Simulation Analysis for Clinker Manufacturing Process and Support of Resolving Production Technical Issues in UBE-Group

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Agenda

・Introduction

・The Study of Cement Manufacturing Process

- Simulation System
- Low-temperature Burning System
- Evaluation an effect of energy saving using mineralizer

・Summary

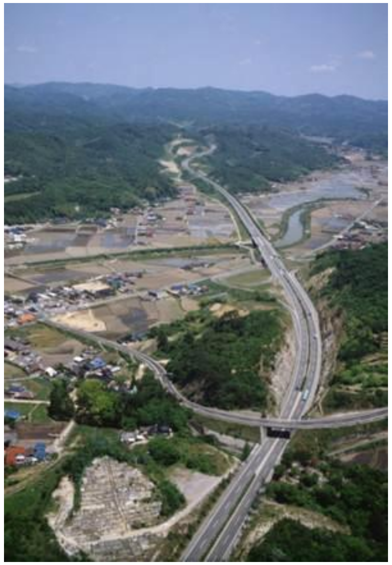
(・Introduction of industrial Application in UBE-Group)

Introduction - Cement Factories in UBE

Isa Limestone Mine and Cement Factory

Kanda Cement Factory

Ube Cement Factory



Private Highway (28km)

Introduction - Three Important Subjects for Cement Industry

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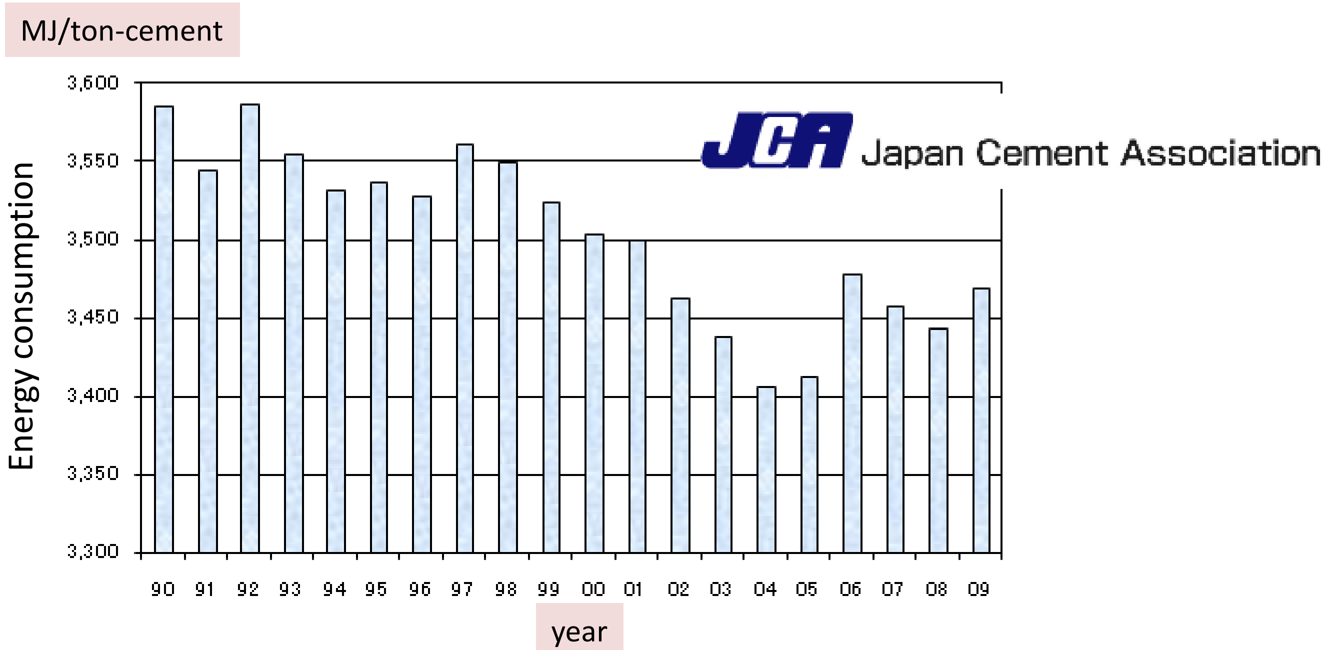
- Reduce Energy consumption(Reduce Carbon Dioxide Emission)
- Increase Waste Usage in Cement manufacturing
- Reduce Electric Power consumption



Energy consumption of cement industry

Innovative Fundamental Technology Development for Cement making 2010～2014

革新的セメント製造プロセス基盤技術開発

経済産業省
Ministry of Economy, Trade and Industry

METI : Ministry of Economy, Trade and Industry

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TAIHEIYO CEMENT CORPORATION

SUMITOMO OSAKA CEMENT CO.,LTD.

MITSUBISHI
MITSUBISHI MATERIALS

Final Goal:

8% energy reduction in cement manufacturing process

R&D Formation for Project

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経済産業省
Ministry of Economy, Trade and Industry

Financial support

General Meeting

Adviser Committee

UBE INDUSTRIES, LTD.
- Cement Process Simulation Technology

SUMITOMO OSAKA CEMENT
- Temperature Measurements Technology in kiln
- Mineralizer for Lower the Burning Temperature

TAIHEIYOU CEMENT CORPORATION
- Mineralizer for Lower the Burning Temperature
- Clinker Composition for Energy Saving

MITSUBISHI MATERIALS
- Temperature Measurements Technology in Kiln

Simulation System -KilnSimu+-

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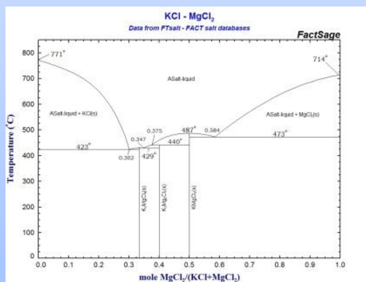
GTT - TECHNOLOGIES

