INDUSTRI SEMEN

SEMEN

- Kata semen berasal dari bahasa Romawi *caementicium* yang berarti bahan perekat
- Semen didefinisikan sebagai campuran senyawa kimia yang bersifat hidrolis, artinya jika ditambah air dalam jumlah tertentu akan mengikat bahan-bahan lain menjadi satu kesatuan massa yang dapat memadat dan mengeras

Sejarah semen

- Semen diproduksi pada awal kerajaan Yunani dan Romawi dengan bahan baku abu gunung berapi dicampur dengan slake lime (kapur padam)
- Teknik ini menghilang pada abad pertengahan
- Semen Portland dikembangkan di Inggris oleh seorang tukang batu Joseph Apsdin pada awal 1800-an
- Nama portland disebabkan beton yang terbentuk mirip dengan batuan alam di Isle of Portland

Tipe-tipe semen

GENERAL FEATURES OF THE MAIN TYPES OF PORTLAND CEMENT

ASTM Type	Classification	Characteristics	Applications
Type I	General purpose	Fairly high C_3S content for good early strength development	General construction (most buildings, bridges, pavements, precast units, etc)
Type II	Moderate sulfate resistance (Modified cement)	Low C_3A content (<8%)	Structures exposed to soil or water containing sulfate ions
Type III	High early strength (Rapid-hardening)	Ground more finely, may have slightly more C_3S	Rapid construction, cold weather concreting
Type IV	Low heat of hydration (slow reacting)	Low content of C_3S (<50%) and C_3A	Massive structures such as dams. Now rare.
Type V	High sulfate resistance	Very low C_3A content (<5%)	Structures exposed to high levels of sulfate ions
White	White color	No C_4AF, low MgO	Decorative (otherwise has properties similar to Type I)

Chemical composition of the main types of Portland cement

ASTM Type		C_3S %	C_2S %	C_3A %	C_4AF %	
I	General Purpose	55	19	10	7	370
II	Mod Sulfate Mod Heat	51	24	6	11	370
III	Early Strength	56	19	10	7	540
IV	Low Heat	28	49	4	12	380
V	Sulfate Resistant	38	43	4	9	380

Bahan baku semen

- Batu kapur (gamping) adalah bahan alam yang mengandung senyawa kalsium oksida (CaO).
- Lempung (tanah liat) adalah bahan alam yang mengandung senyawa seperti silika oksida (SiO_2), aluminium oksida (Al_2O_3), besi oksida (Fe_2O_3) dan magnesium oksida (MgO).

