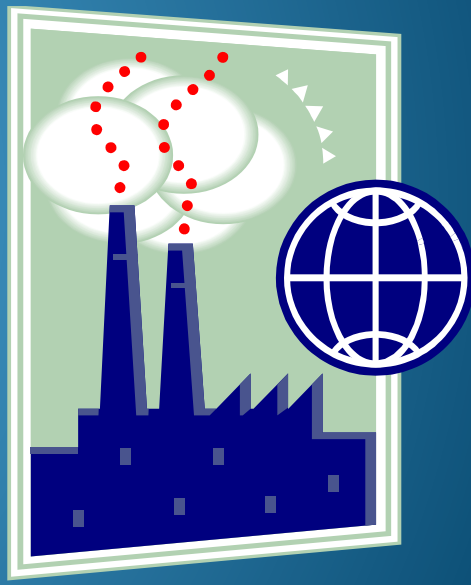
Cement Manufacturing Process

1. What is cement ?
2. History.
3. Overveiw of Cement Manufacturing process.
4. Overveiw of Kiln process.



Portland Cement

. A hydraulic cement made by finely powderising the clinker produced by calcining to incipient fusion a mixture of argillaceous and calcareous materials.

.Portland cement is a powder that is the active ingredient in concrete.

Portland Cement

- Limestone + Shale/Clay + Heat = Clinker + CKD + Exit Gas.
- Material Temperatures Exceed 2700 degrees F
- Pulverized Clinker + Gypsum = Portland Cement.
- Cement is powder so fine that one pound contains 150 billion grains.

Portland Cement (cont'd)

- Basic Chemical Components of Portland Cement:
  - Calcium (Ca)
  - Silicon (Si)
  - Aluminum (Al)
  - Iron (Fe)
- Typical Raw Materials:
  - Limestone ($CaCO_3$)
  - Sand (SiO_2)
  - Shale, Clay (SiO_2, Al_2O_3, Fe_2O_3)
  - Iron Ore/Mill Scale (Fe_2O_3)

Portland Cement (cont'd)

- Calcareous Component (providing Lime - CaO)
  - limestone
  - marly limestone
  - chalk
  - coral limestone
  - marble
  - lime-sand
  - shell deposits
  - lime sludge

- Argillaceous Component (SiO_2, Al_2O_3, and Fe_2O_3)
  - clay
  - shale
  - calcareous marl
  - marl
  - marly clay
  - tuff, ash
  - phyllite ,slate
  - glass

Portland Cement (cont'd)

- Clinker Chemistry

– Tricalcium silicate ($3CaO.SiO_2$), (50-70%)

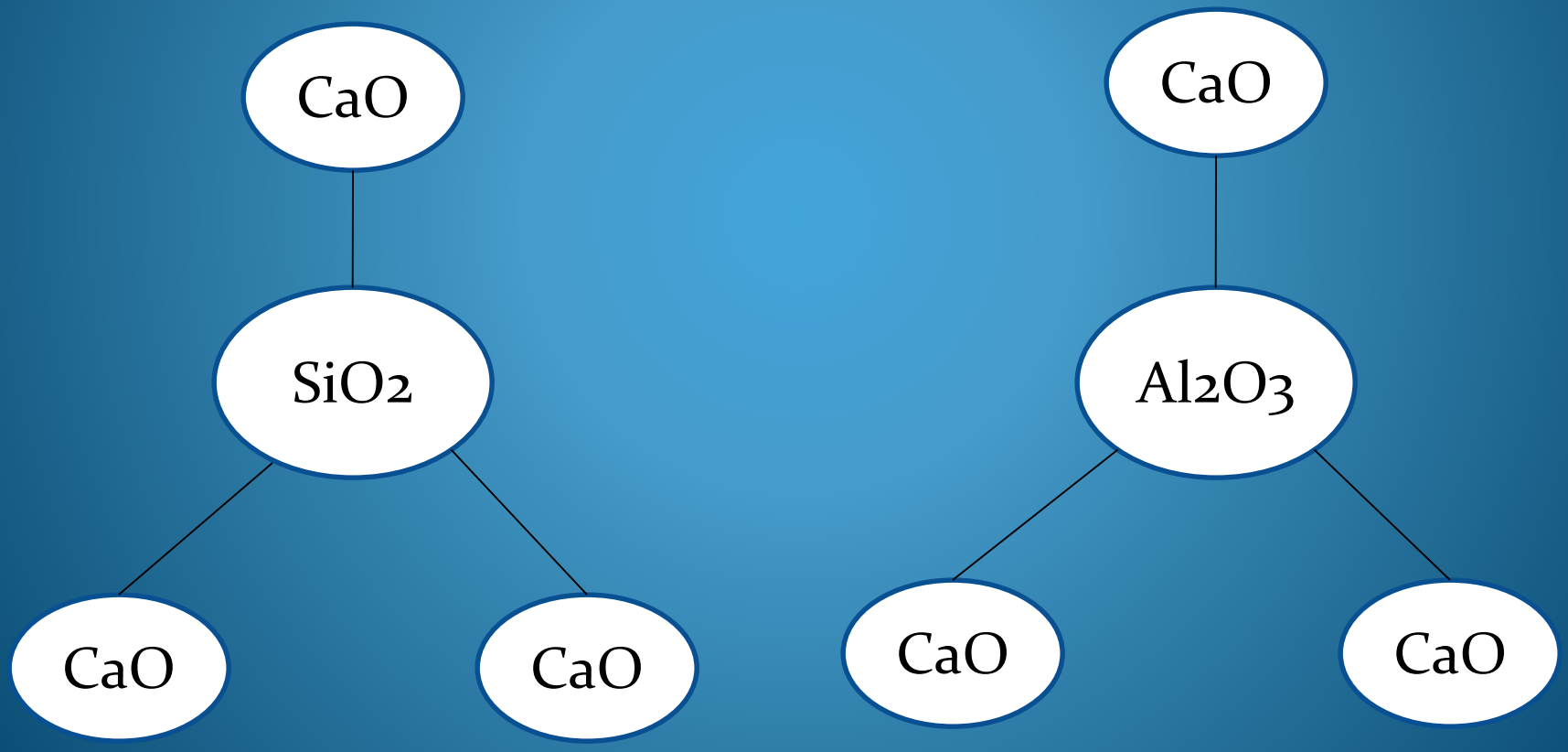
– Dicalcium silicate ($2CaO.SiO_2$), (15-30%)

– Tricalcium aluminate ($3CaO.Al_2O_3$), (5-10%)

– Tetracalcium aluminoferrite

($4CaO.Al_2O_3.Fe_2O_3$), (5-15%)

Portland Cement (cont'd)



History of Portland Cement

- First cements produced by early Greeks and Romans from volcanic ash mixed with slaked lime.
- This art was lost during the Middle Ages.
- Portland cement developed in England by bricklayer Joseph Aspdin in early 1800's.
- Called "Portland" because concrete made with it resembled natural stone from the Isle of Portland.

History of Portland Cement

- First rotary kiln designed to produce Portland cement patented in 1885 by Frederick Ransome.
- First economical U.S. kilns developed by Atlas Cement Company in 1895.
- Thomas A. Edison first developed long kilns (150 feet compared to 60 to 80 feet).

