

Reinhold Environmental Ltd.



2009 APC Round Table & Expo Presentation

July 12-14, 2009, in The Woodlands, TX

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Lime Slurry and Hydrated Lime For Circulating Dry Absorber and Spray Dryer Absorber Systems

July 13, 2009

Chemical Lime

A Lhoist Group Company

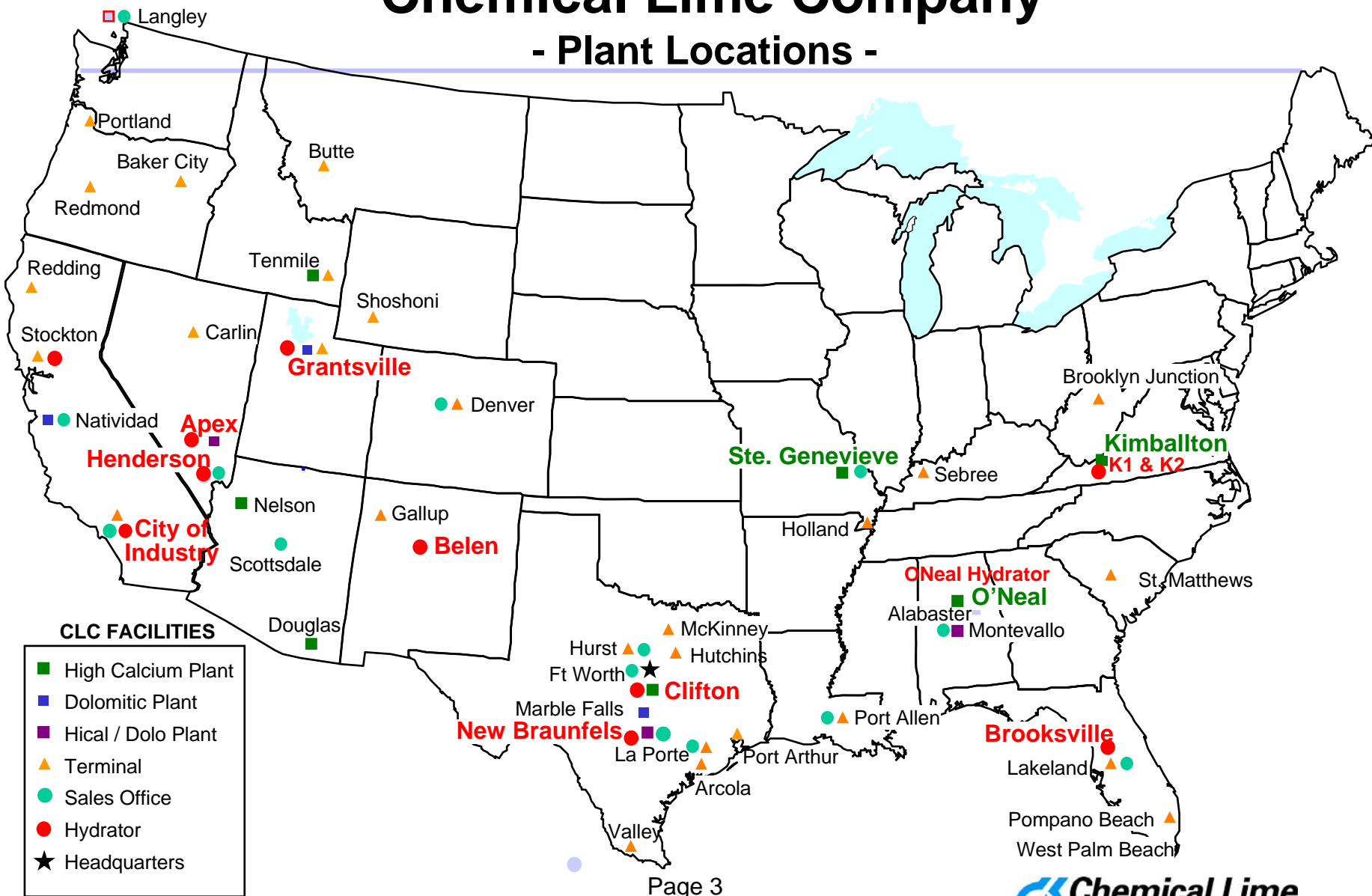
- Worldwide – 22 countries in Asia, Europe and the Americas
- Largest lime company in the world
- European FGD experience, R&D support