Limits of Main Chemical and Oxide Constituents of Ordinary Portland Cement

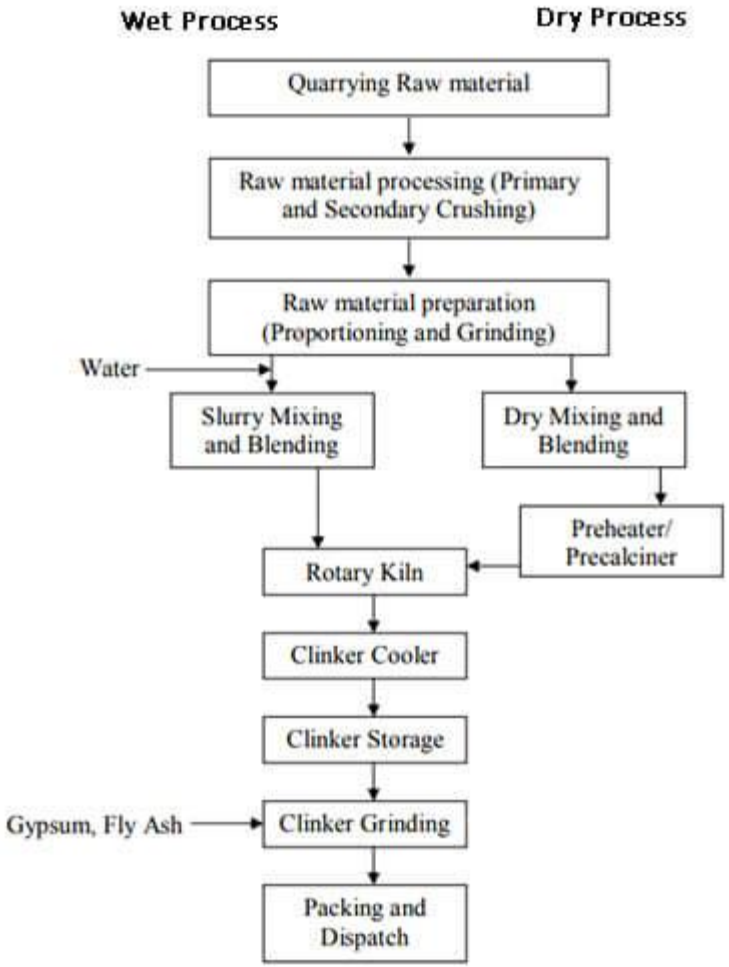
Sr. No.	Constituents	Percent Content (%)
01.	Lime (CaO)	60-67
02.	Silica (SiO_2)	17-25
03.	Alumina (Al_2O_3)	3.0-8.0
04.	Iron Oxide (Fe_2O_3)	0.5-6.0
05.	Magnesium Oxide (MgO)	0.1-4.0
06.	Sulphur Trioxide (SO_3)	1.3-3.0
07.	Alkalies (K_2O, Na_2O)	0.4-1.3

Proses produksi semen

- Ada 2 metode :
  - Proses basah

    Semua bahan baku yang telah halus dicampur dengan air membentuk slurry dan diumpankan ke kiln
  - Proses kering

    Bahan baku seperti batu kapur dan agrice digiling pada kondisi kering secara terpisah dan dicampur pada kondisi kering baru diumpankan ke kiln