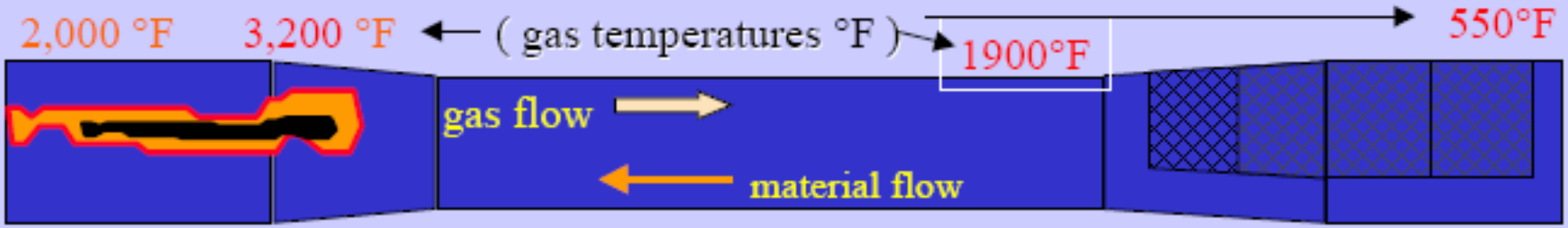
Types of Cement Processes

- Wet Process.
- Dry Process - 74% of cement produced.
- Preheater/Precalciner Process.

Evolution of the cement Process

- Wet process easiest to control chemistry & better for moist raw materials.
- Wet process high fuel requirements - fuel needed to evaporate 30+% slurry water.
- Dry process kilns less fuel requirements
- Preheater/Precalciner further enhance fuel efficiency & allow for high production rates.

