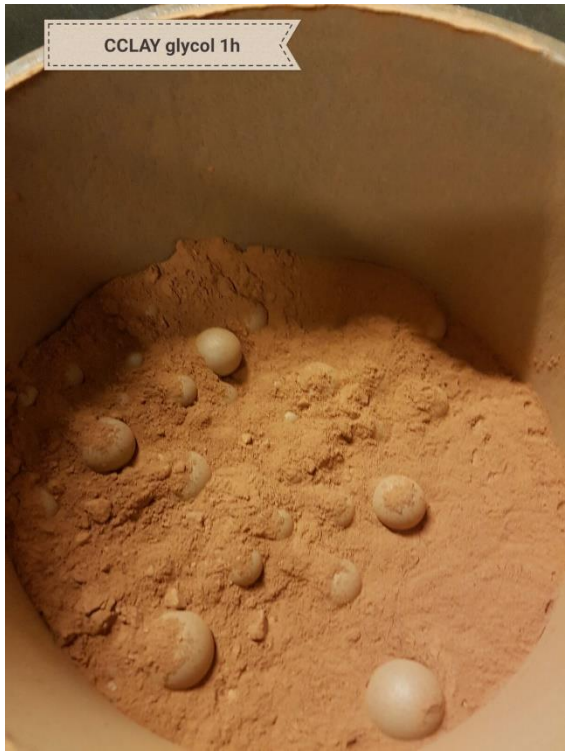


CC 1h no GA



CC 1h PCE 1 0.45%

CC 1h Amine 0.13%



CC 1h Glycol 0.12%

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Franco Zunino, 2018

Impact of high dosage of SP on early strength

	P35+LC2	P35 ref
Cement (kg/m3):	266.00	380
Water (L/m3):	160.00	
LC2 (kg/m3)	114.00	114.00
SP (L/m3)	6.79	3.5
Sand 1 (kg/m3)	904.32	904.32
Sand 2 (kg/m3)	0.00	0.00
Gravel 1(kg/m3)	1019.77	1019.77
Gravel 2 (kg/m3)	0.00	0.00
Water/CPO+LC2	0.42	0.42

Dissemination activities

- 2011: ICCC Madrid (pre congress courses)
- 2015-06: 1st Int. Conference on Calcined Clays. Switzerland
- 2016-06: LC3 seminar, Cuba
- 2016-10: Habitat 3. Ecuador
- 2017-11: RILEM seminar. Colombia
- 2017-12: 2nd Int. Conference Calcined Clays. Cuba
- 2017-07: Presentation Corvallis. USA
- 2018-01: LC3 day, Cuenca. Ecuador
- 2018-05: LC3 day. Switzerland & Portugal
- 2018-08: LC3 day. Honk Kong
- 2018-09: FICEM conference, Panama
- 2018-11: SIKA seminar. La Habana. Cuba
- 2019-02: LC3 day. Miami. USA
- 2019-09: FICEM, Dom. Repulic

Industrial trial Cuba. December 2018


Calcined clay in nodules


Material left in kiln #3

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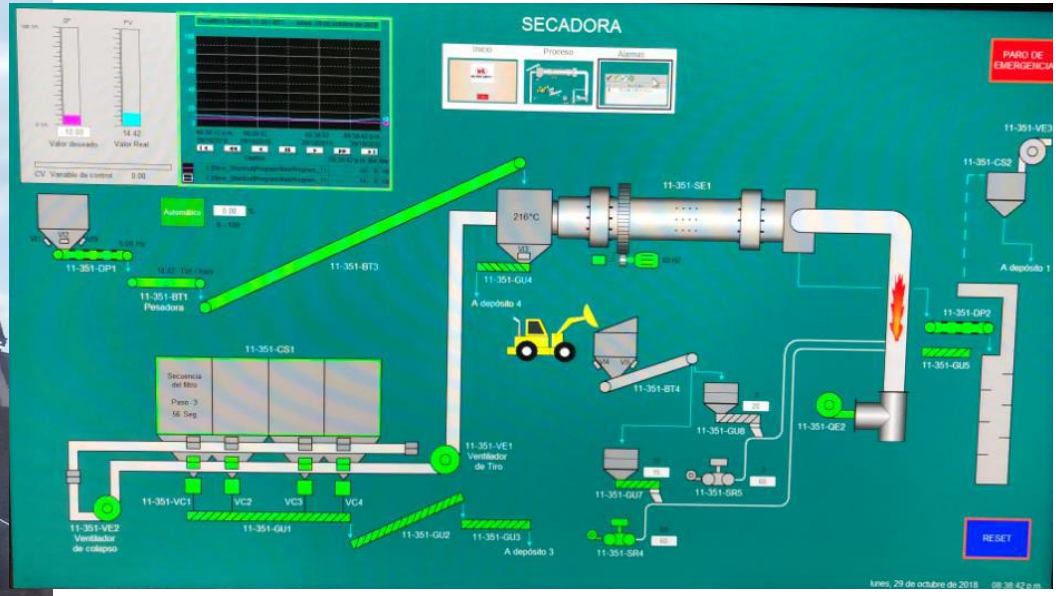
CEMENTO SIGUANEY

Industrial trial Guatemala, 11-2018

cementos PROGRESO®
Compartimos Sueños. Construimos Realidades.



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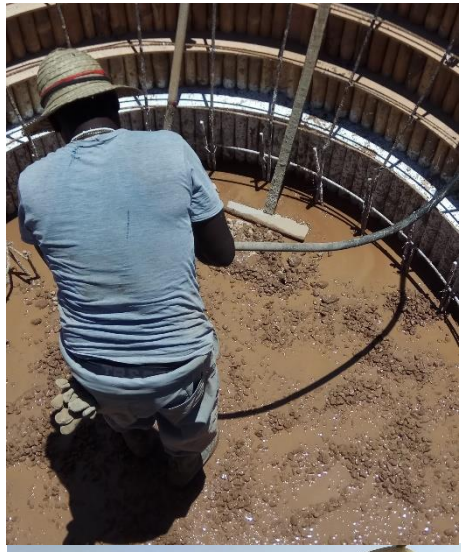
Sculpture at Biennal Havana 2019 with LC3



Current state. Latin America

CUBA
XX company prepares investment
20 miniplants coming up

GUYANA
XX company with interest in technology

MEXICO
XX company with interest in technology

GUATEMALA
XX industrial trial done.
Investment preparation

BOLIVIA
XX company with interest in technology

ARGENTINA
XX company with interest in technology

COLOMBIA
XX company started production
XX1 company ongoing studies

ECUADOR
XX company. Studies finalized.
Investment expected

PERU
XX company ongoing studies

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Forecast of take up of LC3 production in the region

	Built capacity LC3 Ton/Year	Co_2 Savings Ton/Year *	Co_2 Savings USD/Ton
2019	1414286	339429	9062743
2020	4472286	1073349	28658407
2021	5264286	1263429	33733543
2022	12502286	3000549	80114647
	23'653'143	**5'676'754**	**151'569339**

Impact on the region between 2019-2022 (4 years)

- Cement production in the region was 120 million tons in 2016 **(Increase 10% due to LC3)**
- Average Clinker factor around 68-69% **(it could be lowered to around 0.60)**
- Carbon emissions 70 million tons **(reduction of 4% carbon emissions)**

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Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Direktion für Entwicklung und Zusammenarbeit DEZA
Direction du développement et de la coopération DDC
Swiss Agency for Development and Cooperation SDC
Agencia Suiza para el desarrollo y la cooperación COSUDE

Thank you!!

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