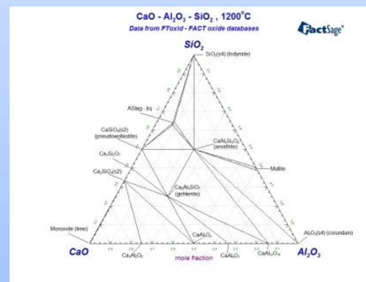
FactSage™

Thermodynamic Data

CHEMAPP

Gibbs Energy Minimizer

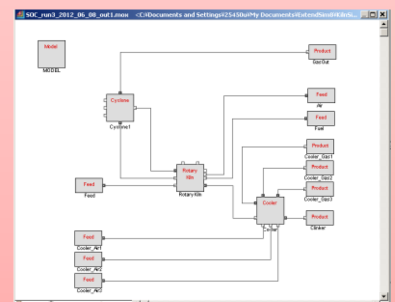


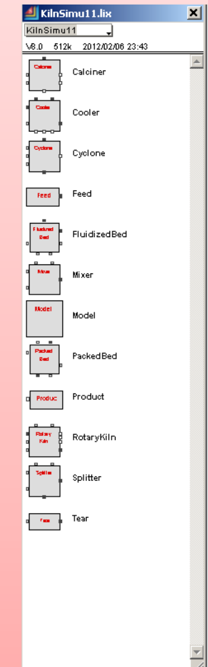


Interface

ExtendSim

GUI

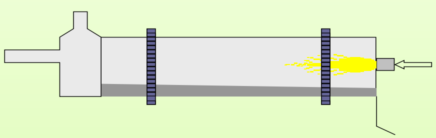


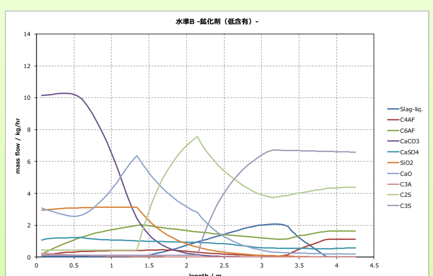


VTT

KilnSimu

Rotary Kiln(Drum) Simulator





Interface

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Reaction in Cement Process

☆Counter Current Process

☆12（or more)System Elements

Fe-Ca-K-Cl-S-Si-Al-Mg-Na-O-N-C

☆Formation of clinker phases

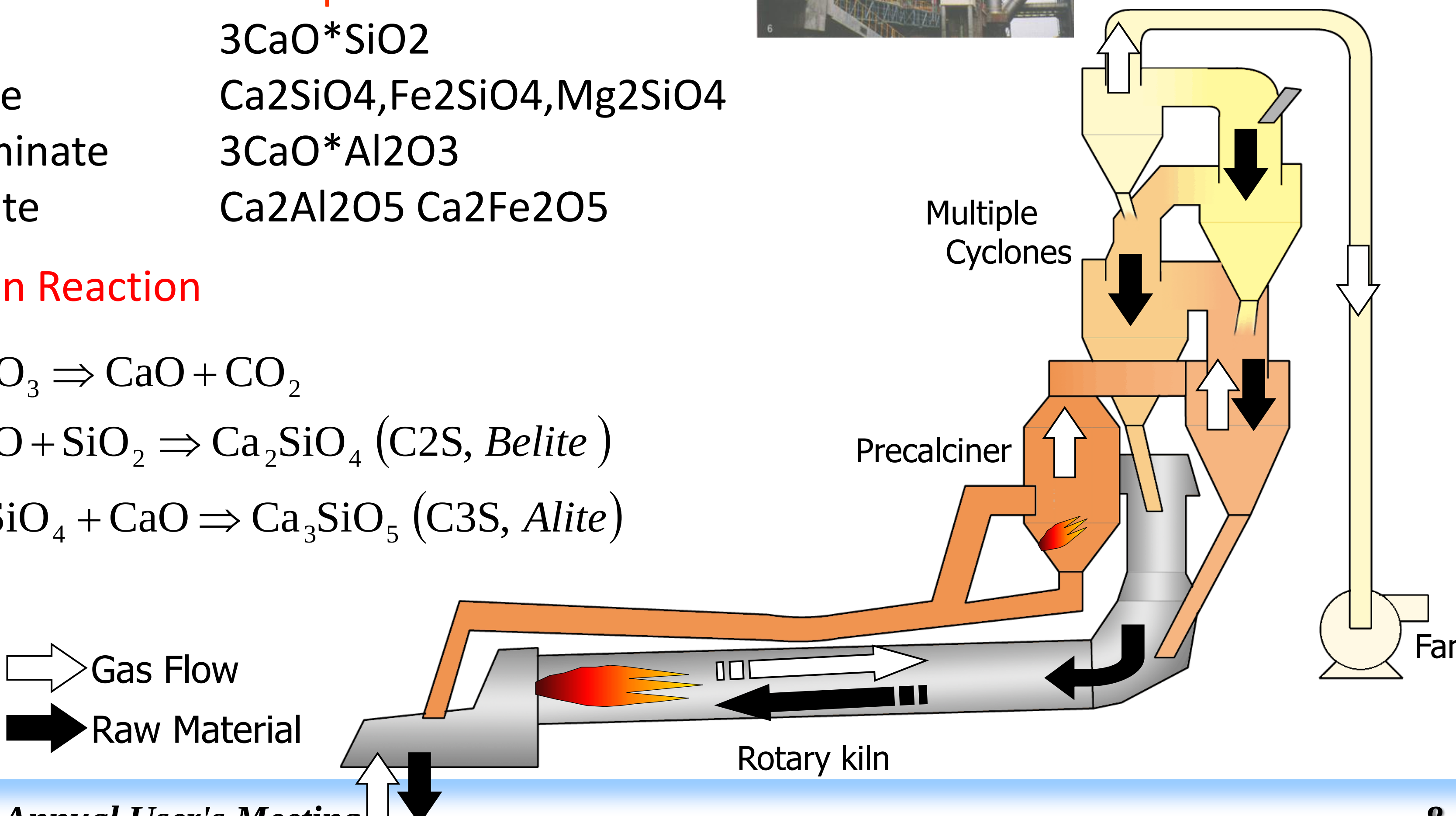
Alite	3CaO*SiO2
Belite	Ca2SiO4,Fe2SiO4,Mg2SiO4
Aluminate	3CaO*Al2O3
Ferrite	Ca2Al2O5 Ca2Fe2O5