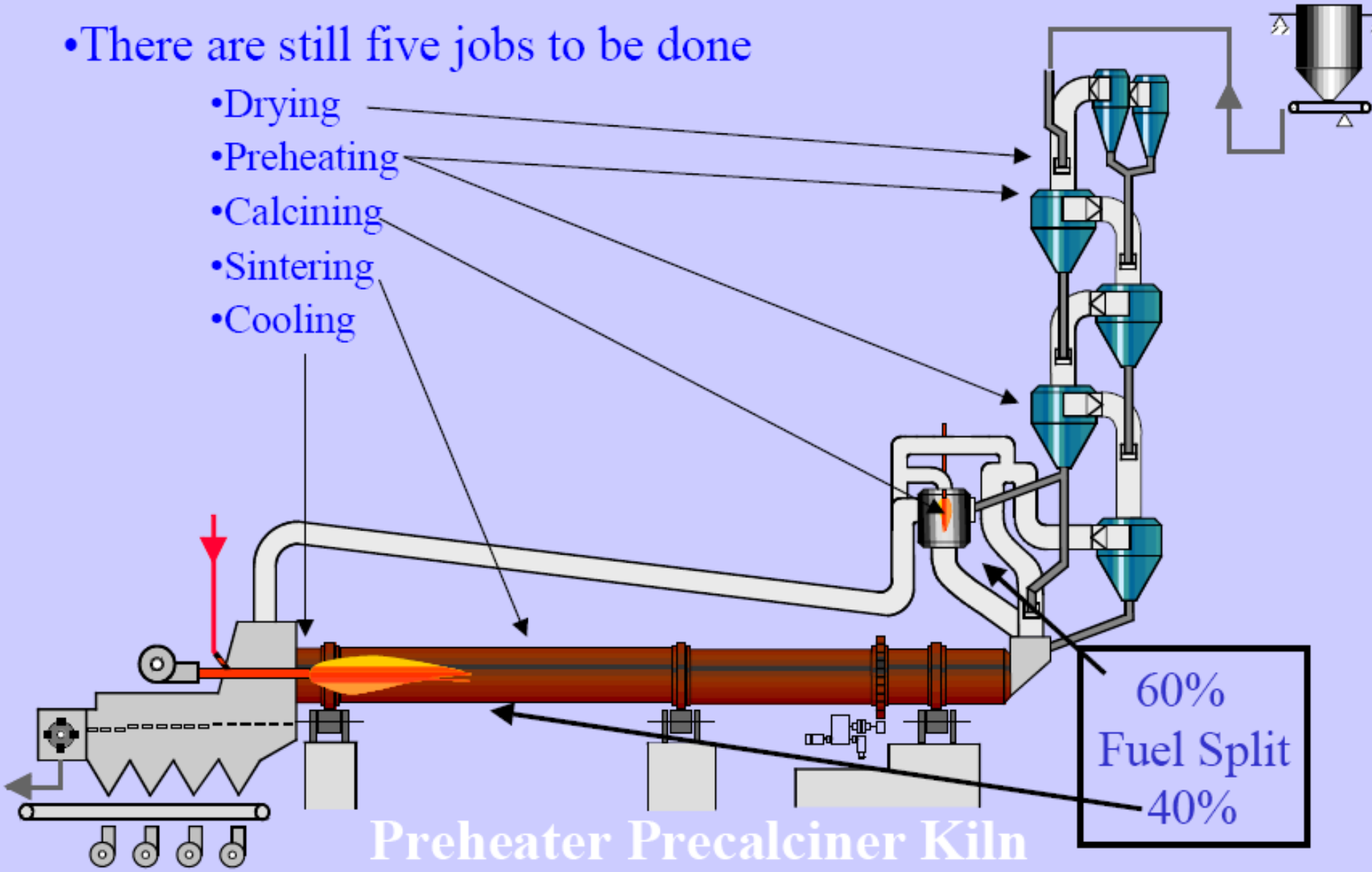
The Wet Cement Kiln



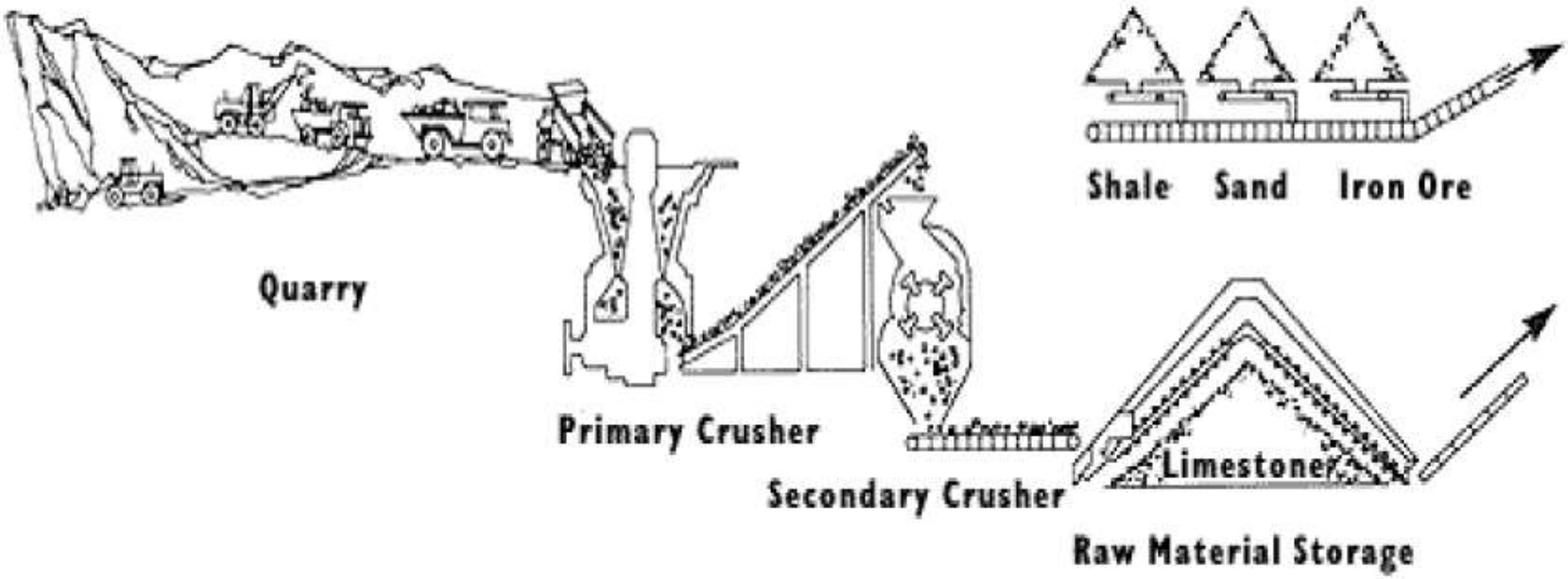
- The kiln is a continuous stream process vessel in which feed and fuel are held in dynamic balance
- 5 distinct process functions are performed in the kiln:
  - Dry
  - Preheat
  - Calcine
  - Sinter
  - Cool

Dry Process Preheater/Precalciner System

- There are still five jobs to be done
  - Drying
  - Preheating
  - Calcining
  - Sintering
  - Cooling



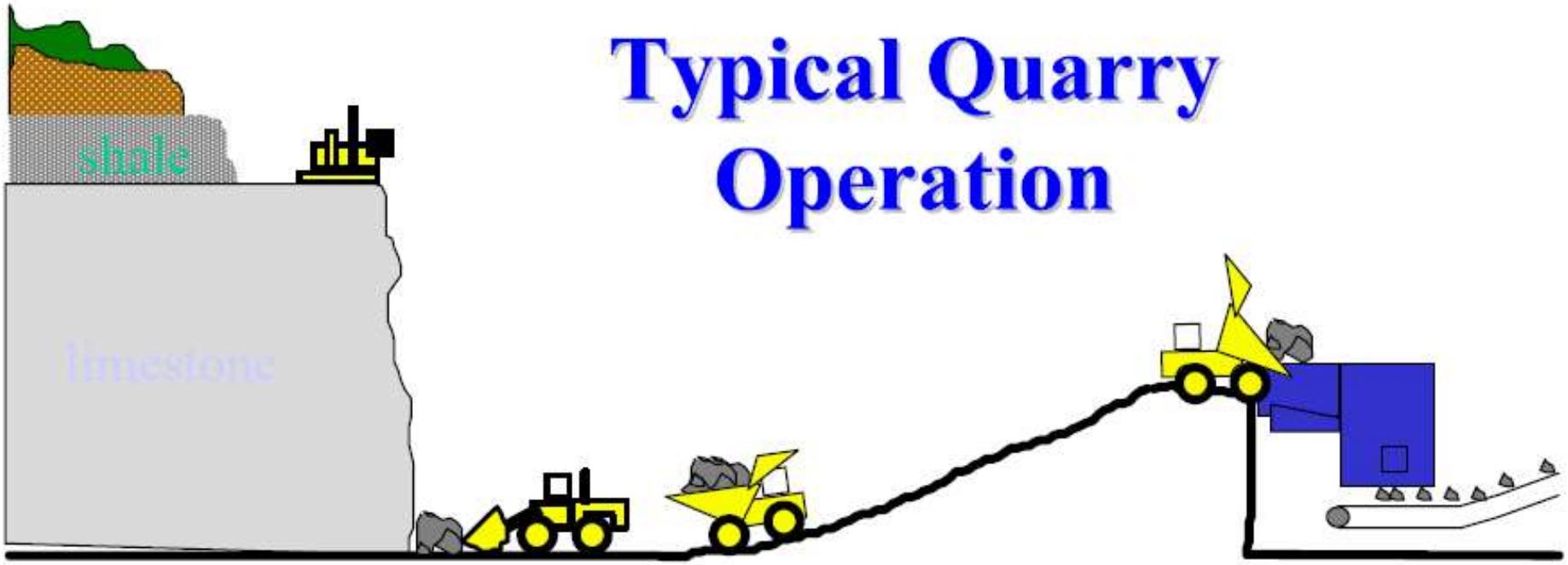
Steps in the Manufacture of Portland Cement



Rock mined from a quarry is crushed in either one or two stages, then stored with other raw materials to await further processing.

