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Understanding the Cement Manufacturing Processes, Quality Control and Grinding Aids

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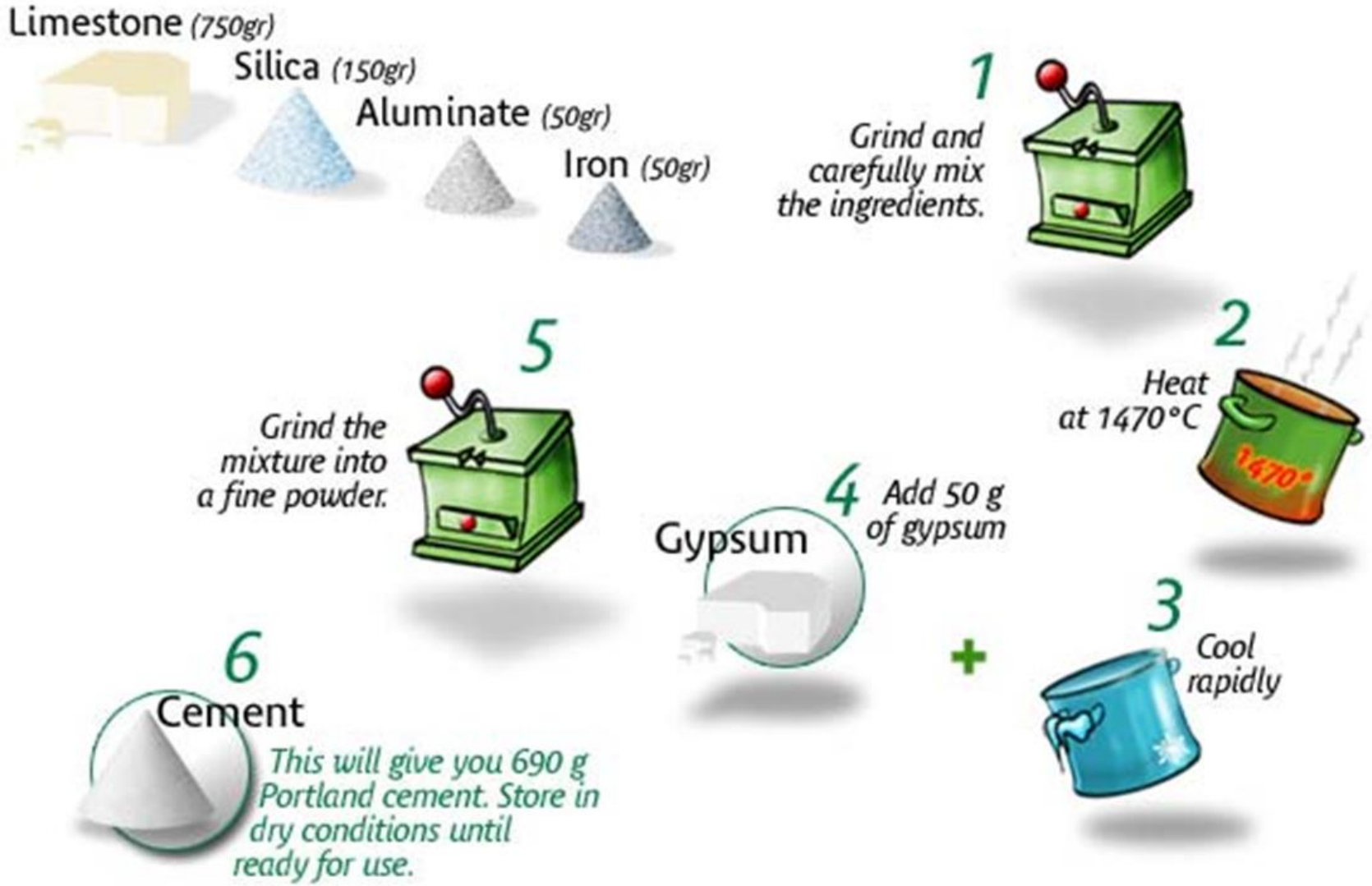
Amrize inside

Agenda

- Cement Manufacturing – 101 Review
- History of Portland Limestone Cement Usage in North America
- How do we determine the amount limestone to be used
- What levers do we have to improve strength performance
- What do we do if we are not hitting our quality targets
- How do we monitor our quality
- Grinding Aids