☆Main Reaction

$$CaCO_3 \Rightarrow CaO + CO_2$$

$$2CaO + SiO_2 \Rightarrow Ca_2SiO_4 \ (\mathrm{C2S}, \mathit{Belite})$$

$$Ca_2SiO_4 + CaO \Rightarrow Ca_3SiO_5 \ (\mathrm{C3S}, \mathit{Alite})$$



Cement Manufacturing Process (Target of Modeling)

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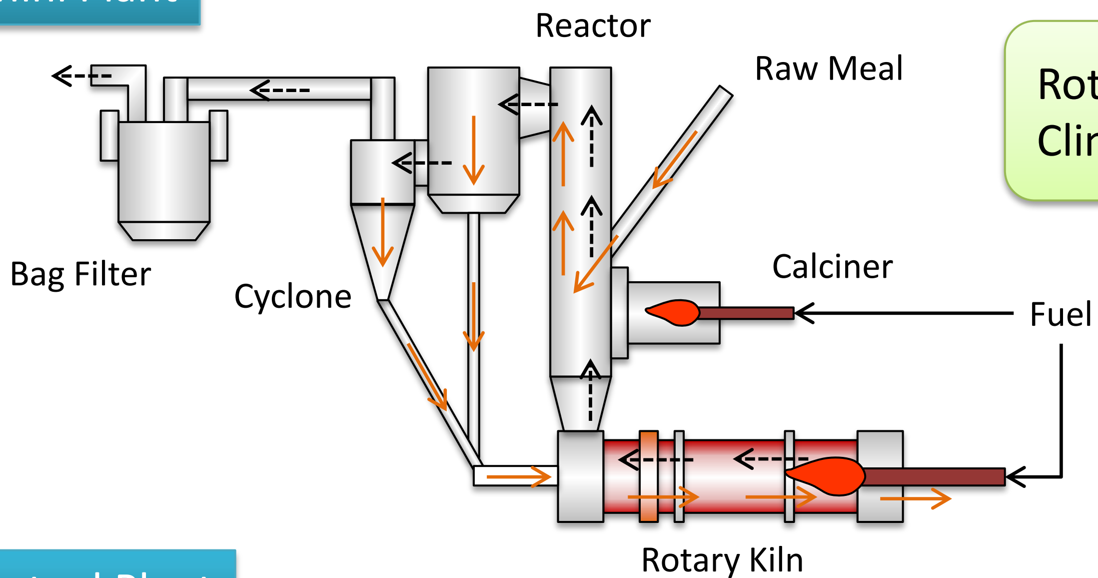
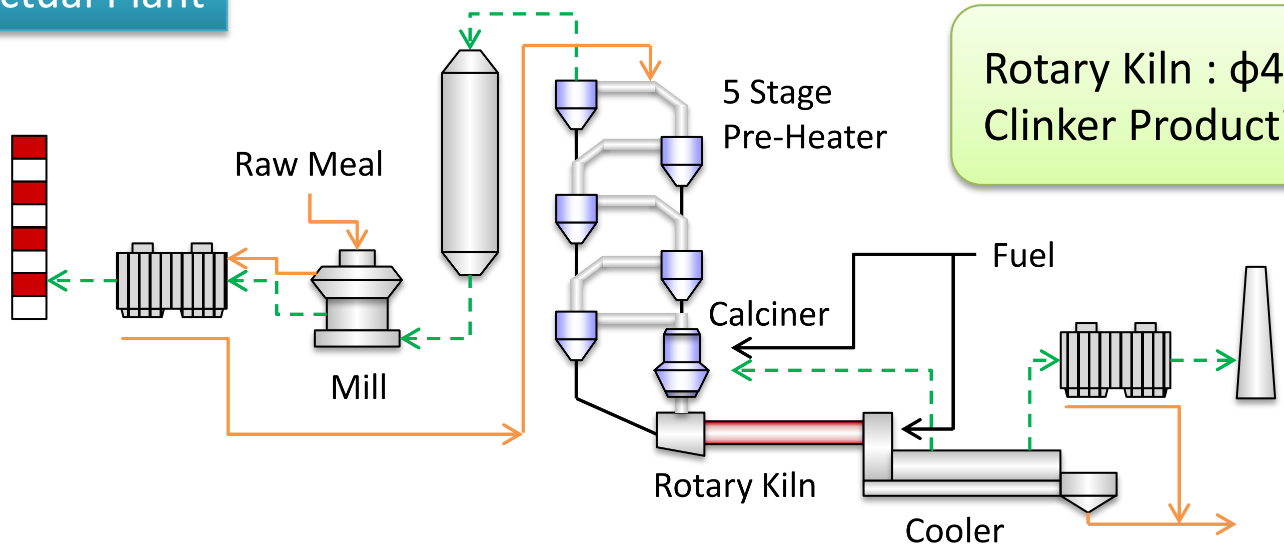
Mini Plant



Rotary Kiln : ϕ0.37m × 3.2mL
Clinker Production Capacity : 25kg/hr

<----- Gas Flow
<—— Raw Meal Flow

Actual Plant



Rotary Kiln : ϕ4.8m × 87.0mL
Clinker Production Capacity : 208ton/hr

<----- Gas Flow
<—— Raw Meal Flow

Calculated Compounds Profile (ex. Mini Plant)