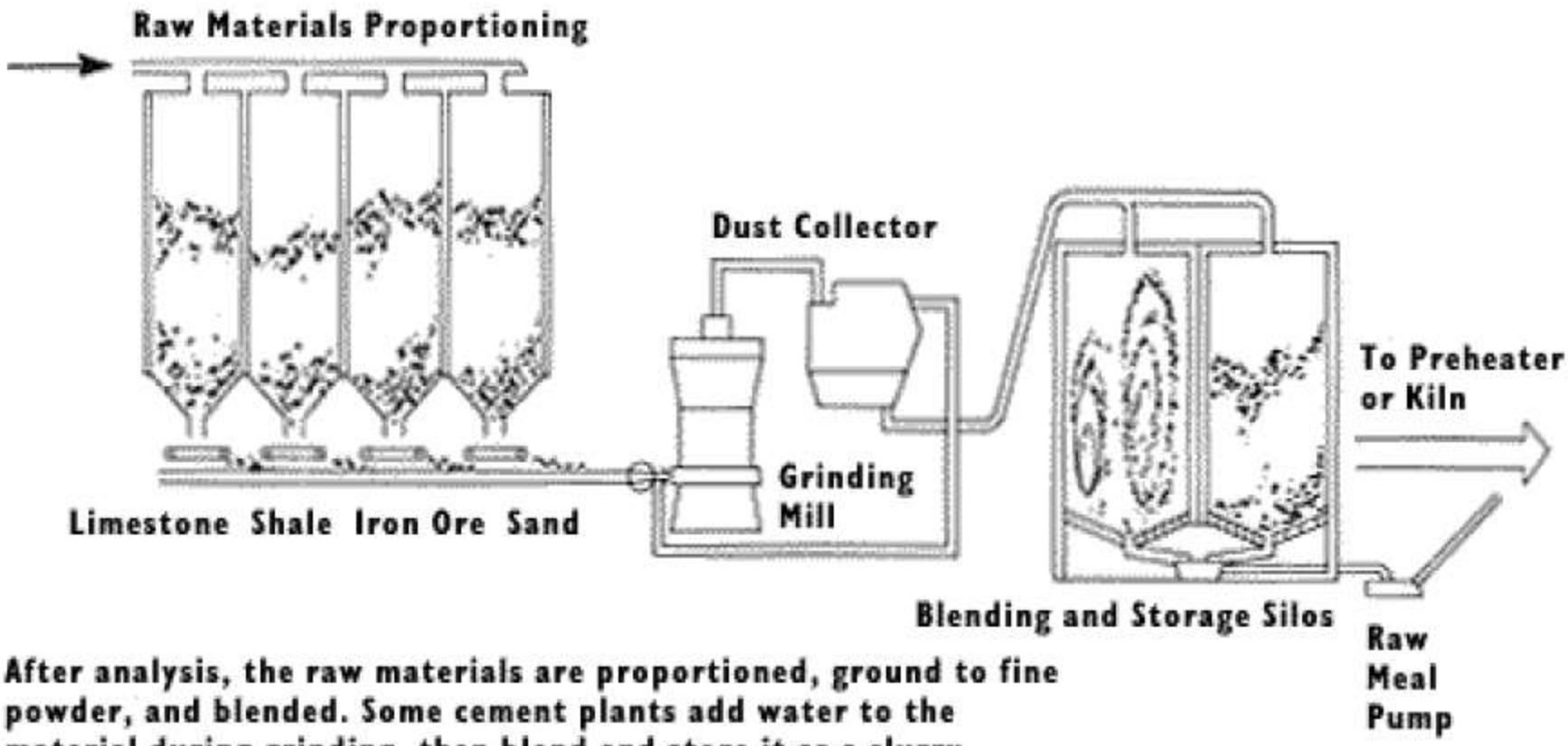
To Proportioning and Grinding

Typical Quarry Operation



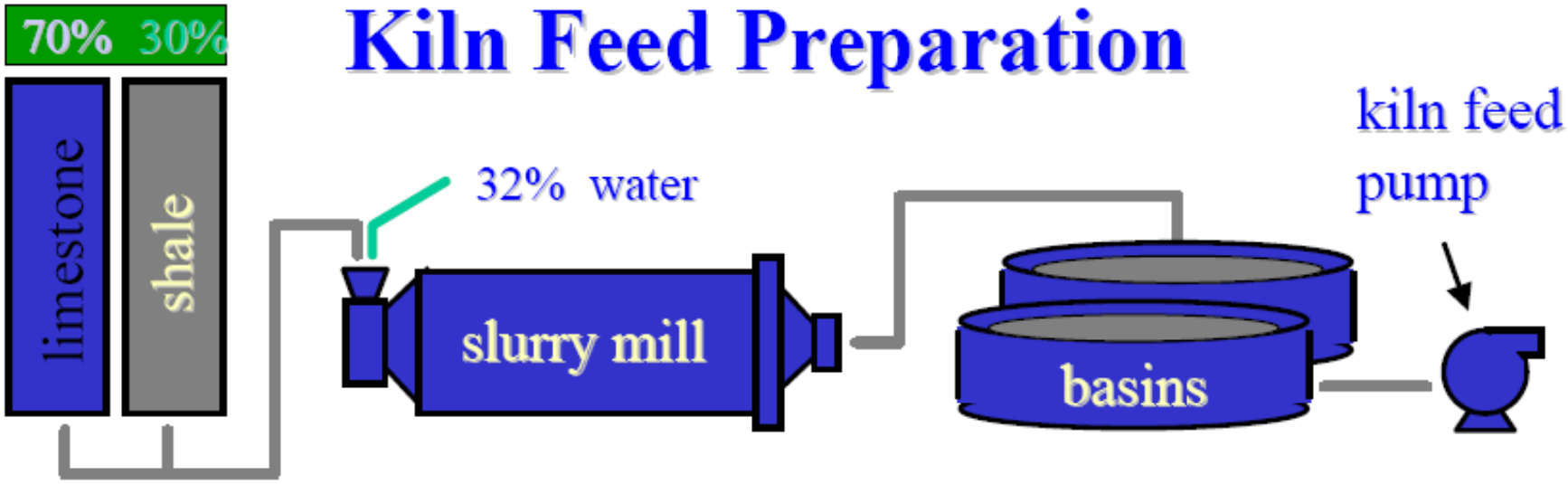
- Typically shale provides the argillaceous components:
  - Silica (SiO_2, Aluminum(Al_2O_3) & Iron (Fe_2O_3)
- Limestone provides the calcareous component:
  - Calcium Carbonate ($CaCO_3$)
- Raw materials may vary in both composition and morphology.

Steps in the Manufacture of Portland Cement



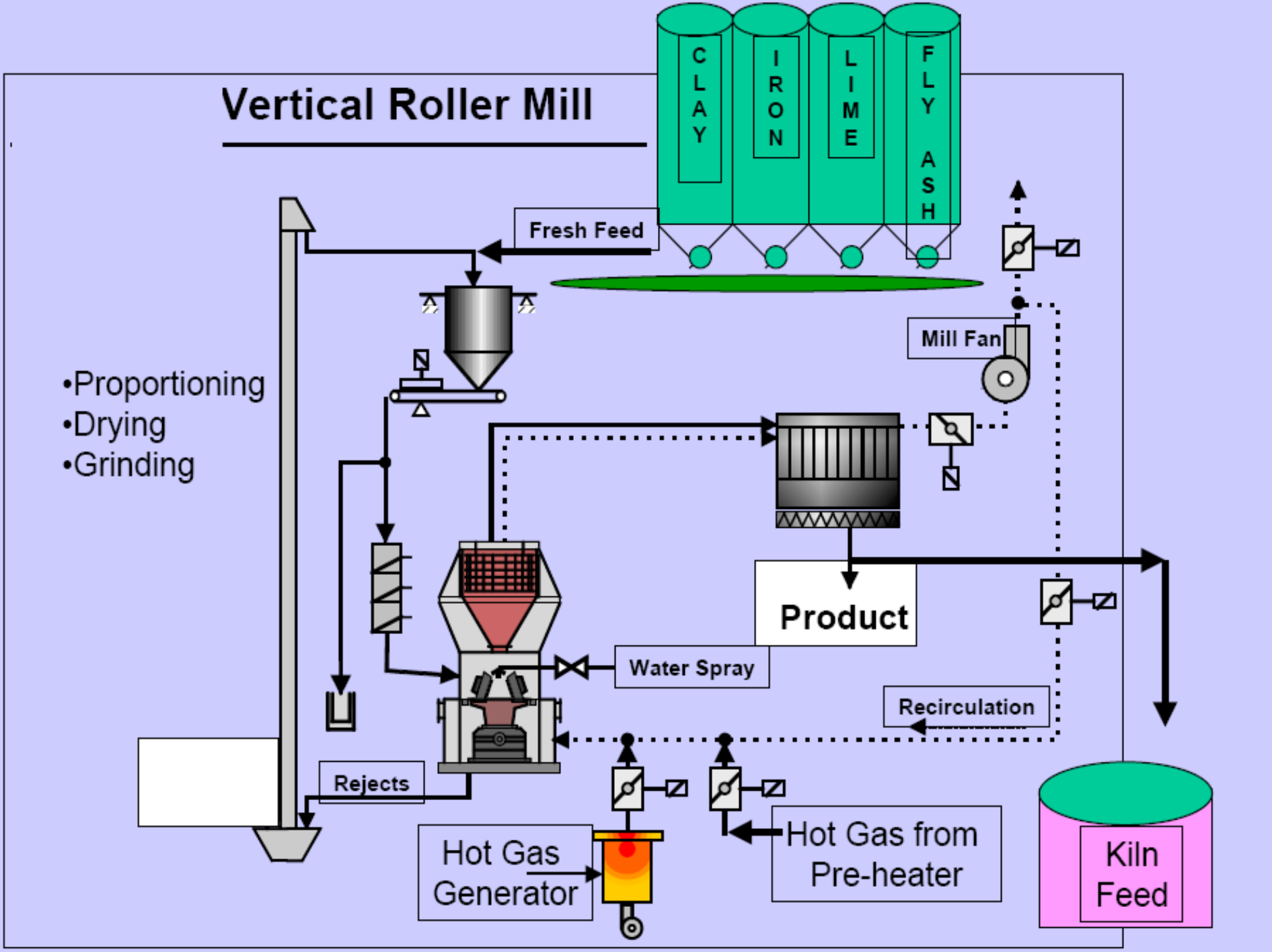
After analysis, the raw materials are proportioned, ground to fine powder, and blended. Some cement plants add water to the material during grinding, then blend and store it as a slurry.