Chemical Lime Company

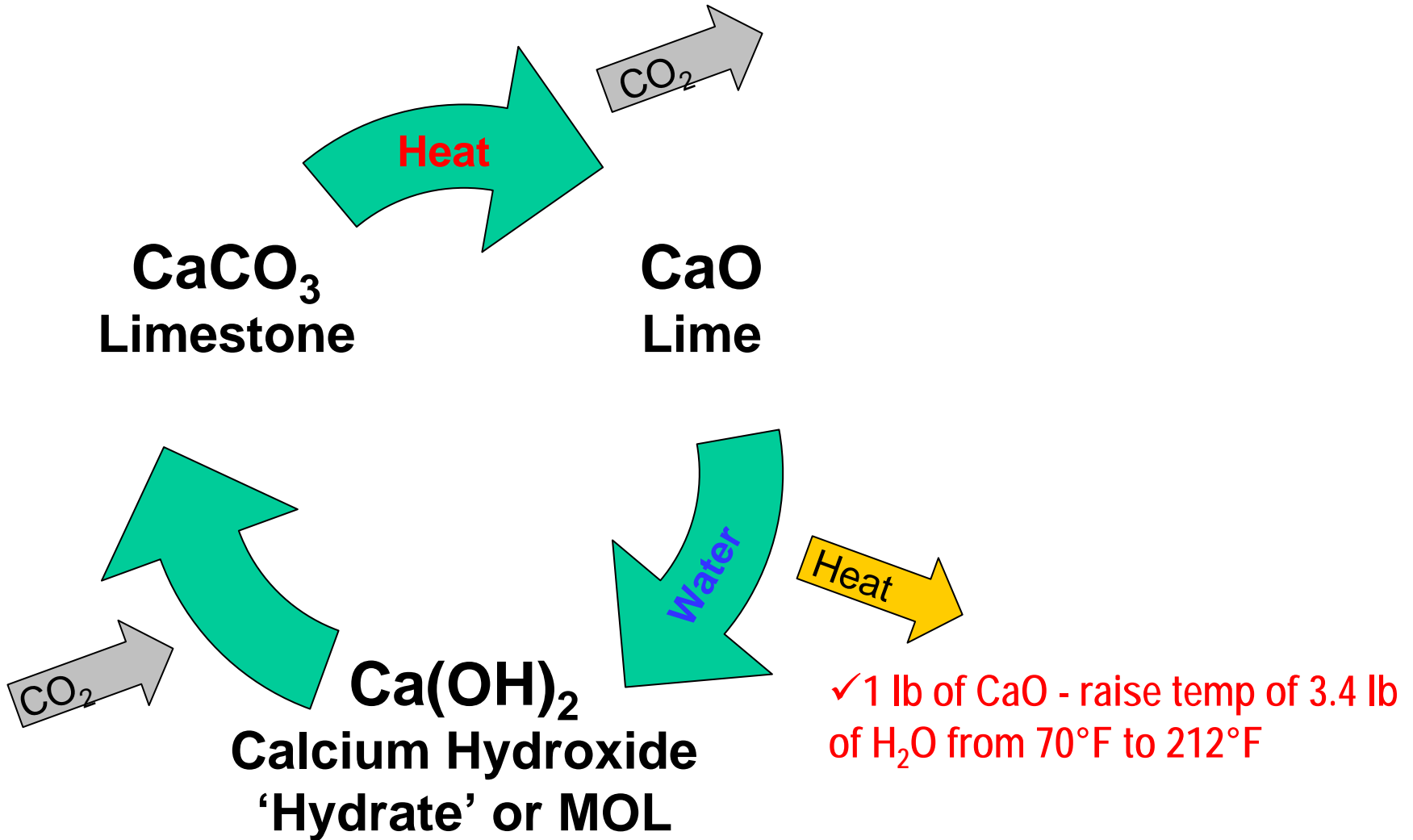
- Plant Locations -



CLC FACILITIES

- High Calcium Plant
- Dolomitic Plant
- Hical / Dolo Plant
- ▲ Terminal
- Sales Office
- Hydrator
- ★ Headquarters

Calcium Products 101



Slurry and Hydrator Experience

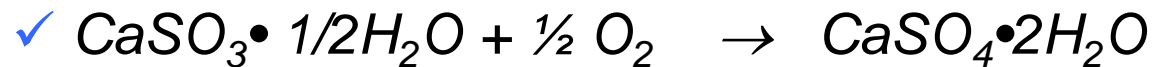
- CLC Owns and Operates 11 Hydrators
 - ✓ Vertical Hydrators
 - ✓ Horizontal Hydrators
- Lhoist's Hydrate Experience in AGC apps in Europe
- CLC Starting new **Sorbacal**® Hydrator Specifically for AGC apps.
- CLC Technical Assistance with Customer's Hydrators
- CLC Owns and Operates over 10 Slurry Terminals
 - ✓ PortaBatch
 - ✓ Detention Slakers
- CLC Technical Assistance with Customer's Slurry Operations

Acid Gas Chemical Reactions with Ca(OH)_2 (Hydrated Lime or Milk of Lime)

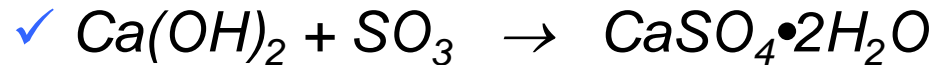
- SO_2 Removal



- Sulfite Oxidation*



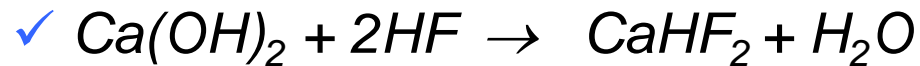
- SO_3 Removal



- HCl Removal



- HF Removal



Hydrated Lime Definitions

Reaction Products between Lime and Water are **Slaked** or **Hydrated Lime**.

Slaking lime creates a **liquid lime slurry (MOL)**.



Excess amount of water;
Much more water than the lime can react with.



Hydrating lime creates a **dry powder** ($H_2O < 1\%$).

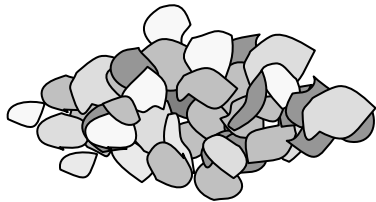


Stoichiometric amount of water;
Just as much water as the lime can react with.



Hydrator - Hydrated Lime

In the hydrator, lime is reacted with water under closely controlled conditions to produce calcium hydroxide or hydrated lime in dry powder form. The hydrated lime then passes through an air-separator which removes coarse particles. The fine powder is pumped into a silo and then loaded for shipping.



+



=



Lime

+

Water

=

Lime Hydrate

(Dry Solid)

(Liquid)

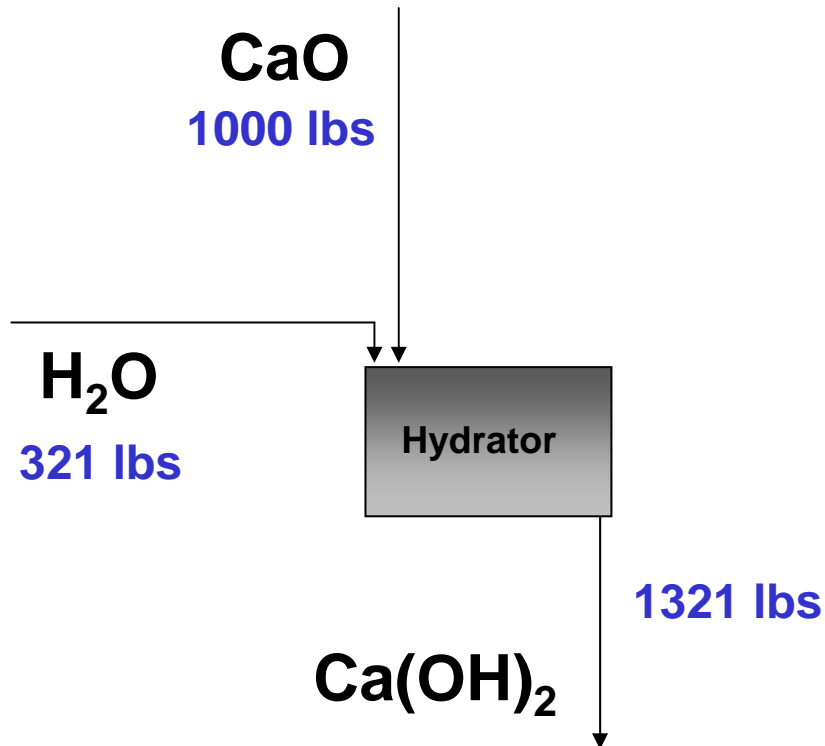
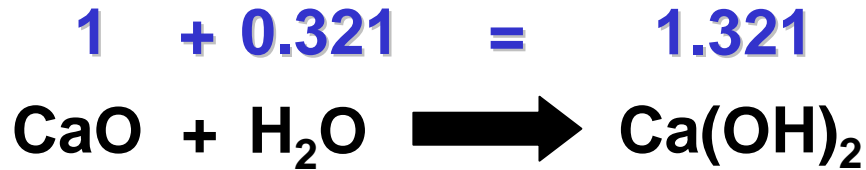
(Dry Powder
< 1 % free moisture)