Cement 101



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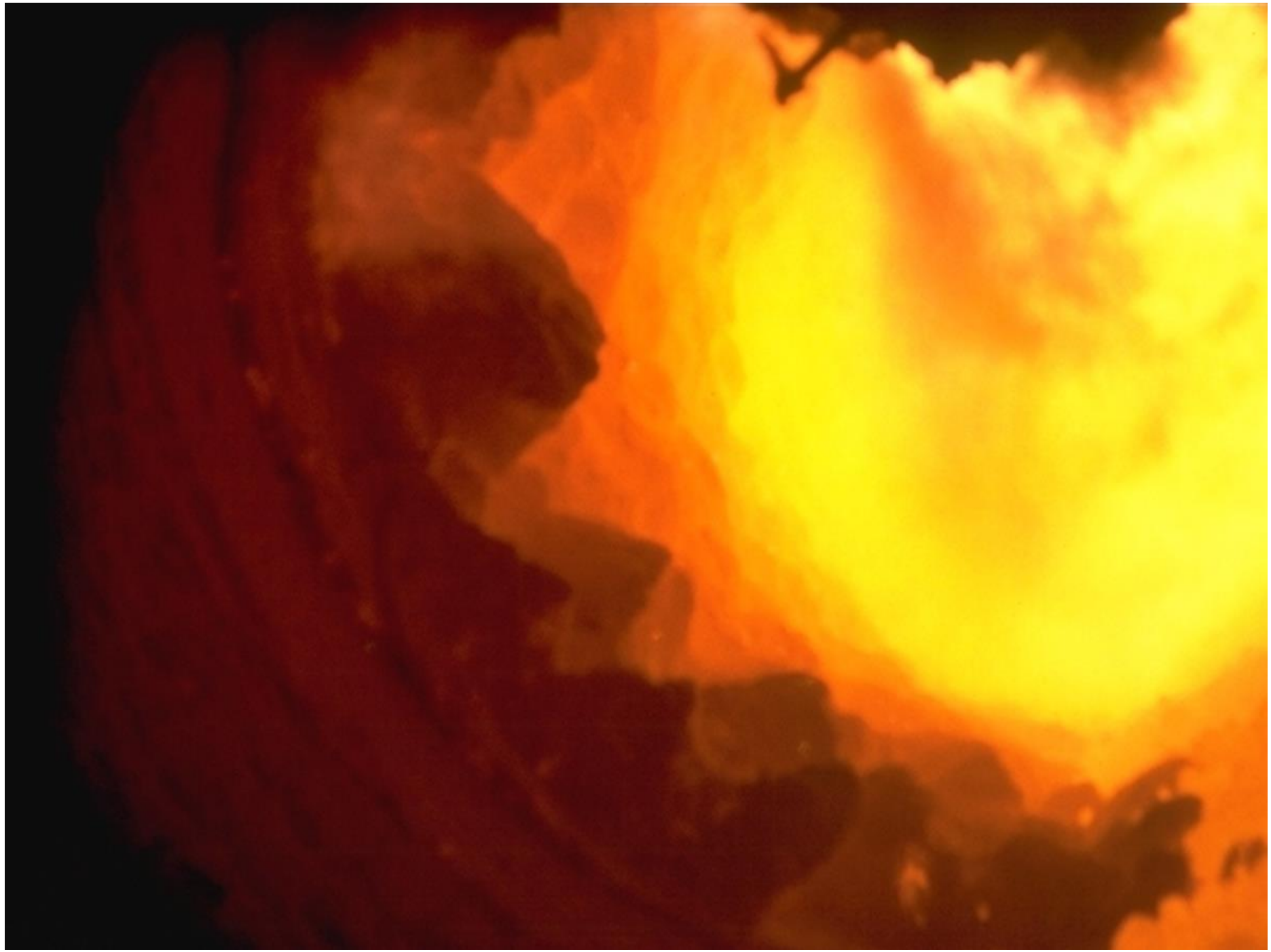

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Portland Cement
Clinker – Bogue Compounds

C_3S $3CaO \cdot SiO_2$ **(Alite)** Tricalcium silicate

The major contributor to strength at all ages. Hydrates and hardens rapidly. Largely responsible for early strength and generates a modest amount of heat.

C_2S $2CaO \cdot SiO_2$ **(Belite)** Dicalcium silicate

Hydrates and hardens slowly and contributes largely to strength at ages beyond one week.

C_3A $3CaO \cdot Al_2O_3$ Tricalcium aluminate

Liberates a large amount of heat. Contributes to early strengths. Low C3A cements are sulfate resistant.

C_4AF $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$ Tetracalcium aluminoferrite

Hydrates rapidly but contributes very little to strength. High C4AF cements are darker in color. C3A + C4AF are fluxes and govern the clinkering temperature.

History of Use of Limestone in Cements

- 1965 Cement with 20% limestone cement in Germany for specialty applications
- 1979 French cement standards allows limestone additions.
- 1983 CSA A5 allows up to 5% in portland cement
- 1990 15±5% limestone blended cements routinely used in Germany
- 1992 UK specs allows up to 20% in limestone cement
- 2000 EN 197-1 allows 5% MAC (typ. limestone) in all 27 common cements, as was commonly practiced in various European cement standards prior to that.
- 2000 EN 197-1 creates CEM II/A-L (6-20%) and CEM II/B-L (21-35%)
- 2004 ASTM C 150 allows 5% in Types I-V
- 2006 CSA A3001 allows 5% in other Types than GU
- 2007 AASHTO M85 allows 5% in Types I-V
- 2008 CSA A3001 includes PLC containing 5%-15% limestone

- 2012 ASTM C595 Includes PLC Containing 5%-15%
- Lafarge PNW 100% Transition in 2017 – sulfate

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WHY IL

- Save the World?
- Increased Domestic Output
- North American Job Security
- Make Money

Old Montra – Equal Performance and Green for Free

- Is this true?
- No – Not all the time
- What have we learned and what are we doing to improve things

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Why Don’t All ILs have the same limestone??