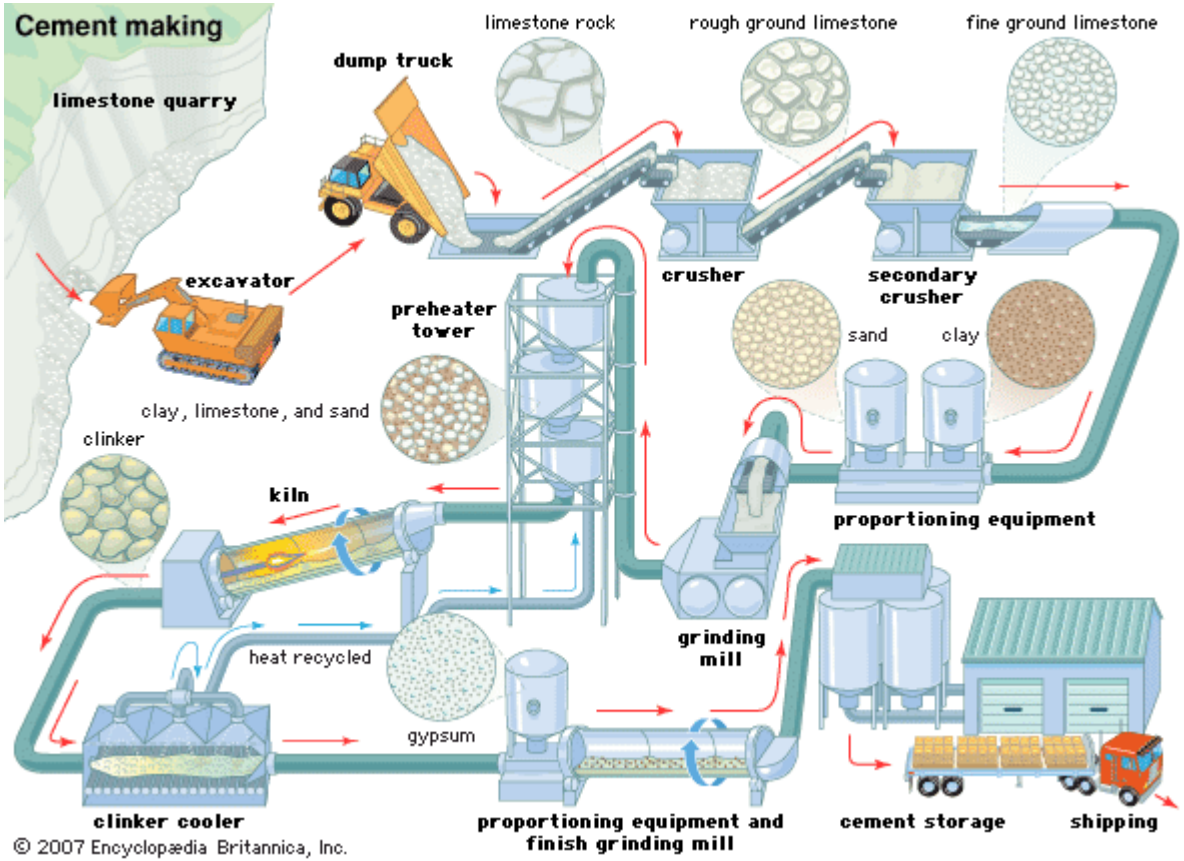


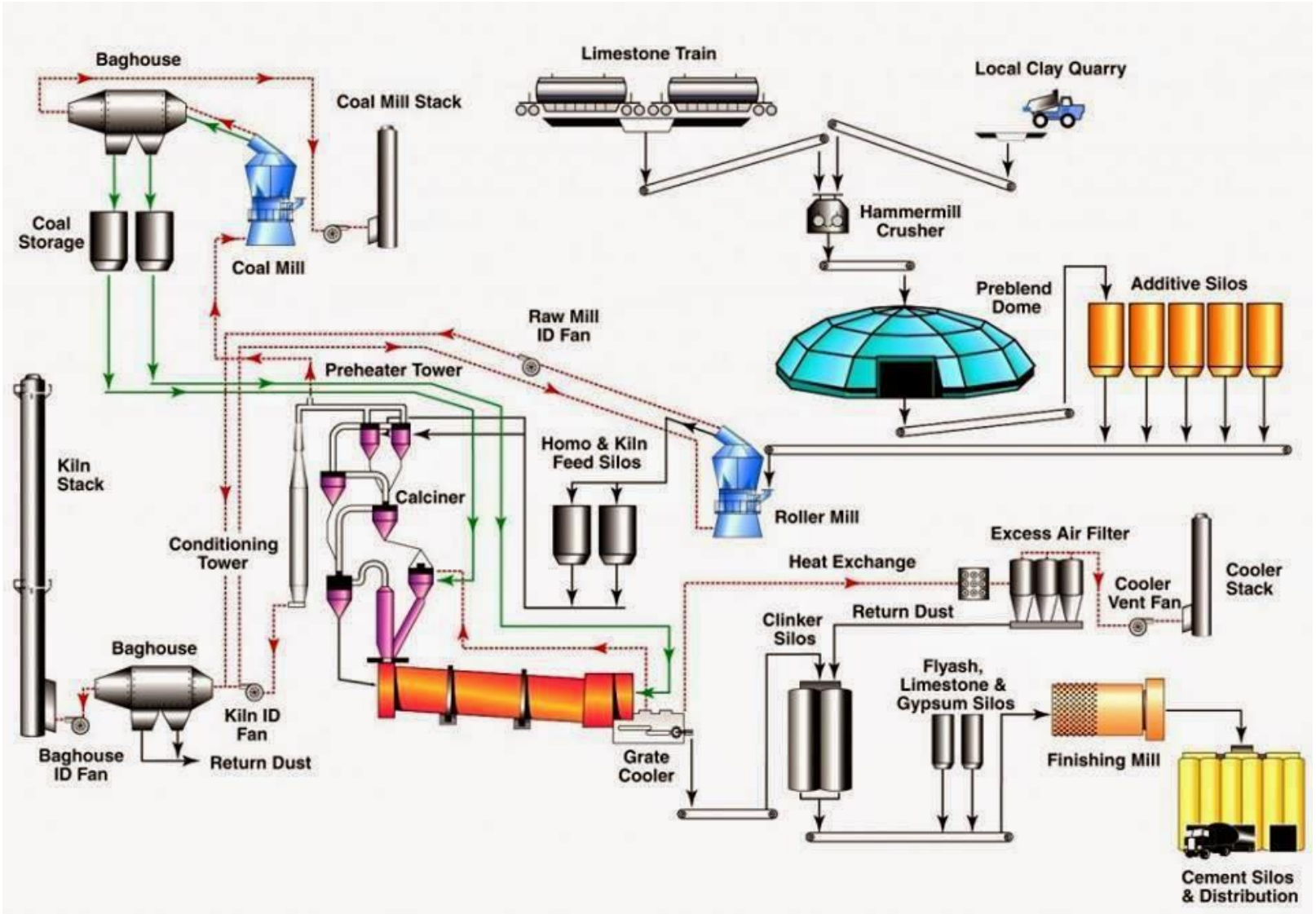
Proses basah vs proses kering

Mixing and crushing of raw materials: Actually the purpose of both processes is to change the raw materials to fine powder.

Dry process	Wet process
❑ This process is usually used when raw materials are very strong and hard.	❑ This process is generally used when raw materials are soft because complete mixing is not possible unless water is added.
❑ In this process, the raw materials are changed to powdered form in the absence of water.	❑ In this process, the raw materials are changed to powdered form in the presence of water
❑ Dehydration zone requires a somewhat shorter distance than wet process.	❑ Dehydration zone would require up to half the length of the kiln easiest to control chemistry & better for moist raw materials
❑ 74% of cement produced.	❑ 26% of cement produced
❑ kilns less fuel requirements	❑ High fuel requirements - fuel needed to evaporate 30+% slurry water- The kiln is a continuous stream process vessel in which feed and fuel are held in dynamic balance
❑ In this process calcareous material such as lime stone (calcium carbonate) and argillaceous material such as clay are ground separately to fine powder in the absence of water and then are mixed together in the desired proportions. ❑ Water is then added to it for getting thick paste and then its cakes are formed, dried and burnt in kilns.	❑ In this process, raw materials are pulverized by using a Ball mill, which is a rotary steel cylinder with hardened steel balls. When the mill rotates, steel balls pulverize the raw materials which form slurry (liquid mixture). The slurry is then passed into storage tanks, where correct proportioning is done. Proper composition of raw materials can be ensured by using wet process than dry process. Corrected slurry is then fed into rotary kiln for burning.