Hydrated Lime – Ca(OH)_2

Element Name	Element Symbol	Atomic Weight [g/mol]
Calcium	Ca	40.1
Oxygen	O	16.0
Hydrogen	H	1.0
<hr/>		
CaO	= Ca + O	
	= 40.1 + 16.0	CaO = 56.1
<hr/>		
H ₂ O	= 2 x H + O	
	= 2 x 1.0 + 16.0	H ₂ O = 18.0
<hr/>		
Ca(OH) ₂	= Ca + 2 x O + 2 x H	
	= 40.1 + 2 x 16.0 + 2 x 1.0	Ca(OH) ₂ = 74.1
<hr/>		

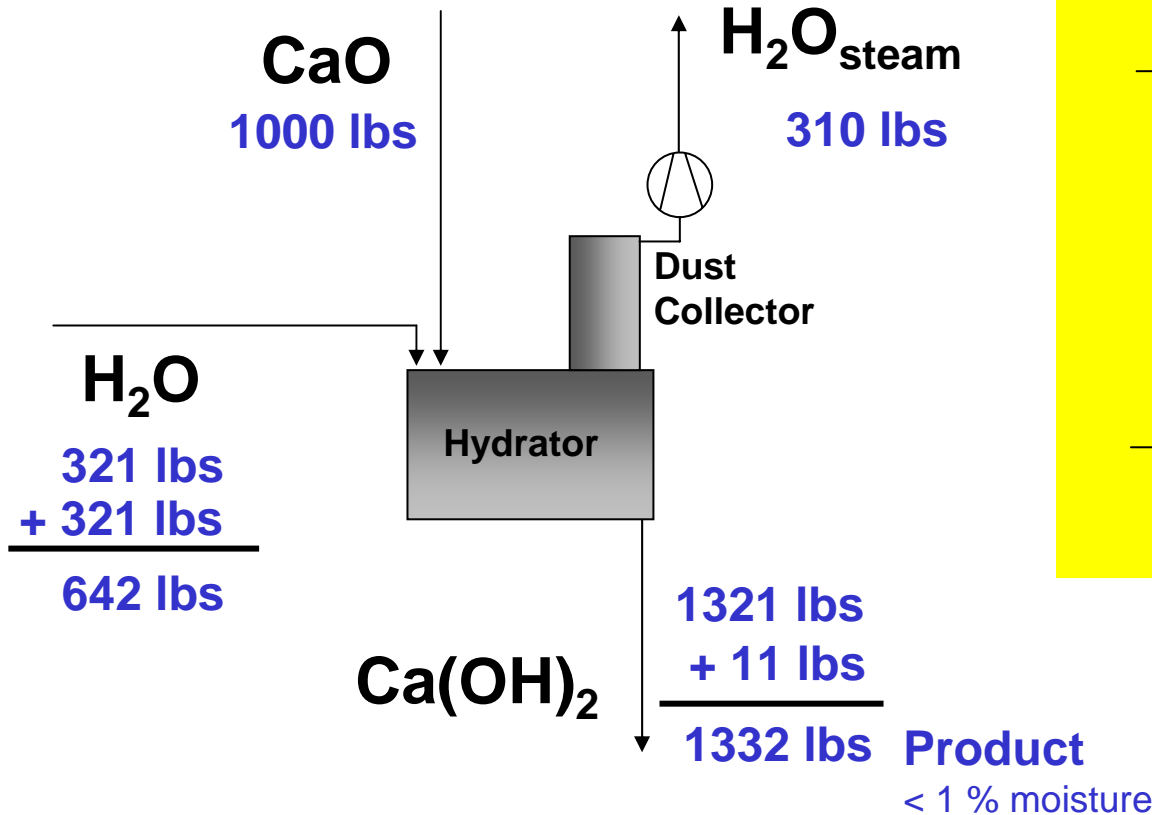
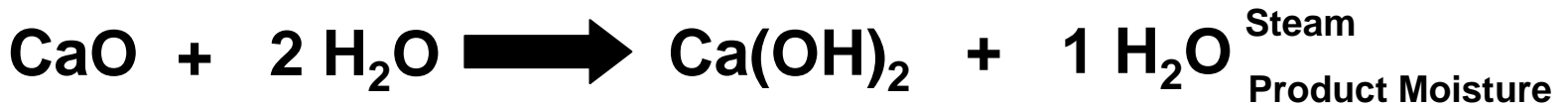
Hydrate 101

Practical Aspects Atmospheric Hydration



Hydrate 101

Practical Aspects Atmospheric Hydration



H₂O Mass Balance

H ₂ O Mass Balance	
IN	642 lbs H ₂ O
OUT	310 lbs steam
	321 lbs product
	11 lbs p. moisture
OUT	642 lbs H ₂ O