- Not all Clinkers have the same reactivity
- Can not compare IL in the PNW or NE US
- Not all combinations give the other desired properties customers require
    1) Bleed
    2) Set
    3) SCMs
    4) Admixtures
    5) Cost!
    6) Other

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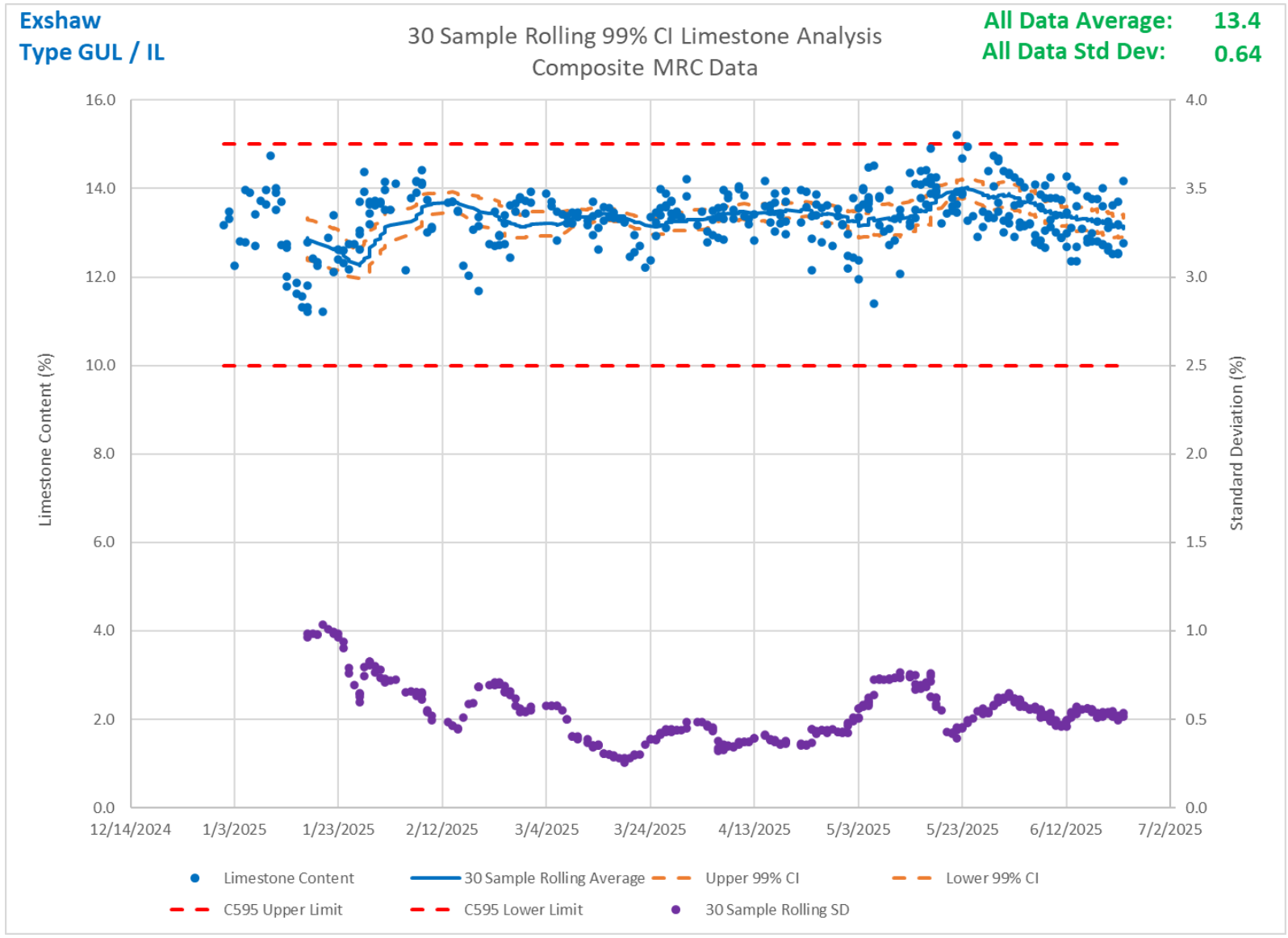
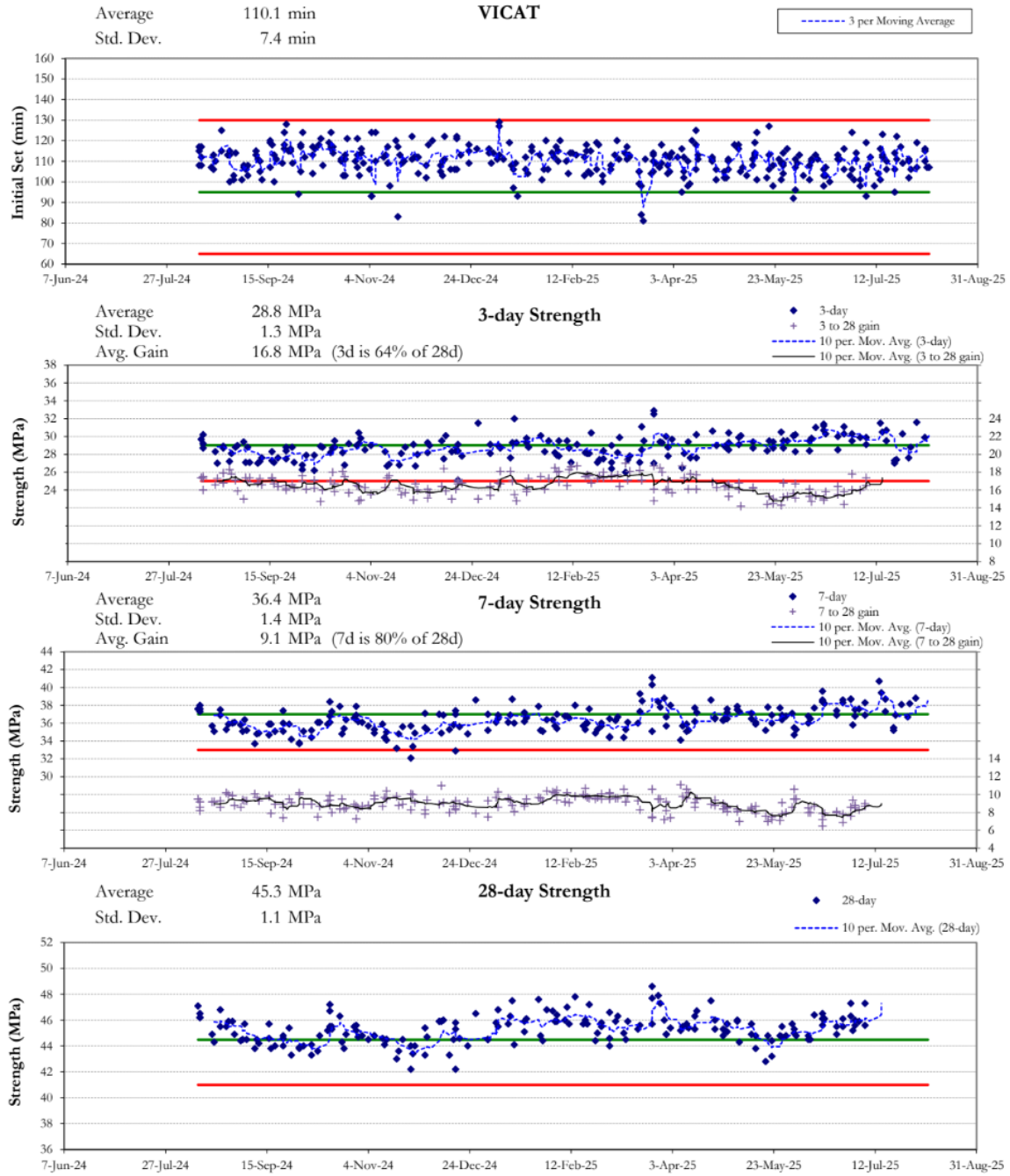
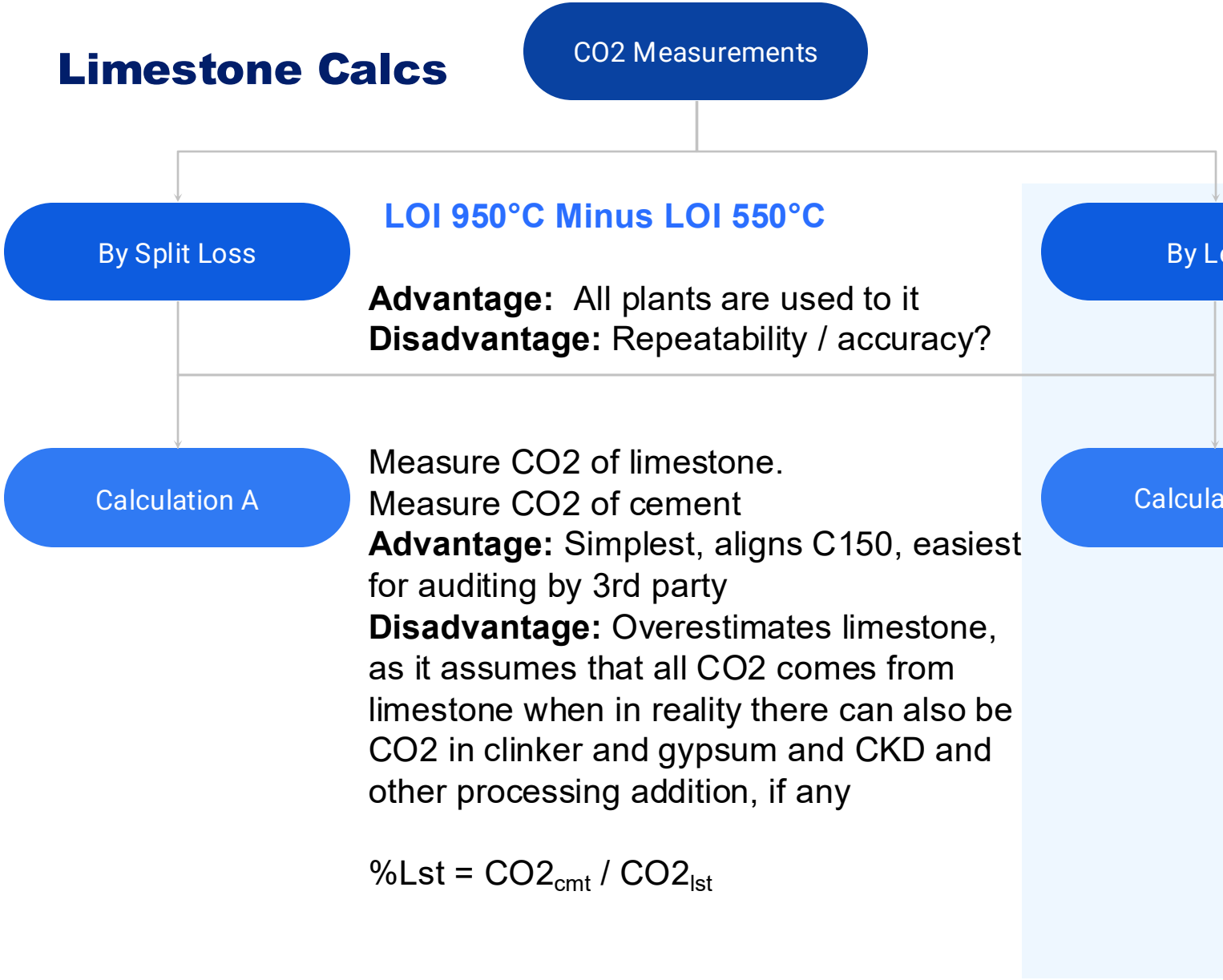
Cement Production – An Industrial Process that requires adjustments and QC