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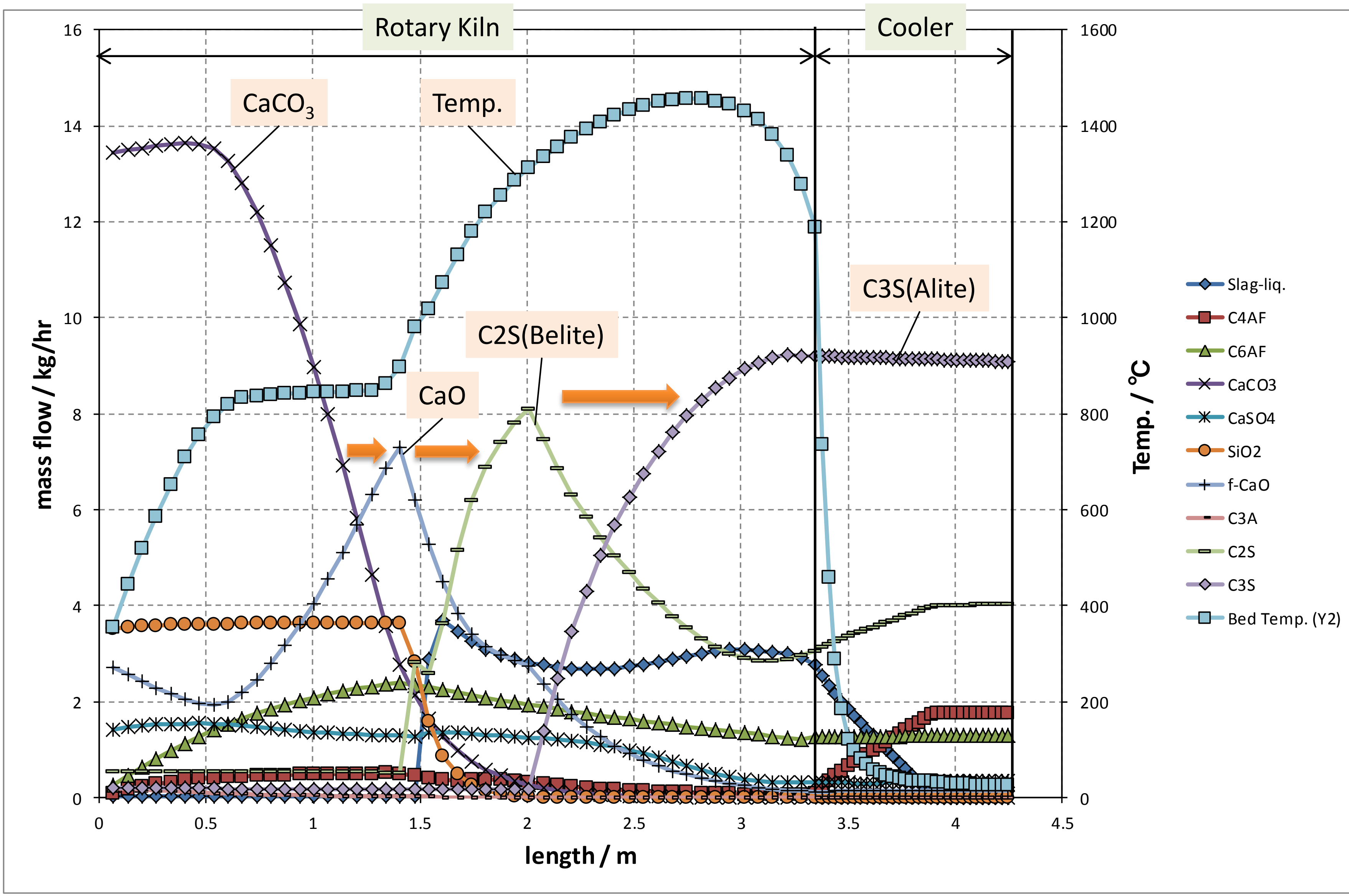

Low-temperature Burning System Using Mineralizer

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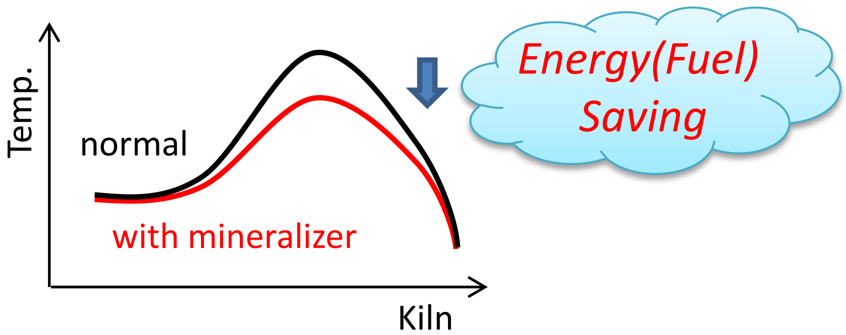
Well known is the effect of the burning temperature drop by adding mineralizer(CaF_2) in clinker manufacturing process.



- Why is there no influence on clinker composition of burning temperature drop? (why does reactions progress with temperature being low?)