Factors that Effect Quality of Hydrate

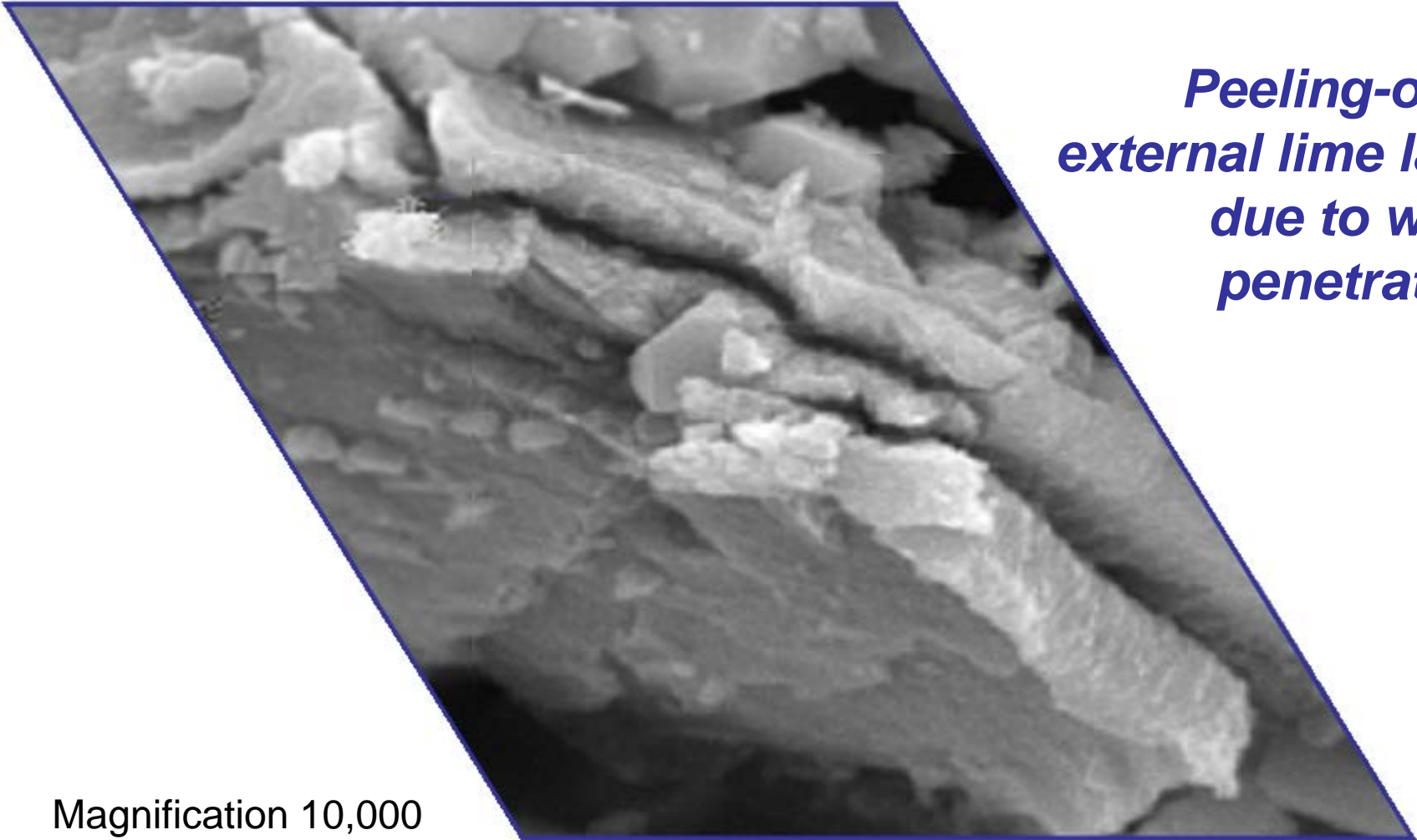
- High Quality Ca(OH)_2 -High CaO + SSA
 - ✓ Quality of Quicklime (lime type, purity and sizing)
 - ✓ Quality of slaking water (Cl, SO_4 , SO_3)
 - ✓ Temperature of slaking water ($>150^\circ\text{F}$)
 - ✓ Air slaking (results in low SSA)
 - ✓ Lime to water ratio (4:1 to 5:1)
 - ✓ Degree of agitation (Avoid hot and cold spots)
 - ✓ Temperature at which slaking takes place
 - ✓ Type of equipment