Kiln Feed Preparation

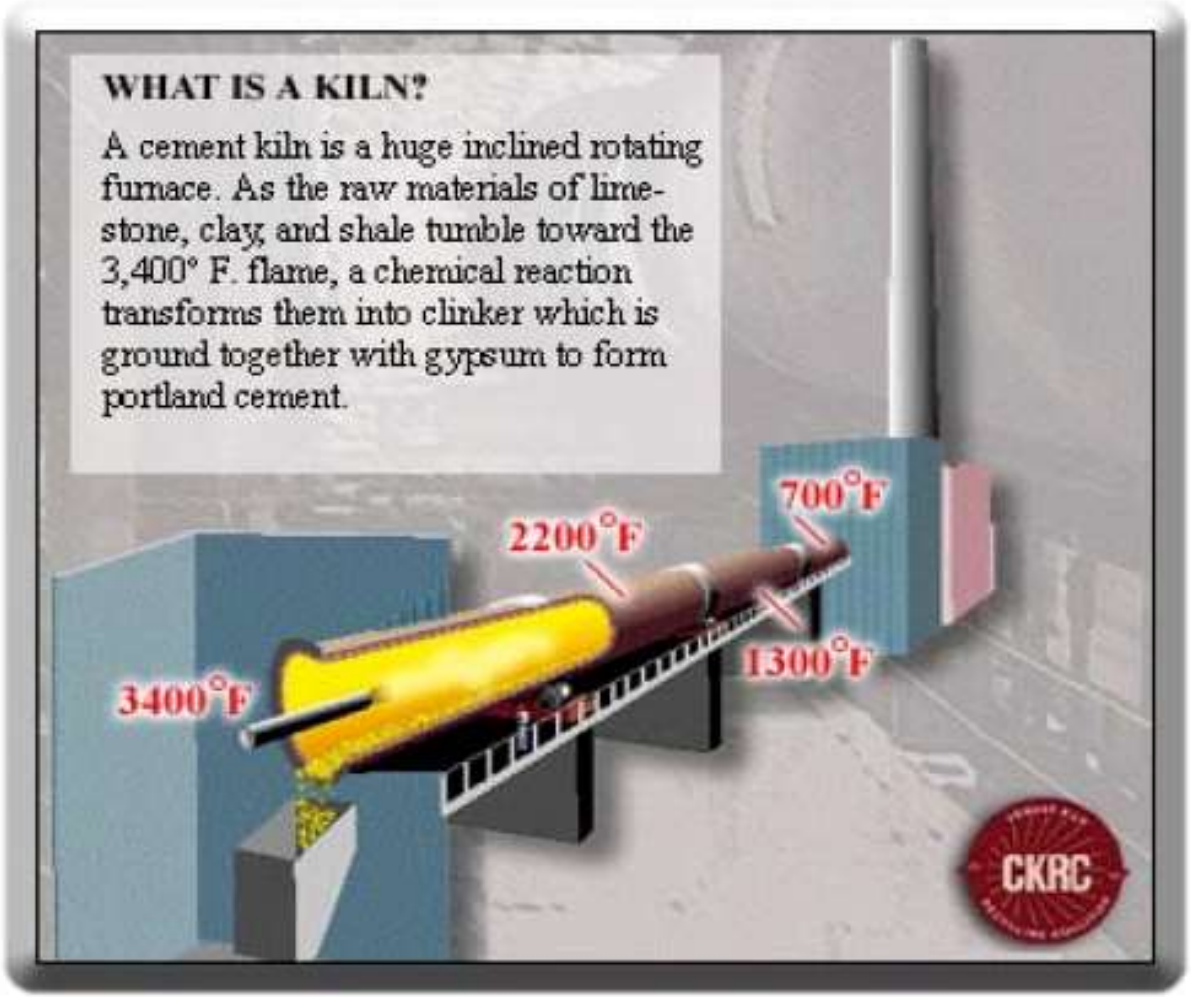


- Proportioning of feed stock.
- Size reduction to < 125μ.
- Control of moisture.
- Blending to reduce standard deviation.
- Uniform delivery rate of feed to the Kiln.