Quality Monitoring – Control Charts



Limestone Calcs



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Finish Mill Process

Two types of Finish Mill Systems - Ball Mills and Vertical Roller Mills

Cement is produced by combining **clinker, gypsum and limestone** together, and grinding this combination into a **fine powder**. A **grinding additive** is used to improve process efficiency and cement performance.

Testing is completed **every 3 hours** during production (Production Quality Control)

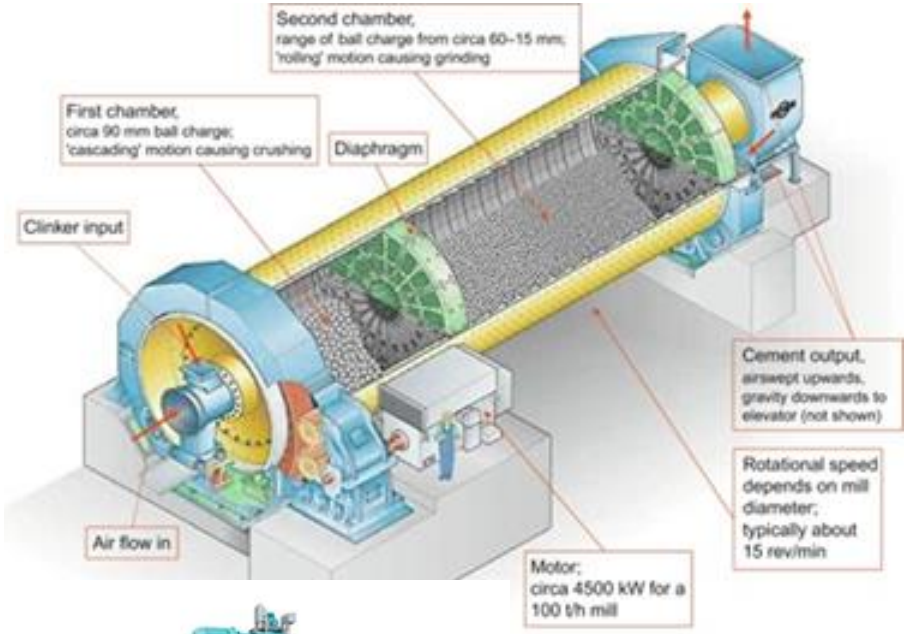
- **Fineness**
- **Chemical Composition**

Testing is also completed on **composite samples** (Production Quality Assurance)

- **Mortar Strength**
- **Setting Time**
- **Flow/Workability**

Ball Mill Advantages:
Higher Strength
Faster Set??

VRM Advantages:
Uniformity
Up to 40% more efficient



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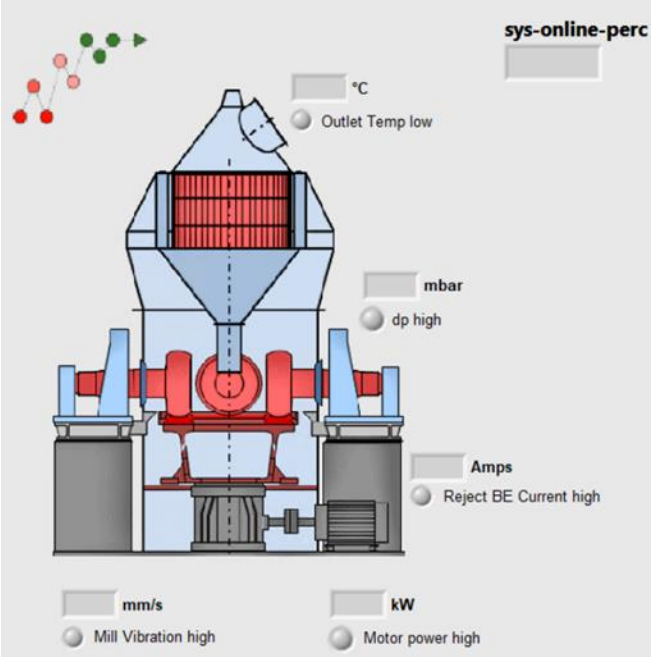
Process Control