Hydrate 101

Hydration Model Acceleration Phase

***Peeling-off of
external lime layer
due to water
penetration.***

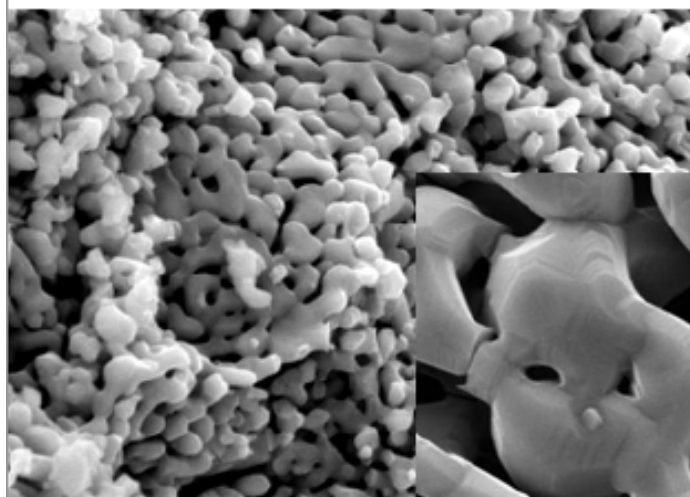
Magnification 10,000



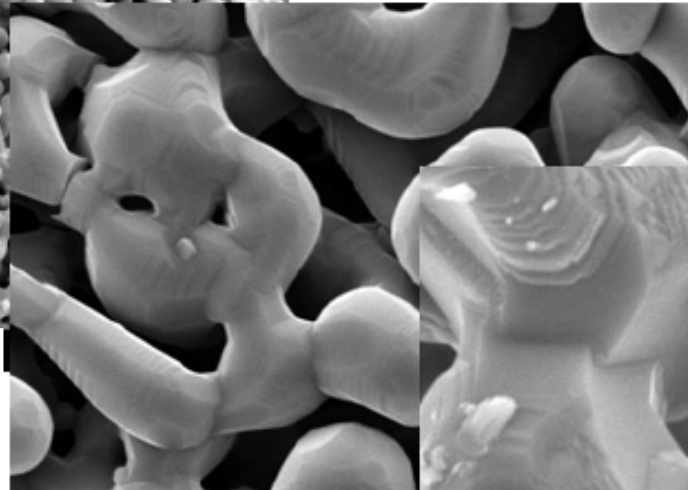
Hydrate 101

Degree of Burning Quicklime

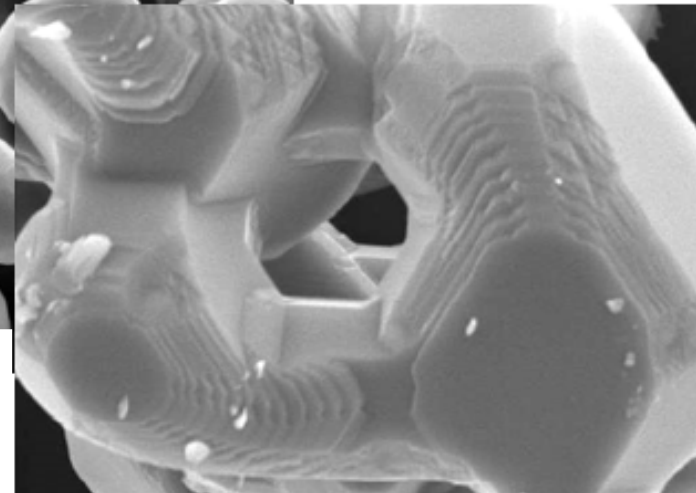
With an increase in burning intensity, the crystalline structure of the lime becomes denser - the lime is classified as soft, medium, or hard-burnt.