⇒We evaluated an influence on kinetic constants by using mineralizer

The results of mini-plant test for the study of low-temperature burning
（Experimented by Sumitomo Osaka Cement Corp.）

		part A	part B	part C
		normal clinker	with mineralizer (low content)	with mineralizer (optimum)
Max Gas Temp.	℃	-	-	-
Max Bed Temp.	℃	1446.9	⇒ 1406.8	⇒ 1361.1
Kiln-end Gas Temp.	℃	991.1	963.1	933.3
Calciner Gas Temp.	℃	1173.9	1175.1	1173.4
C3S	wt%	50.50	44.90	37.80
C2S	wt%	27.70	35.00	40.90
C3A	wt%	5.30	3.50	3.30
C4AF	wt%	10.20	10.10	11.40
f-CaO (desired < 1% for easily sintering)	wt%	0.55	0.61	0.48

Mini-Plant Model by KilnSimu+

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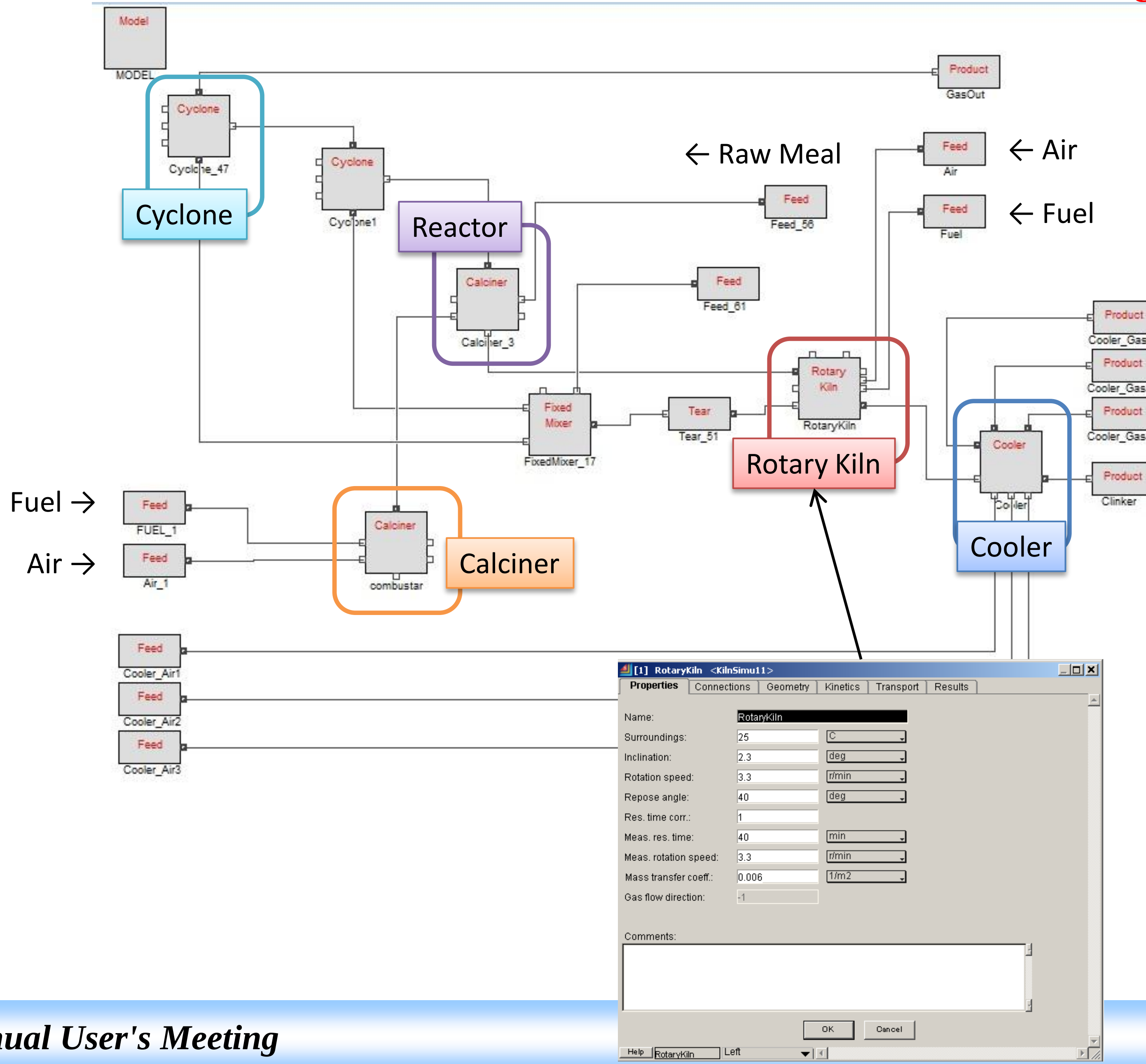
Mini Plant



Comparison to Measured Value

(before kinetic constants tuning)

		part A		part B		part C	
		normal clinker		with mineralizer		with mineralizer	
		Measured	Calculated	Measured	Calculated	Measured	Calculated
Max Gas Temp.	℃	-	1572.4	-	1518.0	-	1460.3
Max Bed Temp.	℃	1446.9	1457.0	1406.8	1416.6	1361.1	1364.5
Kiln-end Gas Temp.	℃	991.1	981.2	963.1	953.9	933.3	920.8
Calciner Gas Temp.	℃	1173.9	1171.5	1175.1	1185.1	1173.4	1180.0
C3S	wt%	50.50	53.26	44.90	43.42	37.80	33.96
C2S	wt%	27.70	22.41	35.00	28.96	40.90	35.46
C3A	wt%	5.30	6.06	3.50	9.22	3.30	9.85
C4AF	wt%	10.20	10.07	10.10	7.36	11.40	6.80
f-CaO (desired < 1% for easily sintering)	wt%	0.55	0.60	0.61	1.30	0.48	2.64

good agreement

different

- Result of part A (normal clinker) agree with the experimental data
- Result of part B and C (with mineralizer) have difference

(next)

tuning up the kinetic constants to match the experimental data

Kinetic Constants Tuning (1)