Two Modes of Control

High Level Control - Automated Process Control (Preferred)

- Testing Results and Process Data are fed into software
- Software analyzes results and makes changes to process parameters
- Allows for fine optimization and minimizes human error

Manual Control - Manual Adjustments to Process

- Required for certain non-steady-state situations - E.G. Mill Start-Up
- All adjustments are made one at a time directly to the process controllers

What happens if something is off in QC???-

- Fringe Bins
- Blending
- Use in other products – 1157, CTB ect

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Fringe System - Mill Instability

Transient Conditions

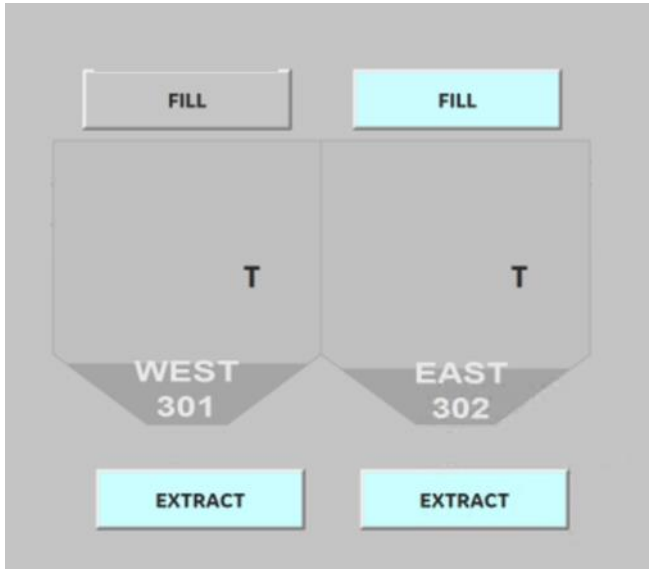
- Mill Start-Up
- Mill Shut-Down
- Product Type Changes

During **periods of instability**, before steady state operations are achieved, cement produced can be of lower quality.

This cement typically **meets ASTM/CSA** requirements, but not necessarily **AMRIZE** standards.

This cement is **segregated** from production silos, into dedicated fringe cement silos

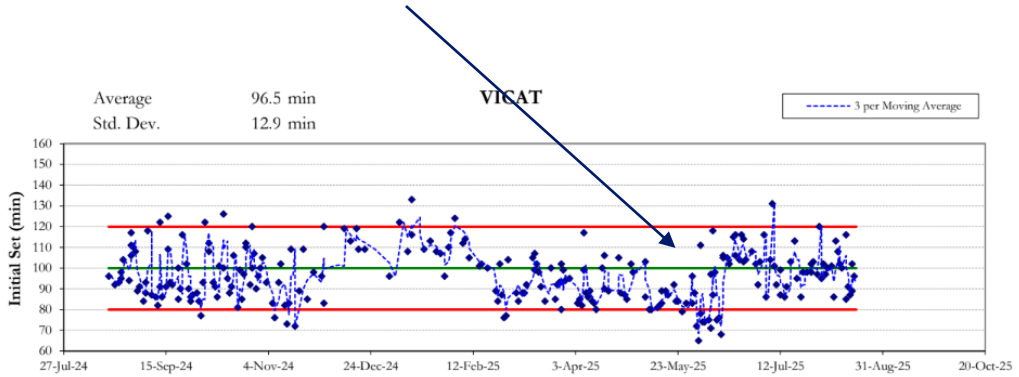
The material is **reintroduced** into the mill systems to be re-milled into cement that meets all **AMRIZE** standards



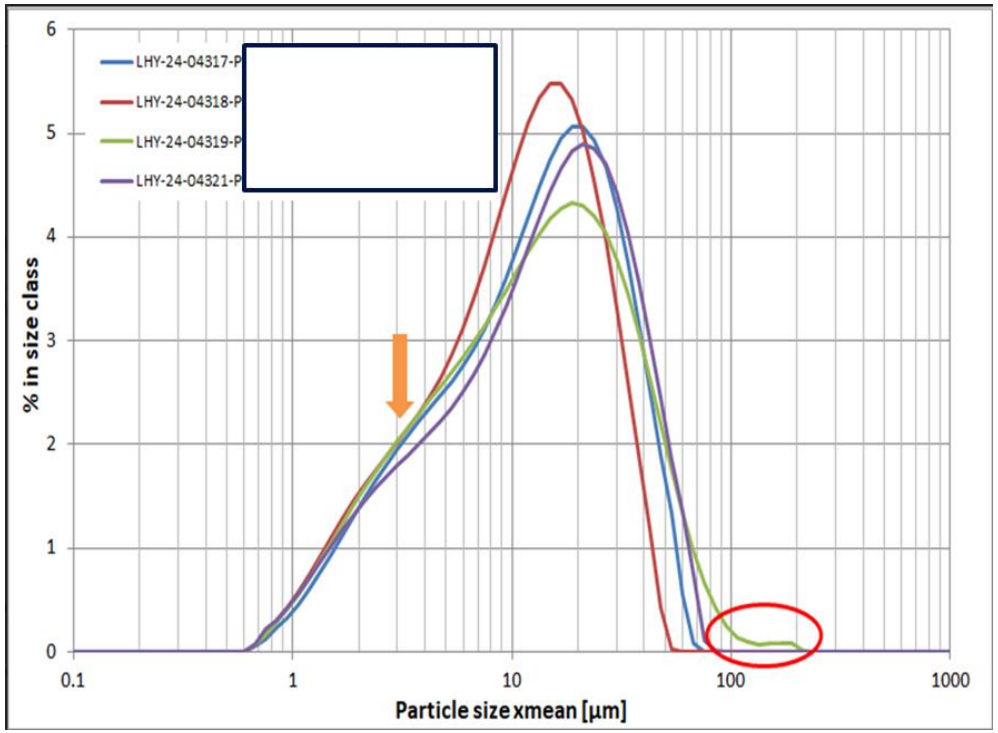
Processes or Steps we can take to improve Quality