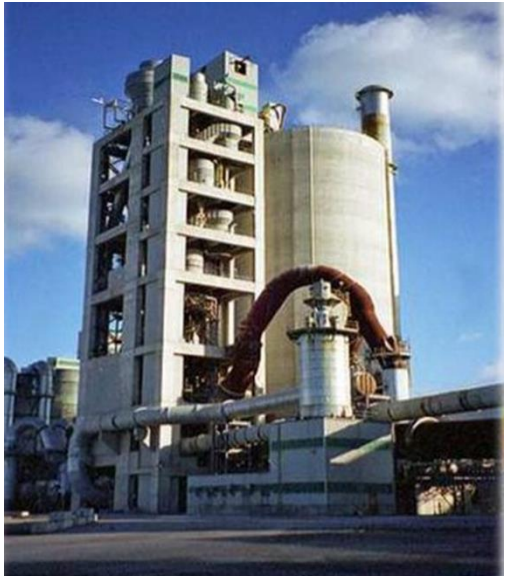
Proses pembuatan semen

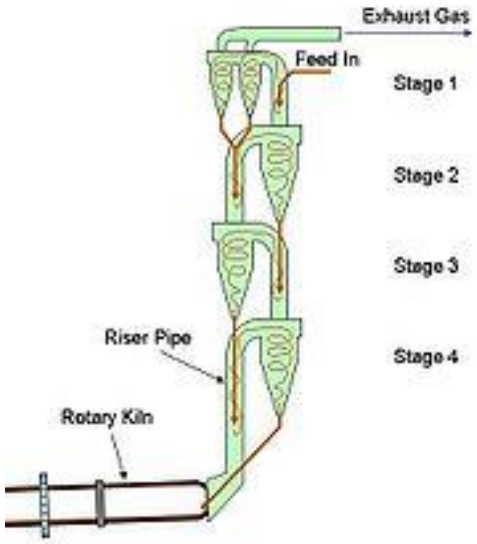



Baghouse
Coal Mill Stack
Limestone Train
Local Clay Quarry
Coal Storage
Coal Mill
Hammermill Crusher
Preblend Dome
Additive Silos
Raw Mill ID Fan
Preheater Tower
Kiln Stack
Homo & Kiln Feed Silos
Calciner
Roller Mill
Conditioning Tower
Excess Air Filter
Heat Exchange
Cooler Vent Fan
Cooler Stack
Return Dust
Clinker Silos
Baghouse
Flyash, Limestone & Gypsum Silos
Kiln ID Fan
Baghouse ID Fan
Return Dust
Grate Cooler
Finishing Mill
Cement Silos & Distribution

Suspension preheater

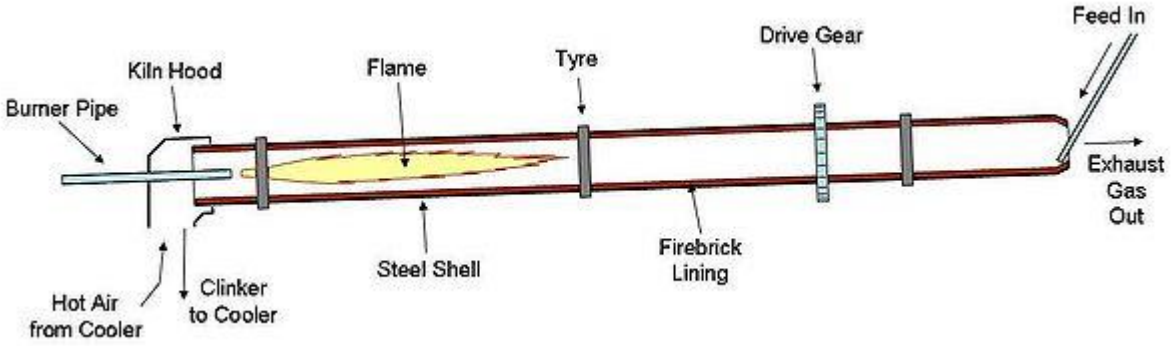
- Pemanasan awal untuk mengurangi beban panas pada rotary kiln dengan memanfaatkan panas yang keluar dari kiln
- Terjadi proses dehidrasi dan kalsinasi awal
- Berbentuk siklon bertingkat