Soft-burnt



Medium-burnt



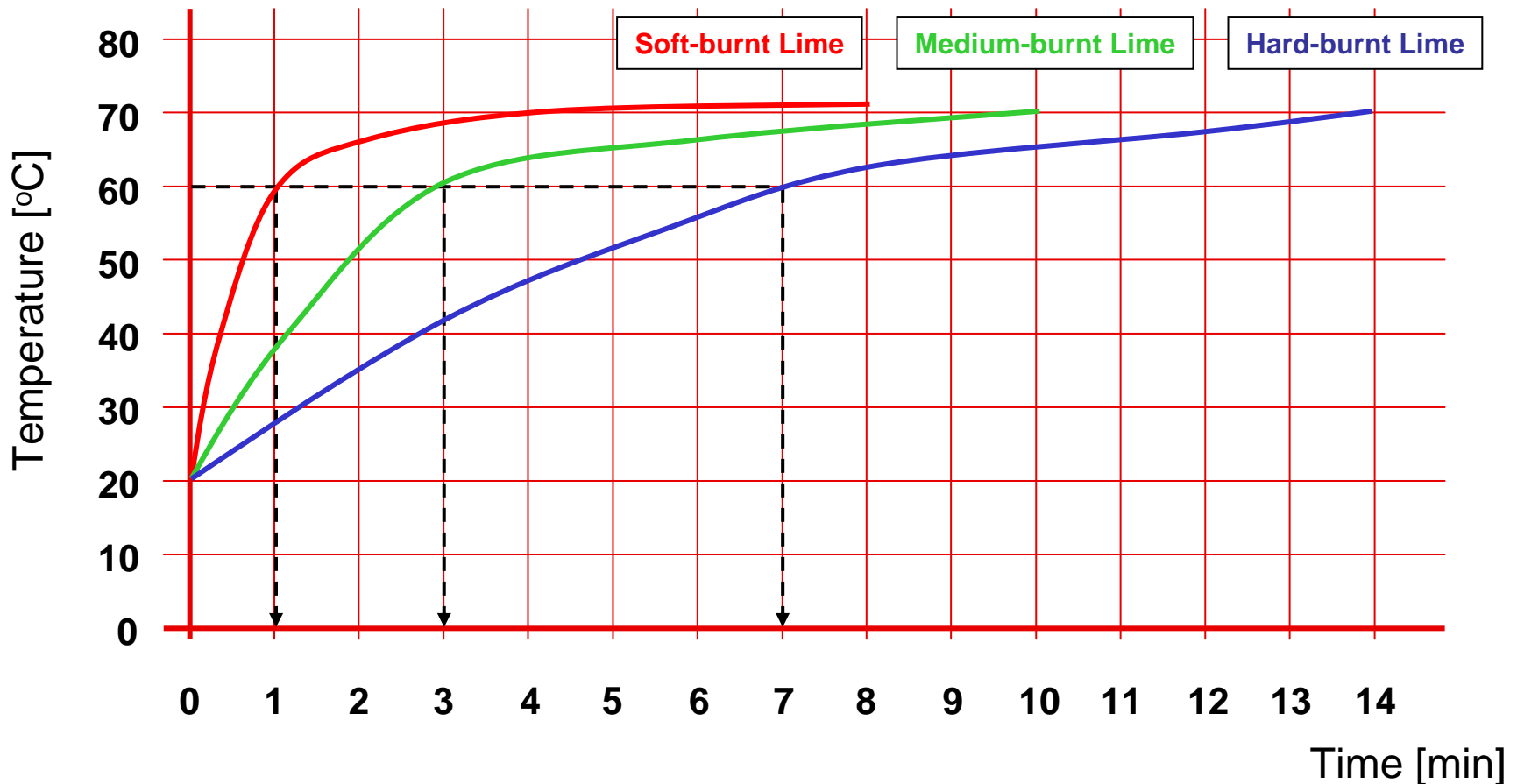
Hard-burnt

Magnification 10,000

Hydrate 101

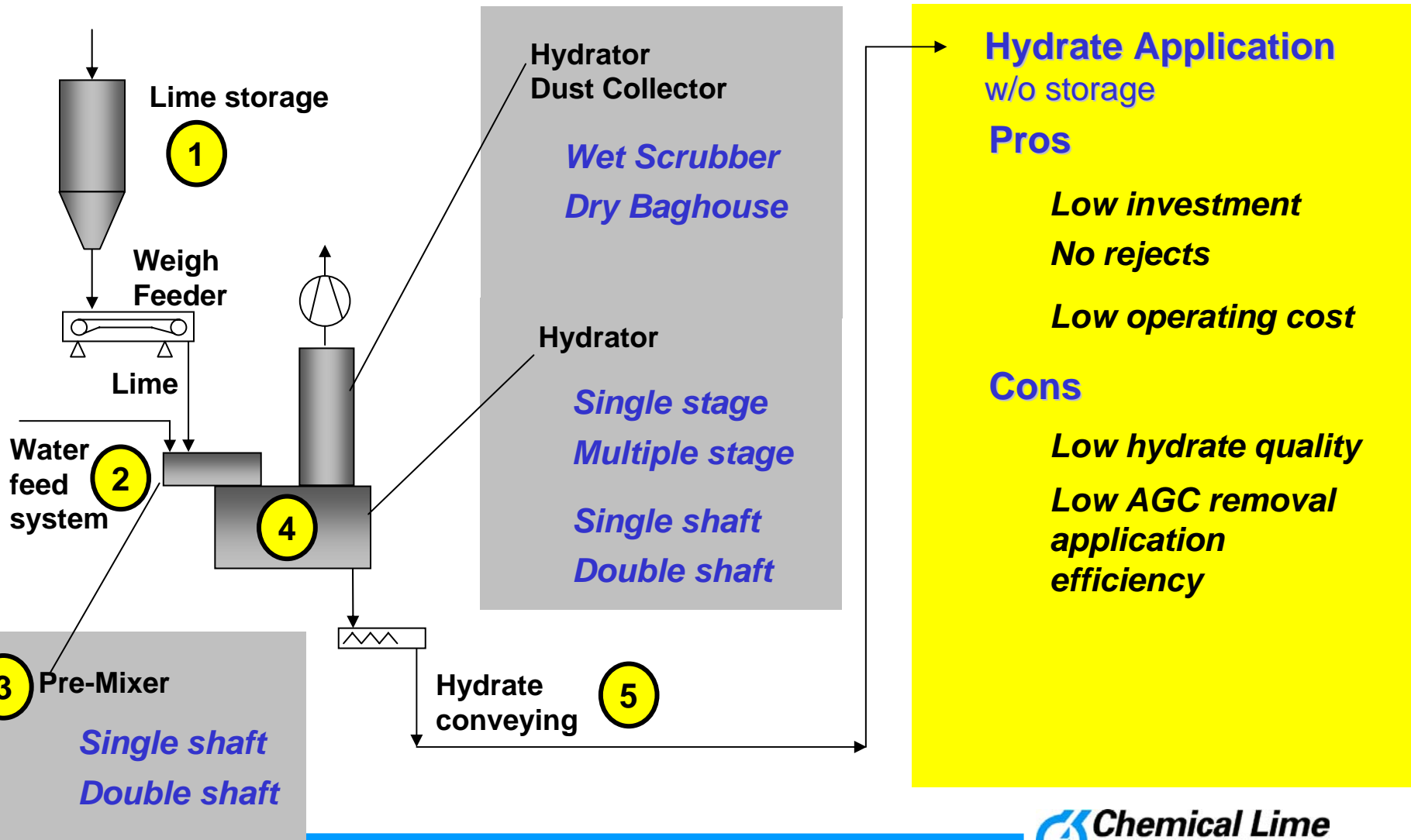
Quicklime Reactivity Wet Slaking

With an increase in lime density the lime reactivity will become slower. Soft-burnt lime has the fastest reactivity and hard-burnt lime has the slowest reactivity. Slower reactivity produces higher SSA and produces less agglomeration.



Hydrate Production Flow Sheet