- **Chemistry**

  C3A Example



- **-Blaine/PSD**
- **- Finer limestone than clinker?**



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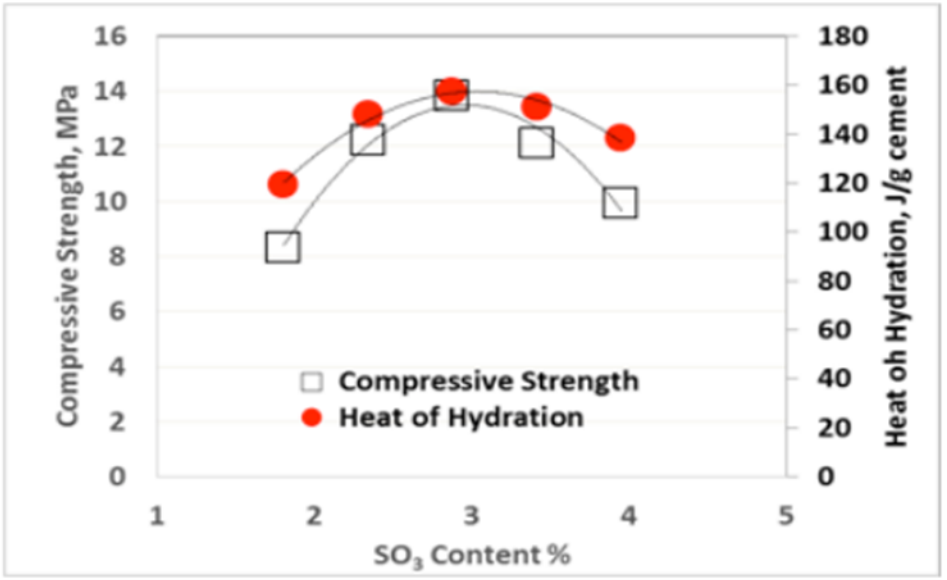
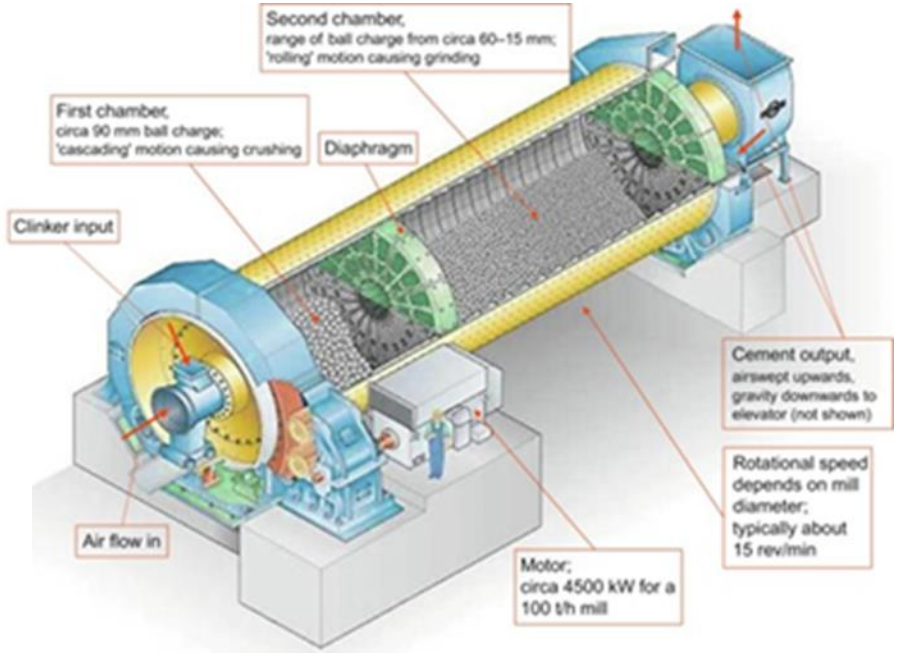
Processes or Steps we can take to improve Quality

SO3 - Gypsum



Annual SO3 Optimization



Limestone Percentage

- Small Changes to increase strength
- May require a nomenclature change
  ie: IL(10) to IL(7)

