



Raw Mix, Clinker and Volatile Cycles · what builds up and why

The raw mix and the clinker it makes, the heat of formation, and the sulfur, chlorine and alkali that circulate until they block.

Licensed to: Sample file · worked example on a demonstration plant

CHLORINE ROOM LEFT	HOT MEAL
57 g per t clinker	BUILD-UP STARTING

LSF	C ₃ S
99.4 lime saturation	65.3 % of the clinker

YOUR FIGURES

	Today	What if	
--	-------	---------	--

The kiln feed (dry)

CaO	43.20		%
SiO ₂	13.60		%
Al ₂ O ₃	3.40		%
Fe ₂ O ₃	2.10		%
MgO	1.30		%
Loss on ignition	35.00		%
Residue on 45 µm, quartz (optional)	1.95		%
Residue on 125 µm, calcite (optional)	0.00		%
Free lime in the clinker	1.02		%

The kiln and its streams

Kiln system	Preheater / precalciner		
Clinker made	2,500		t/day
Kiln feed	160.0		t/h
Kiln feed SO ₃	0.300		%
Kiln feed Cl	0.015		%
Kiln feed K ₂ O	0.550		%
Kiln feed Na ₂ O	0.110		%
Filter dust returned to the kiln	6.0		t/h
Its LOI	18.0		%
Its SO ₃	0.900		%
Its Cl	0.220		%
Its K ₂ O	1.600		%
Its Na ₂ O	0.250		%

The fuels

RESULTS

	Today		What if	Change	What it means
Lime saturation factor	99.4	GOOD	99.4	0	90 to 100 is the usual band; higher is harder to burn.
Silica modulus	2.47	GOOD	2.47	0	
Alumina modulus	1.62	GOOD	1.62	0	
C ₃ S (%)	65.3		65.3	0	
C ₂ S (%)	10.7		10.7	0	
C ₃ A (%)	8.4		8.4	0	
C ₄ AF (%)	9.8		9.8	0	
Free lime to expect from the mix (%)	4.12		4.12	0	0.33 (LSF – 95) + 1.8 (SM – 2) + 0.93 R45 quartz + 0.56 R125 calcite.
Heat of clinker formation (kcal/kg)	434		434	0	Use it in the Kiln Heat Balance.
Relevant chlorine input (g/t clinker)	243		440	+197	
Chlorine room left (g/t clinker)	57	GOOD	-140	-197	
Alkali / SO ₃ ratio in clinker	1.18	GOOD	1.18	0	0.8 to 1.2: sulfur and alkali in balance.
Sulfur volatility	0.58		0.58	0	Above 0.70 the sulfur is driven off faster than the clinker takes it.
Calcination of the hot meal (%)	88.6		88.6	0	
Chlorine taken out by the bypass (%)					
Loss-free mass balance closure (%)	0.04	GOOD	0.15	+0.11	
Chlorine closure (%)	0.2		34.5	+34.3	

Fuel 1 rate	10.26	8.00	t/h
Fuel 1 ash	12.0		%
Fuel 1 sulfur	1.50		%
Fuel 1 chlorine	0.020		%
Fuel 1 alkali (K2O)	0.50		%
Fuel 2 rate (alternative)	0.00	3.00	t/h
Fuel 2 ash	13.0		%
Fuel 2 sulfur	0.30		%
Fuel 2 chlorine	0.700		%
Fuel 2 alkali (K2O)	0.50		%

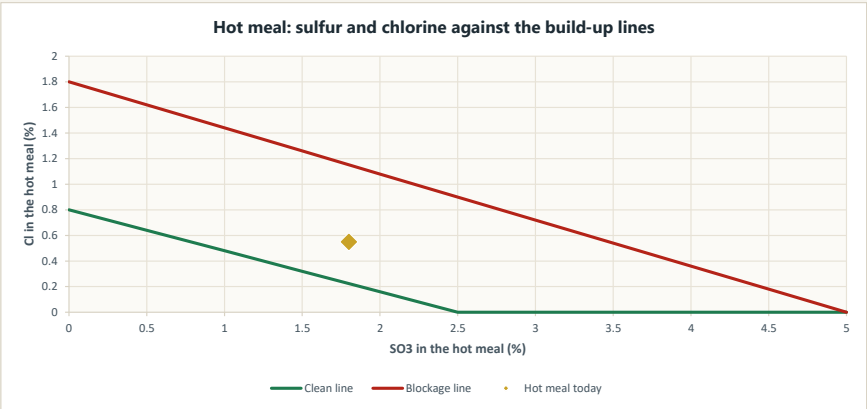
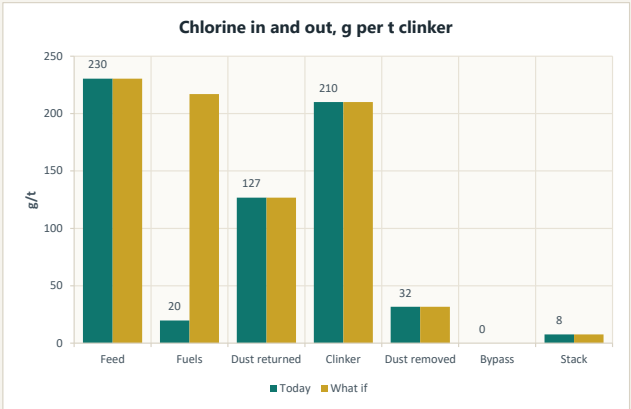
Out of the kiln

Clinker SO3	0.790		%
Clinker Cl	0.021		%
Clinker K2O	0.871		%
Clinker Na2O	0.165		%
Clinker LOI	0.20		%
Filter dust removed	1.50		t/h
Its LOI	18.0		%
Its SO3	0.900		%
Its Cl	0.220		%
Its K2O	1.600		%
Its Na2O	0.250		%
Bypass dust removed	0.00		t/h
Its LOI	2.0		%
Its SO3	2.500		%
Its Cl	3.500		%
Its K2O	4.500		%
Its Na2O	0.600		%
Stack gas	1.55		Nm ³ /kg clinker
Stack SO2	150		mg/Nm ³
Stack HCl	5.0		mg/Nm ³

The hot meal (lowest cyclone)

Hot meal SO3	1.80		%
Hot meal Cl	0.550		%
Hot meal LOI	4.00		%

Yellow cells are yours. Leave a What-if cell empty to keep today's figure; type a new one to see what changes, before anything is changed in the plant.



WHAT TO DO FIRST

READ	CHLORINE ROOM Relevant chlorine input is 243 g/t clinker against a limit of 300. That leaves about 57 g/t of room. Do: At 1 % Cl in a fuel that is roughly 6 kg of fuel per ton of clinker before the limit. Why: This is the number that decides how much more alternative fuel the chemistry will take.
WATCH	HOT MEAL The hot meal is 1.80 % SO3 and 0.55 % Cl, between the two lines. It shows as cleaning frequency long before the kiln stops. Do: Decide whether to spend the remaining margin on alternative fuel or keep it as operating comfort. Why: Reducing volatility buys room without touching the fuel bill.
READ	NO BYPASS This kiln has no bypass, so every gram of chlorine entering has to leave in the clinker or the dust. Do: If the chlorine room is small, discarding filter dust is the cheaper move before a bypass. Why: A bypass costs heat on every ton of clinker, for ever. Dust discard costs only the dust.