Basic Elements



3 Stage Hydrator

Stage 1: Premix Chamber

- Lime and water are introduced
- Multi point water injection
- High agitation required to avoid hot spots
- Up to 70% of total reaction

Stage 2: Reaction Chamber

- Special designed paddles to improve mixing
- Completion of reaction

Stage 3: Stabilizing Chamber

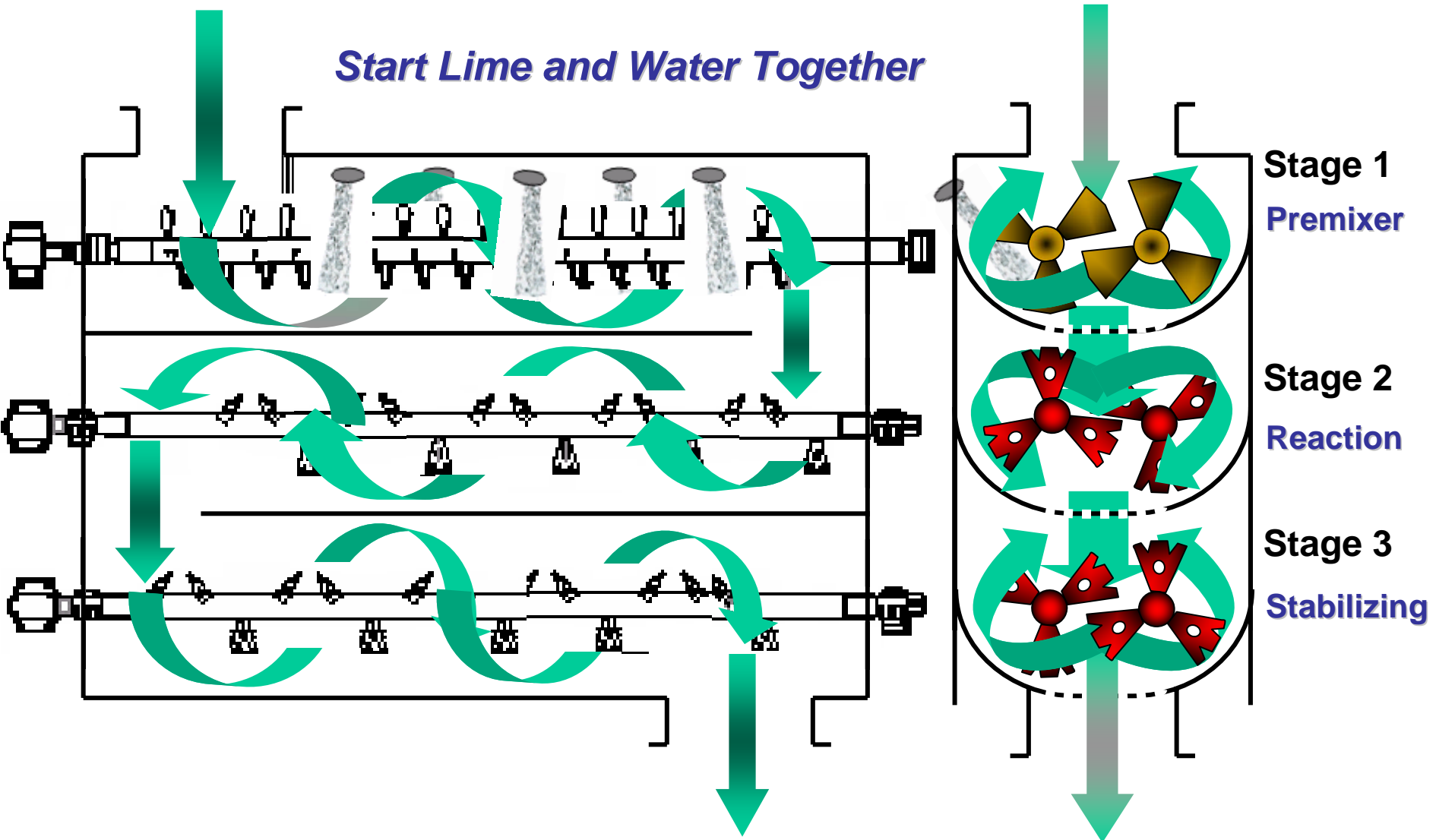
- Stabilizing the mix
- Special designed paddles for improved mixing