Mill Temperature

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Grinding Aid - Cement Quality Enhancement

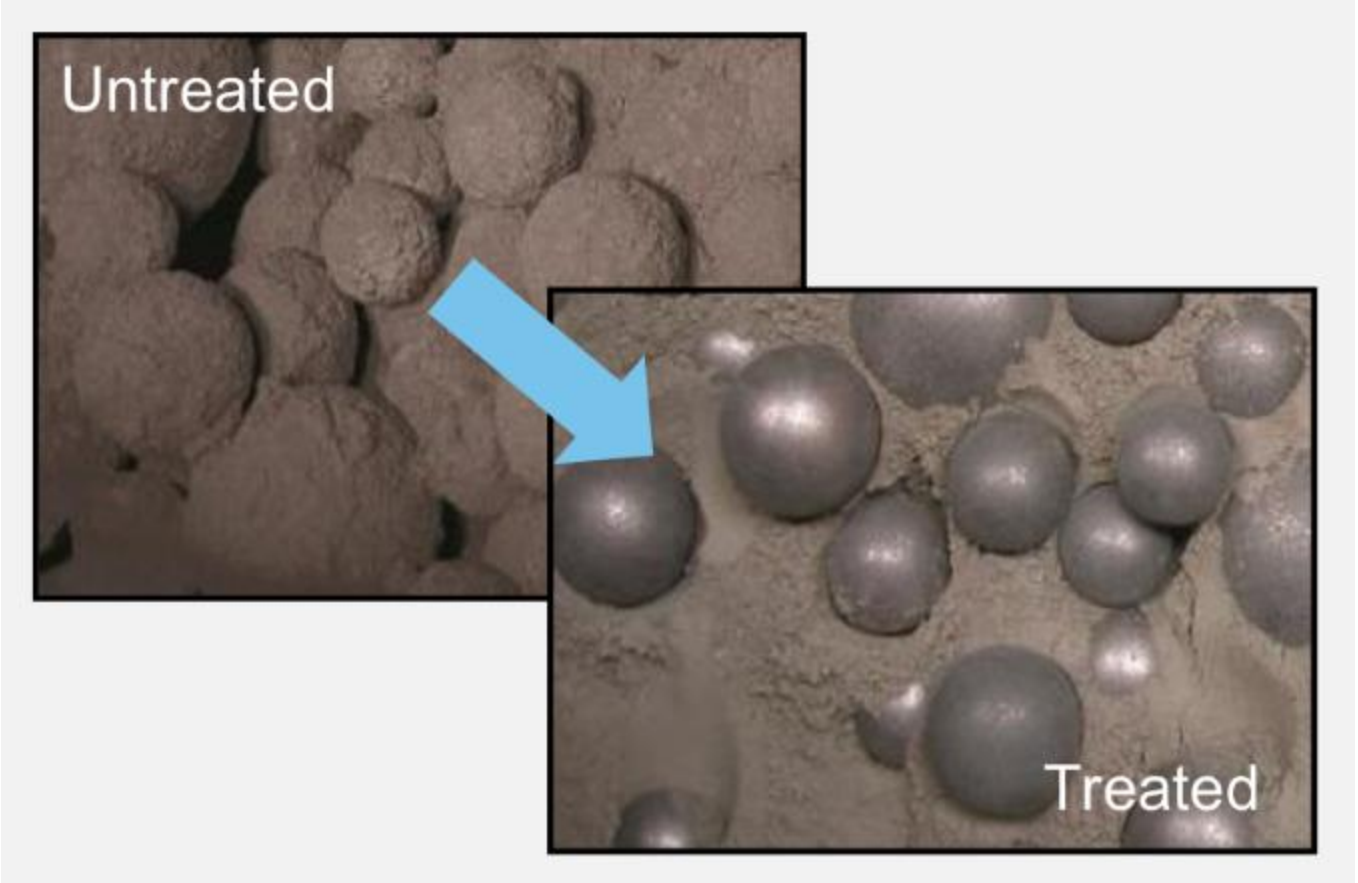
Historically used to improve efficiency and productivity only – Pack Set

Grinding Aids can contain other additives, which can be used to improve cement quality in addition to process efficiency

- Strength
- Setting Time
- Flow/workablity

How often do we change?

- Average Once Every 10 years
  - Cost
  - Cement Chemistry/mineralogy
    - Complaints
    - Performance (flow ect)



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Grinding Aid - Cement Quality Enhancement

DEG (Di-ethaline glycol) & TIPA (Tri-isopropanol amine) – First used in the 1930s

- Increase Limestone Content in 2016 from 9.5% to 14%
- Maintain Mortar Strengths and Setting Time

Benefits of Grinding Aid

Increased efficiency: Lower energy consumption during cement production.
Improved product quality: Finer cement particle size and enhanced mechanical properties.
Economic savings: Reduced production costs and better performance lead to long-term economic benefits.
Sustainability: Contributes to more efficient and sustainable modern construction practices.

Mapei Grinding Aid Trial Summary				
	Clinker Type	Limestone Content	28 Day Mortar Strength	Setting Time
		%	Mpa	min
Standard Grinding Aid	Type 10	9.5	43.5	110
Mapei MCH 280	Type 10	14.0	43.5	110

- Specialty Grinding Aids

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