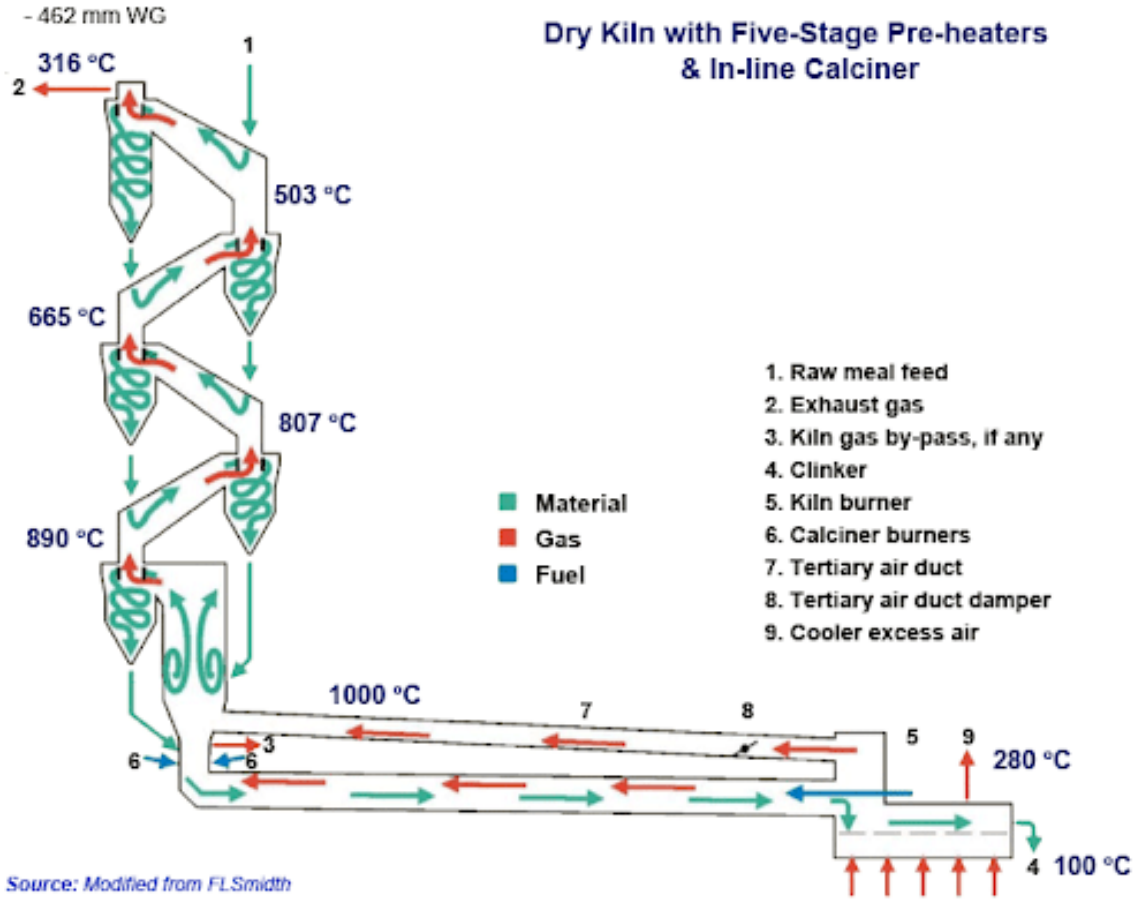


Rotary kiln

- Kiln berbentuk silinder panjang dengan posisi horisontal dengan kemiringan 3-4^{o}
- Suhu mencapai 1400 ^{o}C
- Kecepatan putar 30 – 250 rph