CIM - Hydrax – 4G; 2 – 2 – 2 Design
3 stage/dual shafts/adjustable speed
Internal coating for better flow ability

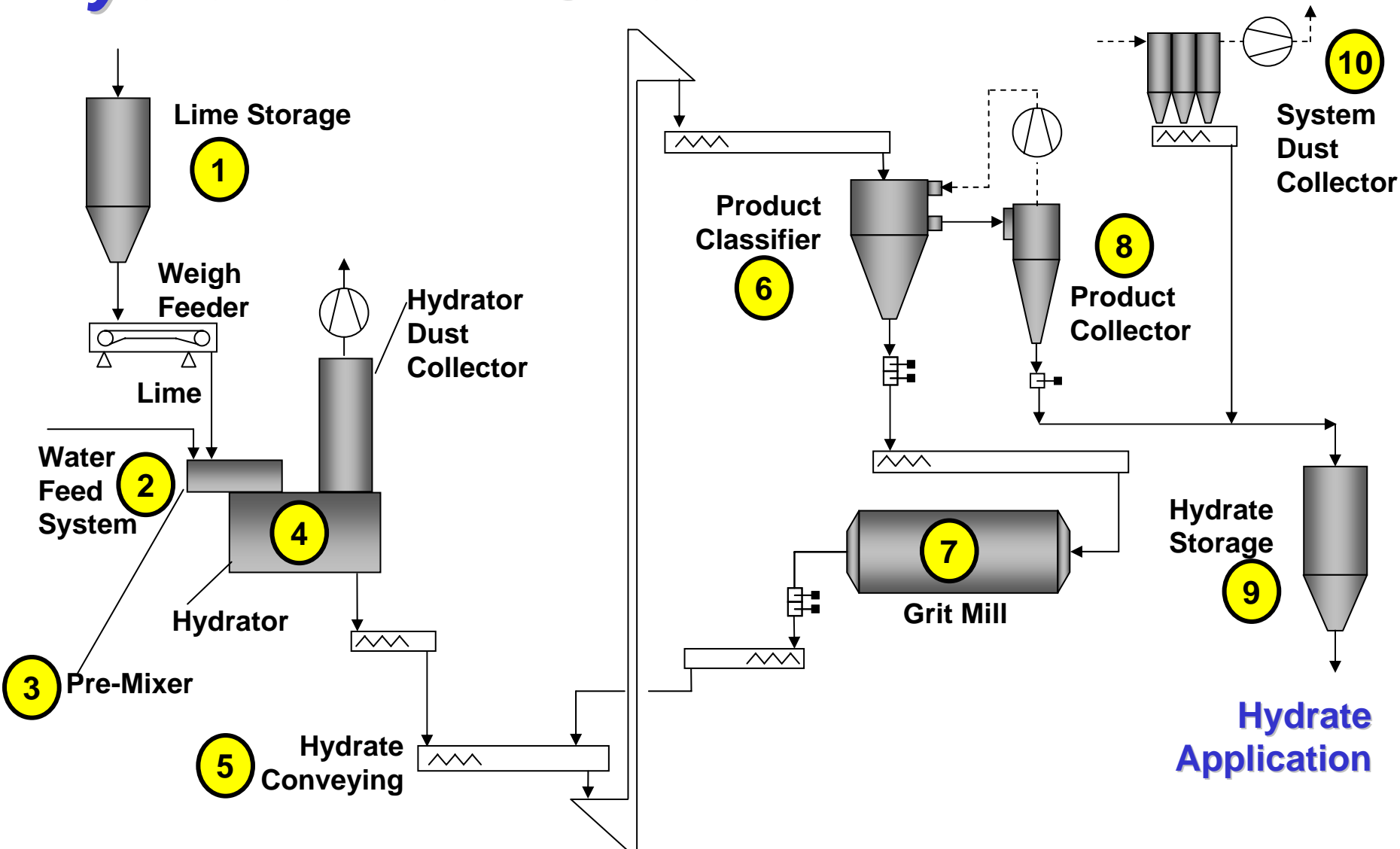


Material Flow through Hydrator

Start Lime and Water Together



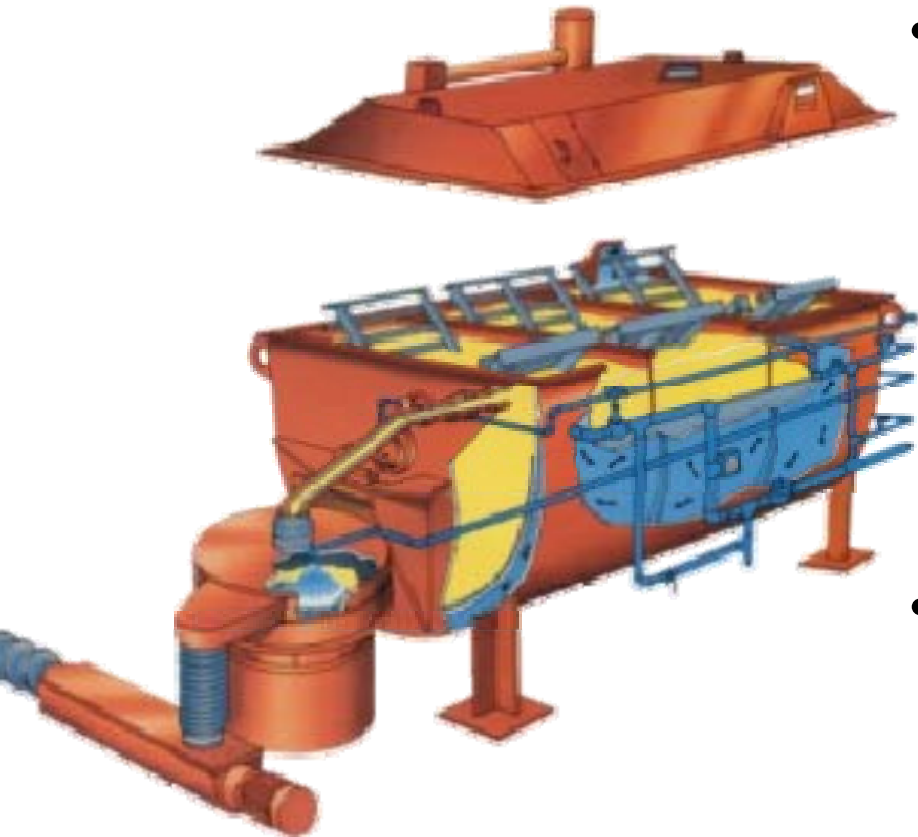
Advanced Elements Hydrator Flow Sheet



Lime Slakers – Slurry or Lime Milk

- Detention or Slurry Slakers
- Ball Mill Slakers
 - ✓ Vertical
 - ✓ Horizontal
- Paste Slaker (not used for SDA)
- Batch Slaker (typically not used for SDA)
- Hydrate Mixer – slurry hydrate with water

Detention Slakers

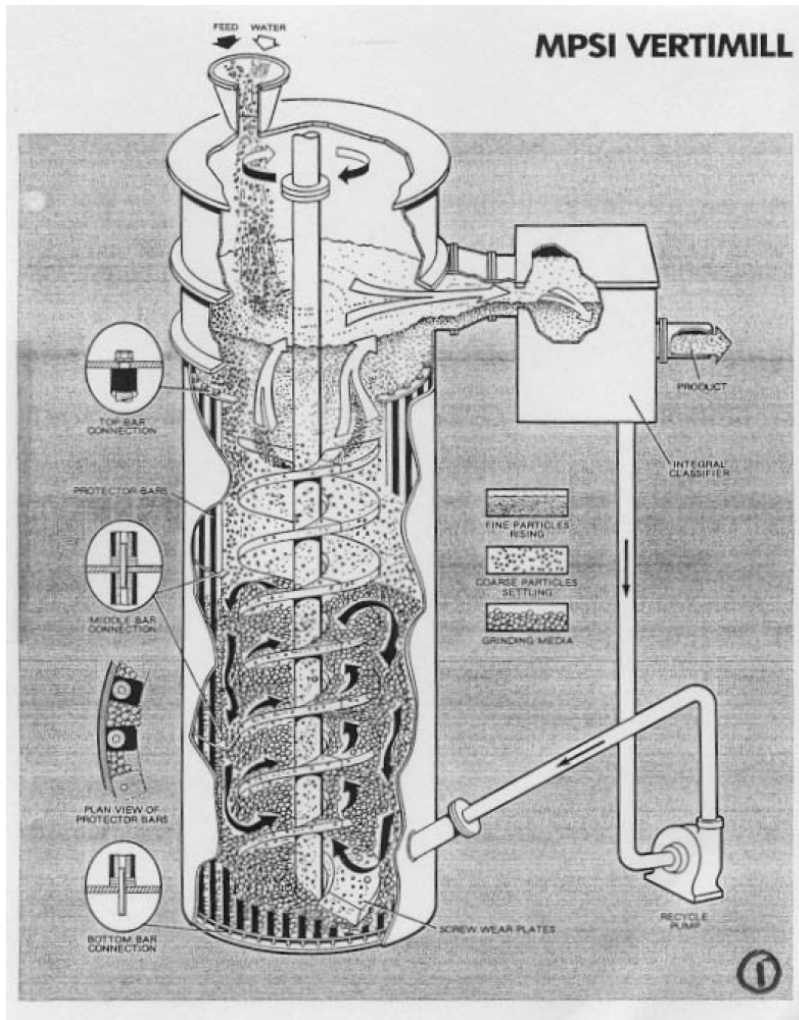


- Advantages to Detention Slakers
 - Lime sizing maintained = higher SSA
 - Temperature control = higher SSA
 - Agitation control = higher SSA
 - Flexibility with Lime quality & sizing
 - Grit Removal – removes impurities
- Disadvantages
 - Maximum output - 50 ton/hr
 - Sulfate/sulfite can coat CaO
 - Grit disposal cost and issues

Horizontal Ball Mill Slaker



Vertical Ball Mill Slaker



- Advantages to Ball Mill Slakers
 - Higher output sizing
 - No grit disposal
 - High sulfate/sulfite water
 - Dolomitic Lime
- Disadvantages
 - Small lime particles = lower SSA
 - No temp control = lower SSA
 - Grit = Impurities in slurry
 - Initial cost – 3x cost detention

Lime Transportation and Handling

- Transportation
 - ✓ Rail – covered hopper or PD
 - ✓ Truck – pneumatic tanker
- Unloading and conveying
 - ✓ Bottom dump w/ screw to bucket conveyor
 - ✓ Pneumatic for PD or truck
 - ✓ Avoid vacuum system for rail unloading
- Pneumatic conveying
 - ✓ Dense Phase preferred
 - ✓ Dilute Phase

Hydrate Transportation and Handling

- Transportation
 - ✓ Truck – pneumatic tanker
 - ✓ Rail – rare limited to 70 tons and can consolidate
 - ✓ Hauling ~30% chemically bound water
- Unloading and conveying
 - ✓ Pneumatic
 - ✓ De-humidification ????? (avoid hot air systems)
- Pneumatic conveying
 - ✓ Dense or dilute phase
 - ✓ Consider screw type Pump for long distance

Lime and Hydrate – Future Supply and Price

- Long Term Reserves
 - ✓ Limestone Reserves - 50 to 100 years
- Industry Adding Kiln Capacity
 - ✓ Tight supply early 2008
 - ✓ Late 2008 – downturn in steel = excess supply
 - ✓ Regulatory Pressure – emission controls, CO2
 - ✓ Increasing Demand – FGT demand
- Price
 - ✓ Energy dependent – coal prices unstable
 - ✓ Transportation costs – fuel prices unstable

Questions ??