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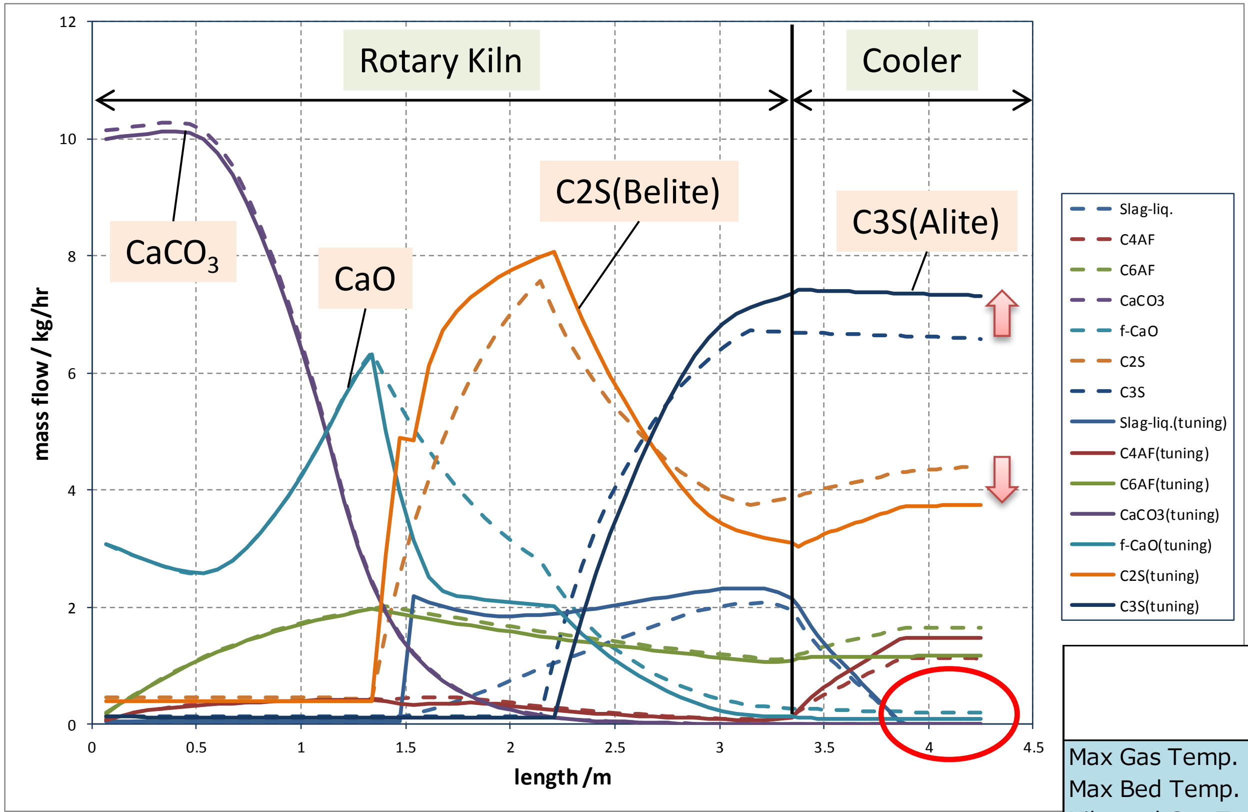


----- before tuning
—— after tuning

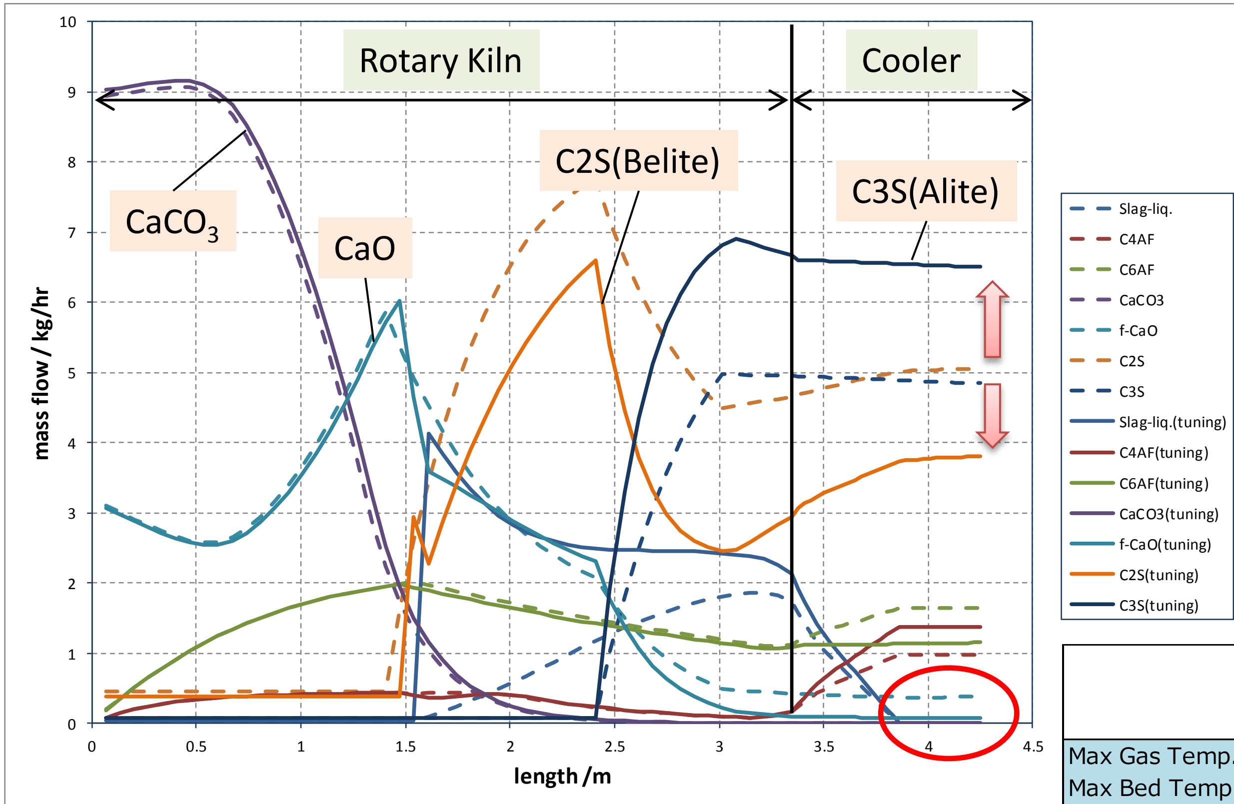
Reactions progress actively

part B

		part B		
		Measured	Calculated	
			no tuning	tuning
Max Gas Temp.	℃	-	1518.0	1518.0
Max Bed Temp.	℃	1406.8	1416.6	1417.4
Kiln-end Gas Temp.	℃	963.1	953.9	950.0
Calciner Gas Temp.	℃	1175.1	1185.1	1185.1
C3S	wt%	44.90	43.42	48.71
C2S	wt%	35.00	28.96	24.98
C3A	wt%	3.50	9.22	6.28
C4AF	wt%	10.10	7.36	9.77
f-CaO (desired < 1% for easily sintering)	wt%	0.61	1.30	0.61

Kinetic constants tuning is successful.