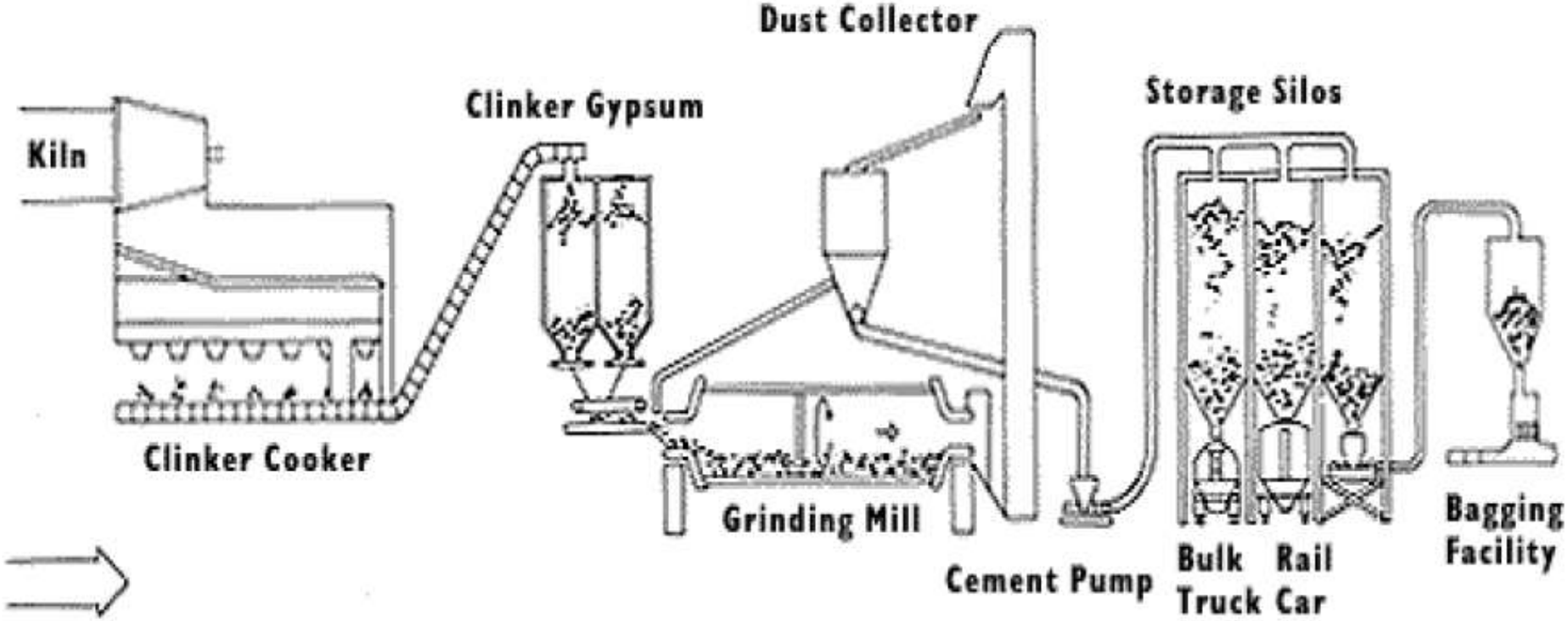
Vertical Roller Mill



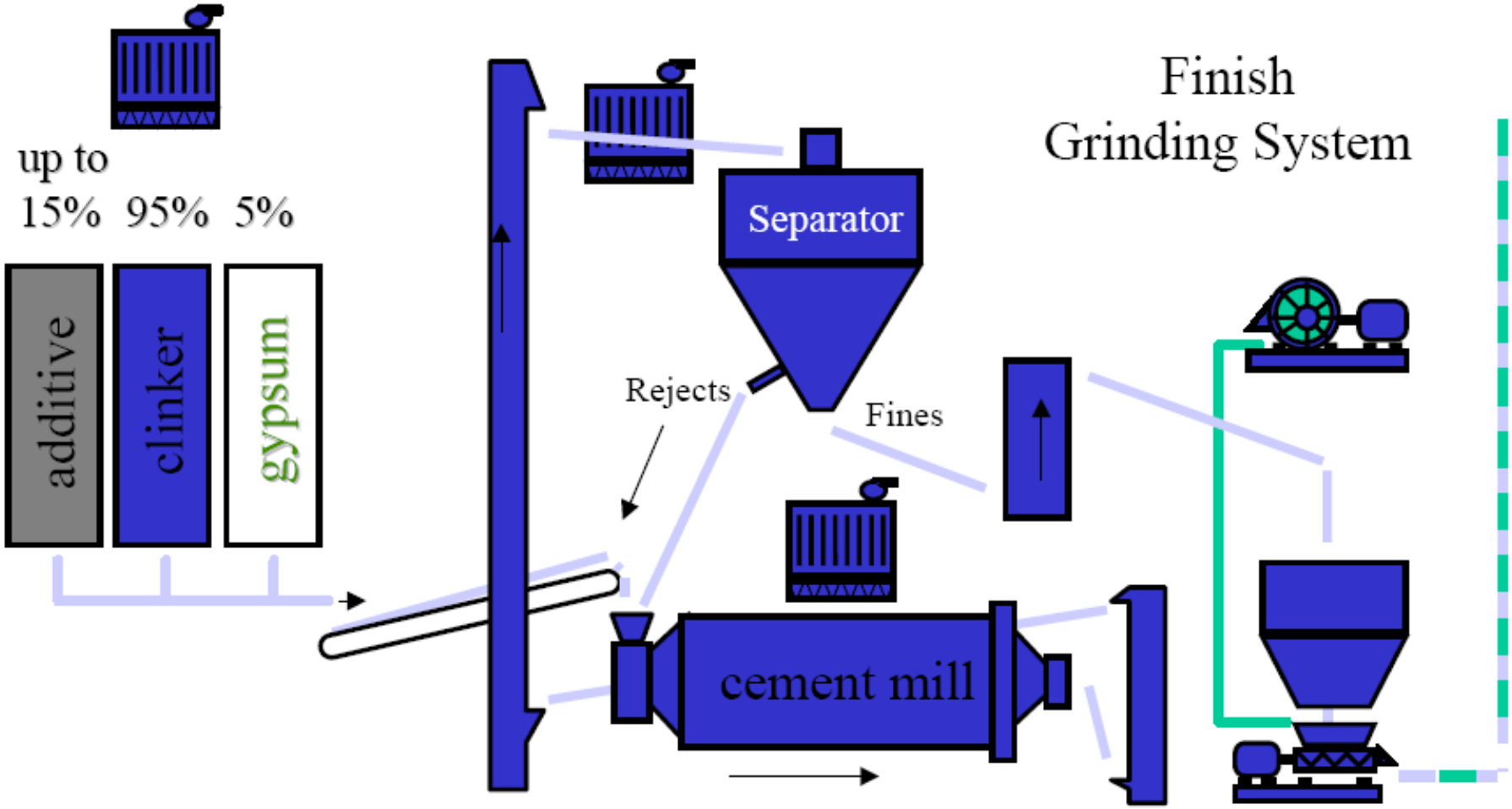
Steps in the Manufacture of Portland Cement



Steps in the Manufacture of Portland Cement



Once cooled, the clinker is ground with a small amount of gypsum.
It's now portland cement-ready to be bagged or shipped in bulk.



- Clinker, gypsum, and optional additives are weighed to proper proportions and ground in the cement mills.
- Additives may include: Fly-ash, Limestone…..

Cement Kiln

the Largest Moving Equipment in any Manufacturing Operation

And the Hottest

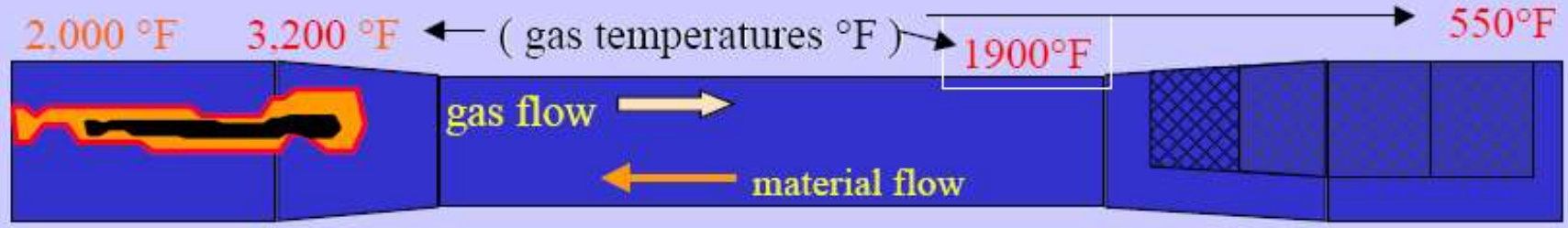
Cement Kilns

- High temperature
- Long residence time
- Natural alkaline environment
- CKD is only by-product of the process.
- Thermal stability