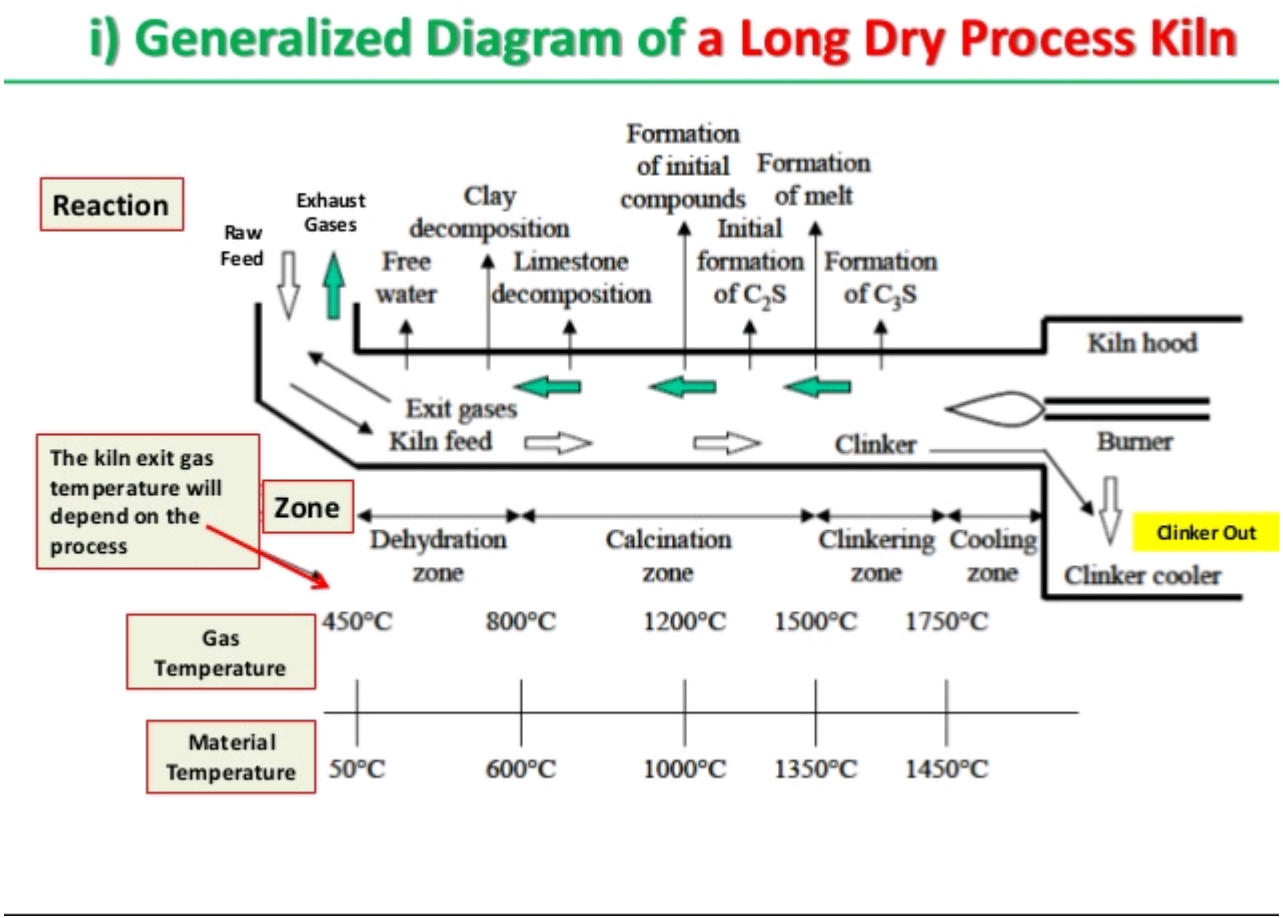


Rotary kiln dengan preheater



Source: Modified from FLSmidth

Zone reaksi pada rotary kiln



5. Ractions in the pre-heater& kiln.

- the burning process of raw materials is performed in two stages: preheating upto 900°C & rotary kiln up to 1450 °C

Reactions:

~100℃→ free water evaporates.

~150-350C°→ loosely bound water is lost from clay (chemically combined).

~350-650°C→decomposition of clay→SiO_2&Al_2O_3

~600°C→decomposition of $MgCO_3$→$MgO\&CO_2$ (evaporates)

~900°C - 1100℃→decomposition of $CaCO_3$→$CaO\&CO_2$ (evaporates)

~1150-1280℃→liquid formation & start of compound formation.

~1280°C→clinkering begins.

~1300-1450°C→clinkering

~100°C→clinker leaves the kiln & falls into a cooler.

Komposisi semen

Composition

Chemical Name	Chemical Formula	Shorthand Notation	Mass (%)
Tricalcium silicate	$3CaO \cdot SiO_2$	C_3S	50 - 70
Dicalcium silicate	$2CaO \cdot SiO_2$	C_2S	15 - 30
Tricalcium aluminate	$3CaO \cdot Al_2O_3$	C_3A	5 - 10
Tetracalcium aluminoferrite	$4CaO \cdot Al_2O_3 \cdot Fe_2O_3$	C_4AF	5 - 15
Calcium sulfate dihydrate	$CaSO_4 \cdot 2H_2O$	CSH_2	~ 5