Kinetic Constants Tuning (2)



----- before tuning
—— after tuning

		part C		
		Measured	Calculated	
			no tuning	tuning
Max Gas Temp.	℃	-	1460.3	1460.7
Max Bed Temp.	℃	1361.1	1364.5	1368.1
Kiln-end Gas Temp.	℃	933.3	920.8	924.5
Calciner Gas Temp.	℃	1173.4	1180.0	1180.0
C3S	wt%	37.80	33.96	45.59
C2S	wt%	40.90	35.46	26.68
C3A	wt%	3.30	9.85	6.48
C4AF	wt%	11.40	6.80	9.58
f-CaO (desired < 1% for easily sintering)	wt%	0.48	2.64	0.50

part C

(next)

evaluation an effect of energy saving by using mineralizer in the actual plant model

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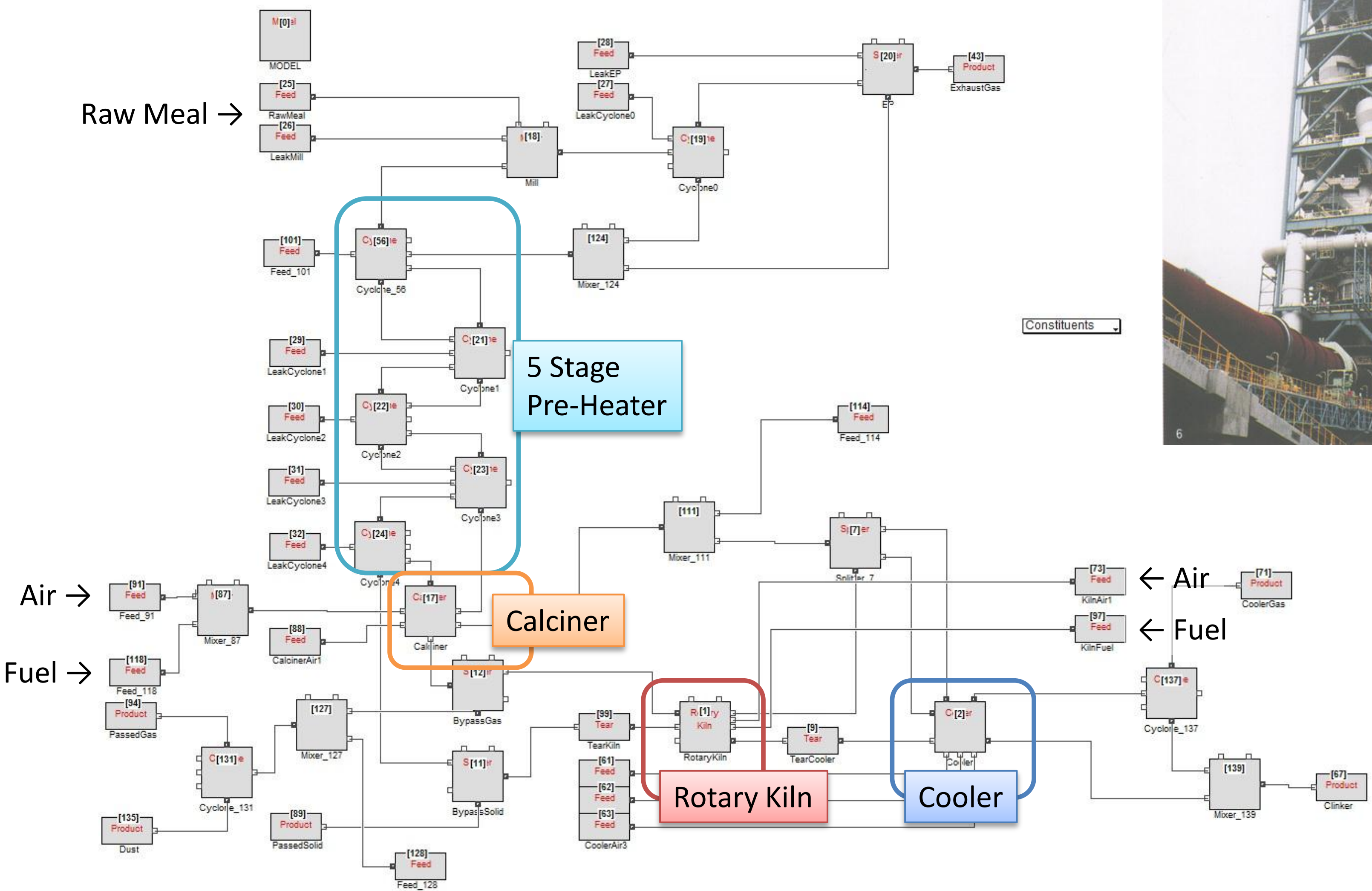
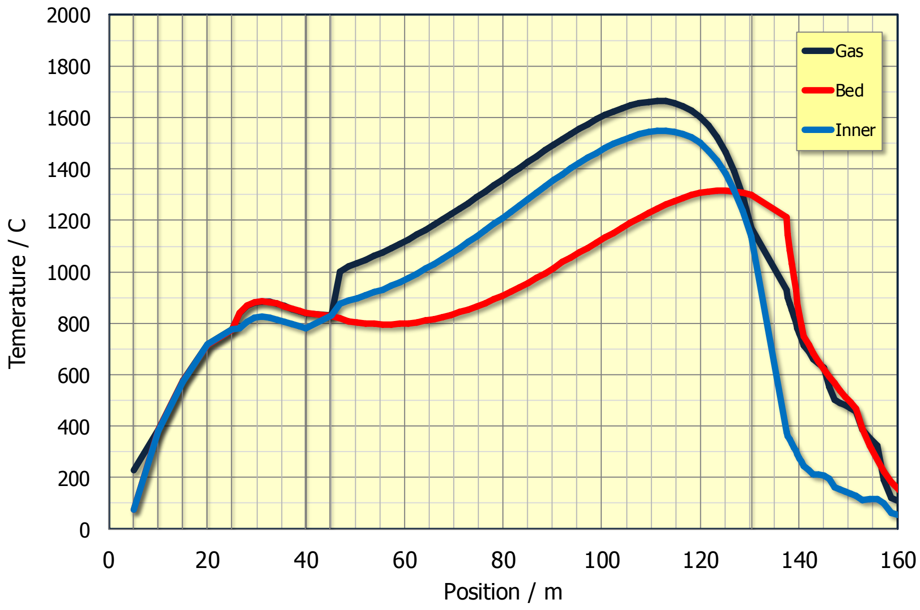
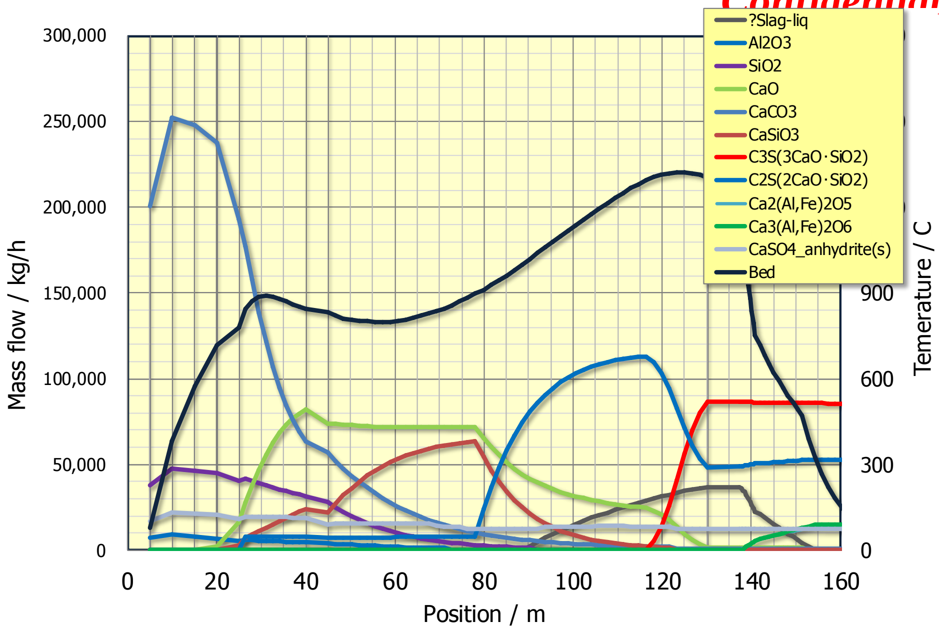
Actual Plant Model by KilnSimu+