Kiln Process Control

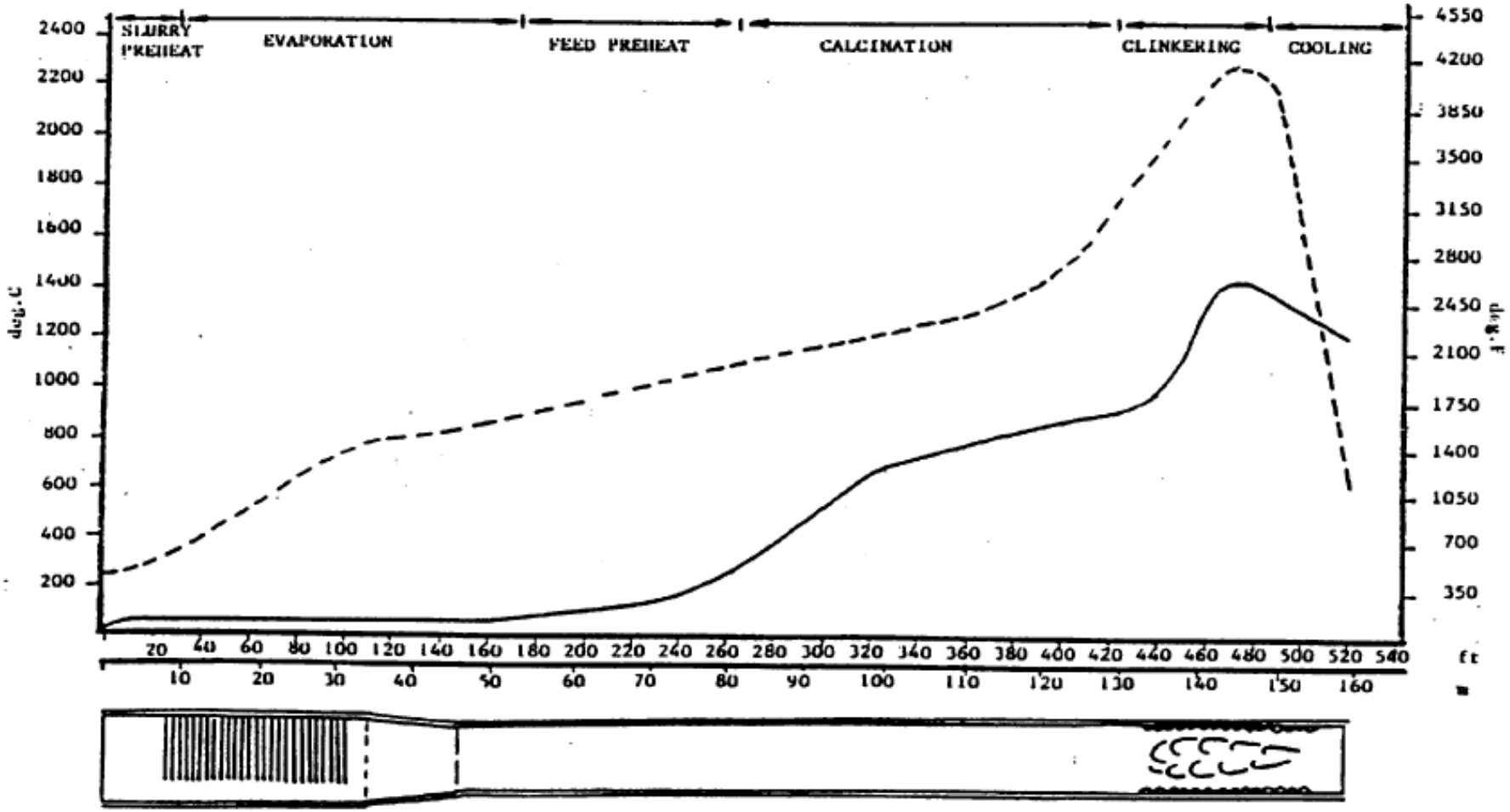
- Critical Parameters: Fuel, Feed, Kiln Speed, Gas Flow
- Kiln Temperatures - Burning Zone
- Kiln Stability
- Chemistry
- Instrumentation