NSP(new suspension preheater) Kiln



The Effect of Energy Saving





		normal clinker	with mineralizer	difference
Max.Gas Temp.	℃	1763.2	1667.4	**-95.8**
Max.Bed Temp.	℃	1410.7	1319.3	**-91.4**
C3S(3CaO·SiO2)	wt%	60.58	43.52	
C2S(2CaO·SiO2)	wt%	15.89	26.96	
C3A	wt%	9.48	8.27	
C4AF	wt%	8.52	7.31	
f-CaO	wt%	0.32	0.71	
Heat Comsumption	kcal/kg	913.5	843.7	**-69.8（Δ7.6%）**

Validation of energy saving

Summary

Application of FactSage/ChemApp/KilnSimu interface plays an important role in analysis of Cement clinker manufacturing process, especially in developing a study of “low-temperature burning system using mineralizer”.

- First, we examined the low temperature clinker burning test by mini-plant.
- Next, we tuned up the simulation parameters(kinetic constants) to match the results of experiment.
- Finally, we evaluated an effect of energy reduction and an influence on kinetic constants by using mineralizer in the actual plant model.

(In the future)

We’re planning to play the demonstration test of this system in the actual plant.

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Industrial Application in UBE-Group

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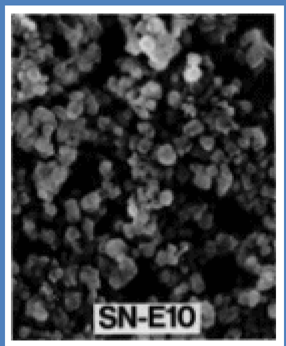
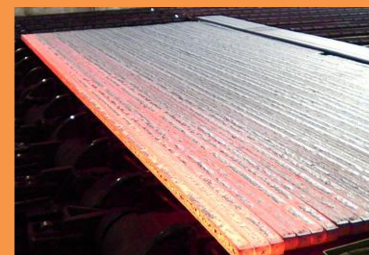


silicon nitride(Si_3N_4)

the study of introduction of kiln for burning process

UBE STEEL CO.,LTD.



steel(billets, casting)

the study of energy saving operation in electric furnace

宇部マテリアルズ株式会社
Ube Material Industries

magnesia(MgO)

analysis for kiln burning process (removing impurities)

FactSage™

KilnSimu

技術の翼
革新の心
Wings of technology
Spirit of innovation
UBE

Thank you !