The Wet Cement Kiln

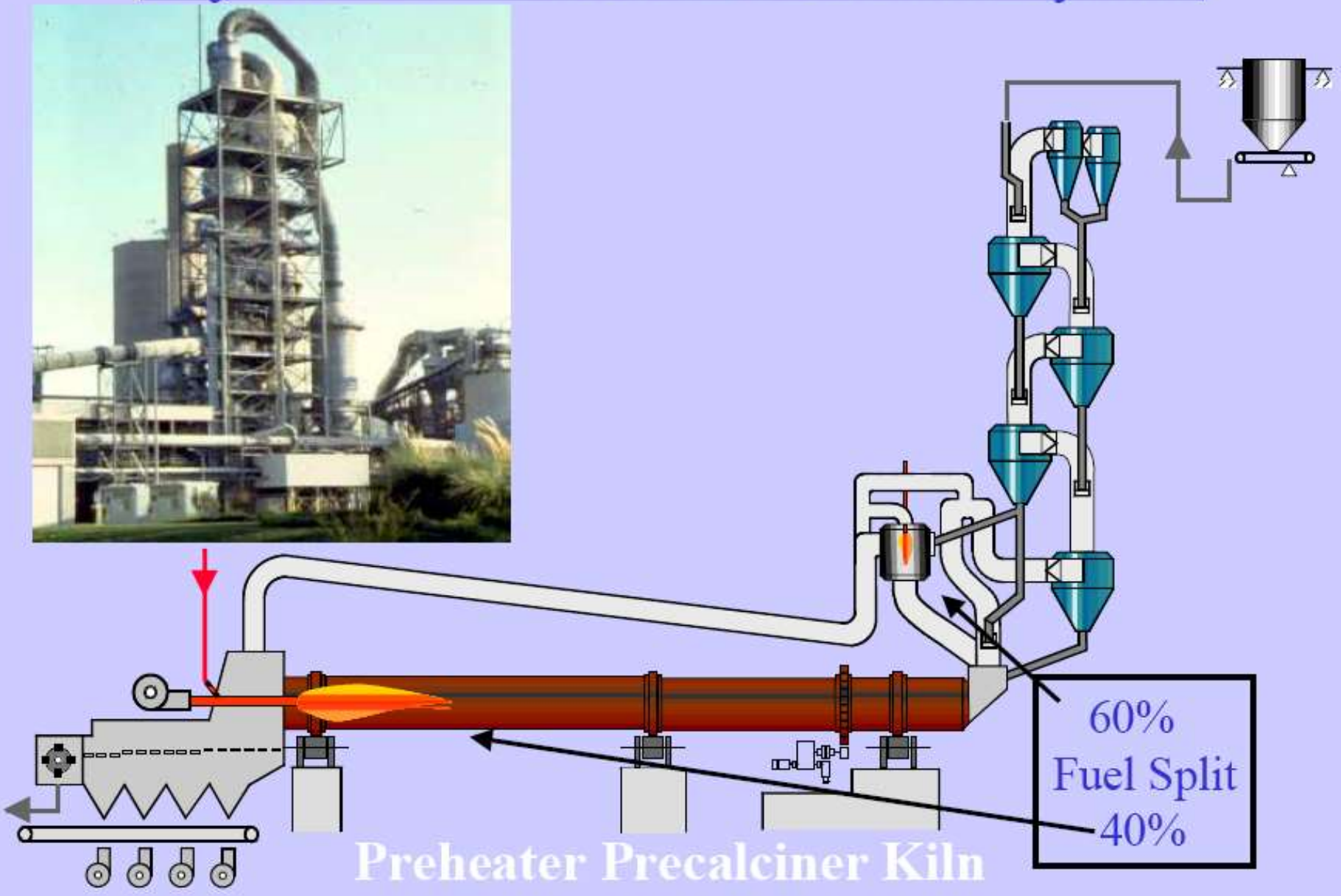


Critical Parameters: Fuel, Feed, Kiln Speed, Gas Flow
Kiln Temperatures

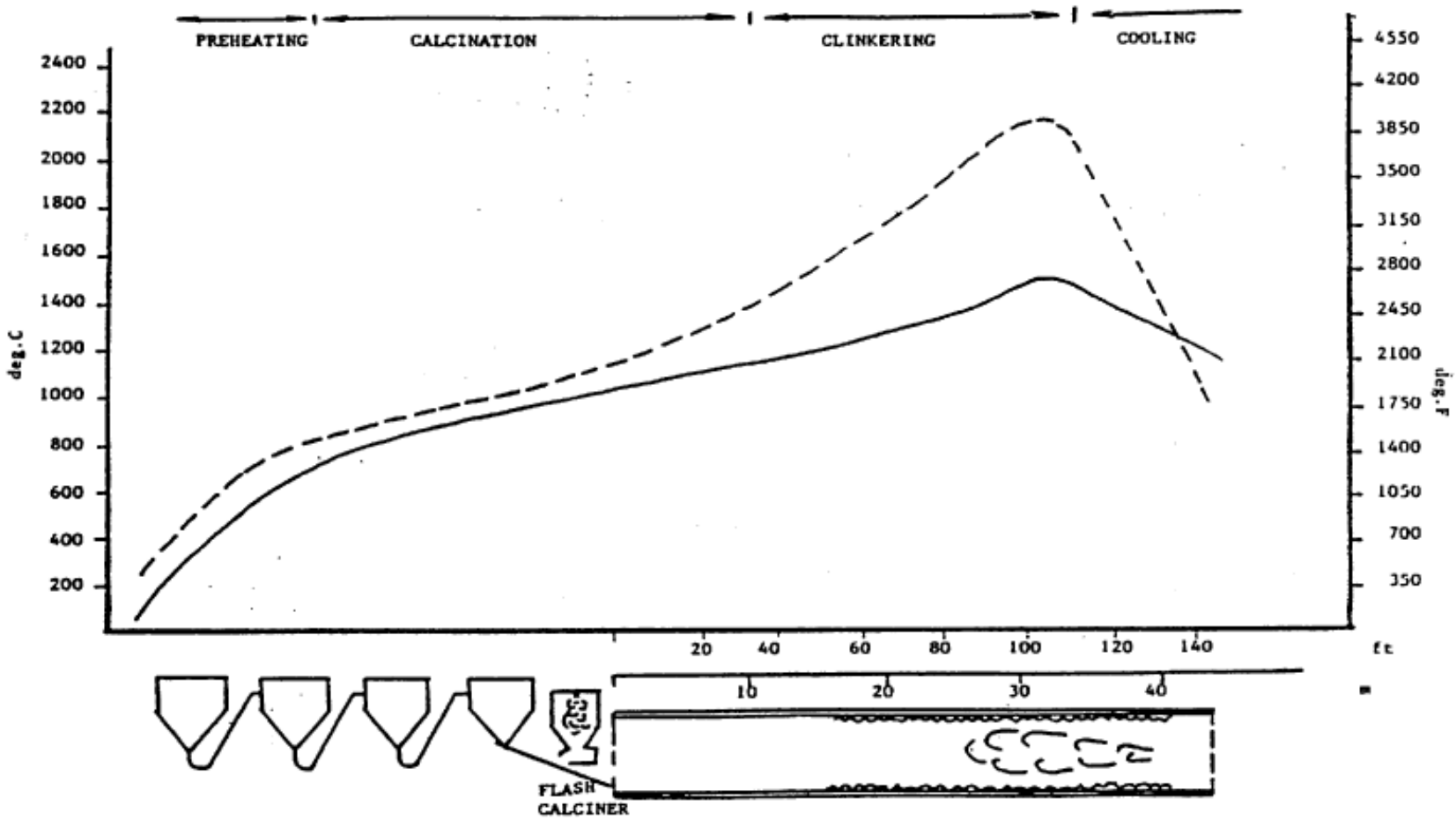
Wet Kiln Process Material and Gas Temperatures



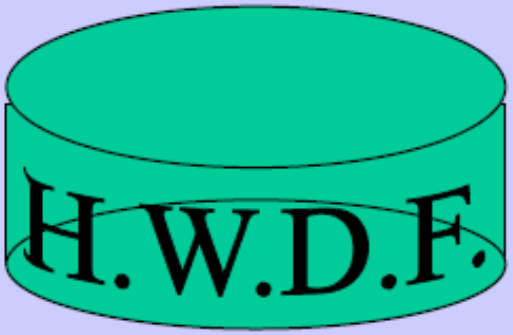
Dry Process Preheater/Precalciner System



Dry Kiln Process Material and Gas Temperatures

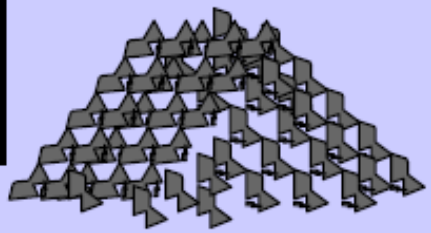


Kiln Fuels



Coal
&
Pet Coke

T.D.F.



Alternate
Fuels

A typical wet kiln burns about 400# of fuel to make a ton of clinker (5.0 mmBtu/ton of clinker)

Fuels can be any combustible hydrocarbon such as:

- coal, coke, natural gas, used motor oil, wood, tires, cellulose others.

Cement Kilns Excellent Environment for Destroying &Recycling Wastes

A Cement Kiln Provides:

- 3,000degreeF + Flame
- Long retention times of gasses and materials.
- Stability of a large dependable industrial process.
- Many inherent safeguards.

A Cement Kiln Is A Proven Technology For Beneficial REUSE of Otherwise Waste Materials

The Benefits are:

- Energy Recovery

- Material Recovery

Recycling Programs

Energy Replacement for Coal/Coke.

- Liquid fuels.
- Solid fuels.

Material Replacement for Raw Materials (Limestone, Shale and Sand).

- Solids/sludge slightly contaminated with metals.
- Solids/sludge slightly contaminated with Organics.

THAT WAS A BREIF ON MAJOR CEMENT INDUSTRY'S WORK.