Innovative Fundamental Technology Development for Cement making in Japan

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Process Technology Research Laboratory

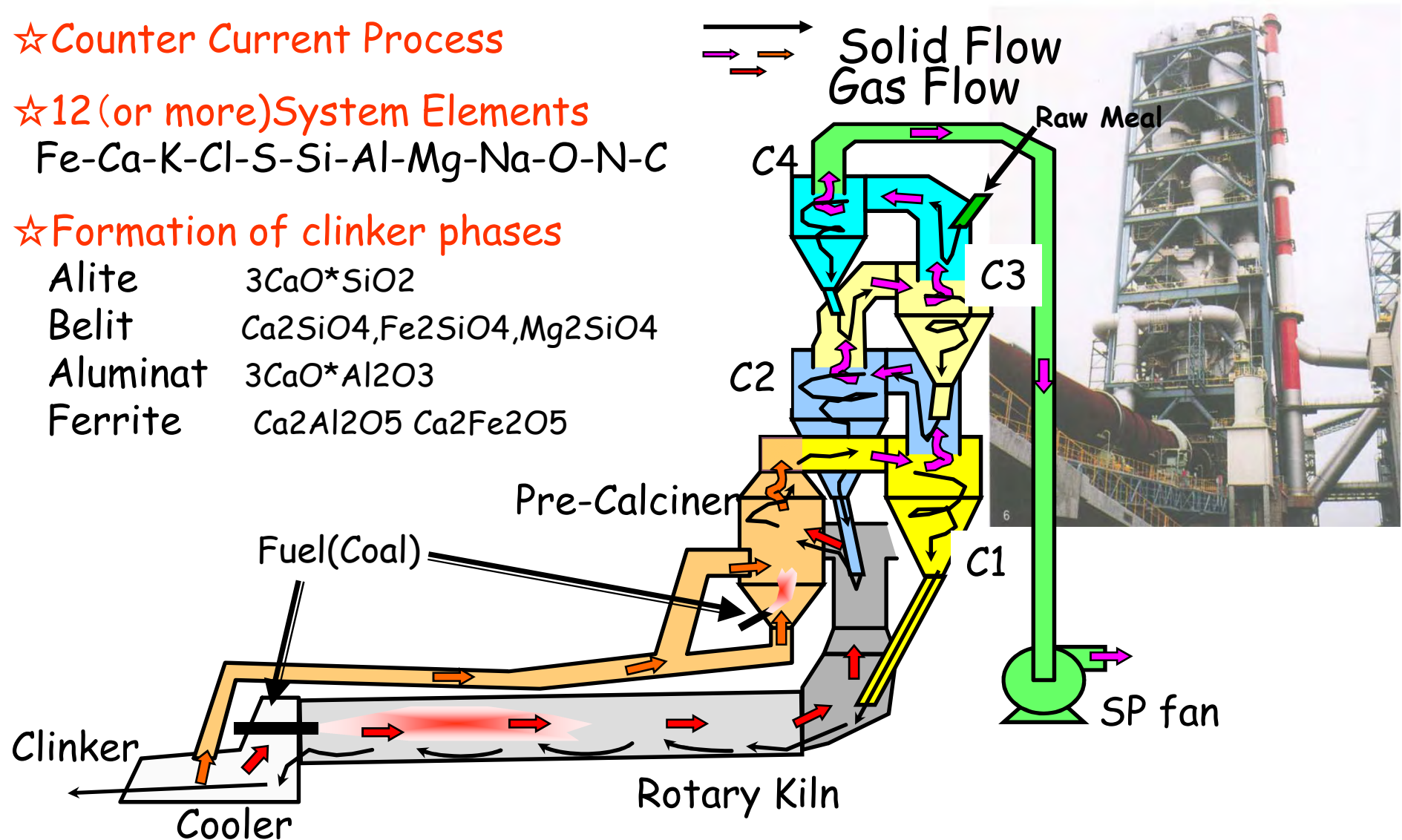**UBE** / **UBE INDUSTRIES.LTD.**

Clinker Burning Process

☆Counter Current Process

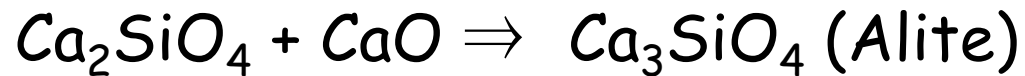☆12（or more)System Elements
 Fe-Ca-K-Cl-S-Si-Al-Mg-Na-O-N-C

☆Formation of clinker phases
 Alite $3CaO*SiO2$
 Belit $Ca2SiO4,Fe2SiO4,Mg2SiO4$
 Aluminat $3CaO*Al2O3$
 Ferrite $Ca2Al2O5$ $Ca2Fe2O5$

Solid Flow
Gas Flow

Raw Meal

C4

C3

C2

C1

Pre-Calciner

Fuel(Coal)

Clinker

Cooler

Rotary Kiln

SP fan

Reaction in Cement Process

Main Reaction

$CaCO_3 \Rightarrow CaO + CO_2$

$2CaO + SiO_2 \Rightarrow Ca_2SiO_4$ (Belite)

$Ca_2SiO_4 + CaO \Rightarrow Ca_3SiO_4$ (Alite)

☆Formation of Slag Liquid

　　　Liquid Mixture of Oxide

☆Formation of Solid Solution

Alite	$3CaO*SiO_2$
Belit	$Ca_2SiO4, Fe_2SiO_4, Mg_2SiO_4$
Aluminat	$3CaO*Al_2O_3$
Ferrite	$Ca_2Al_2O_5$ $Ca_2Fe_2O_5$

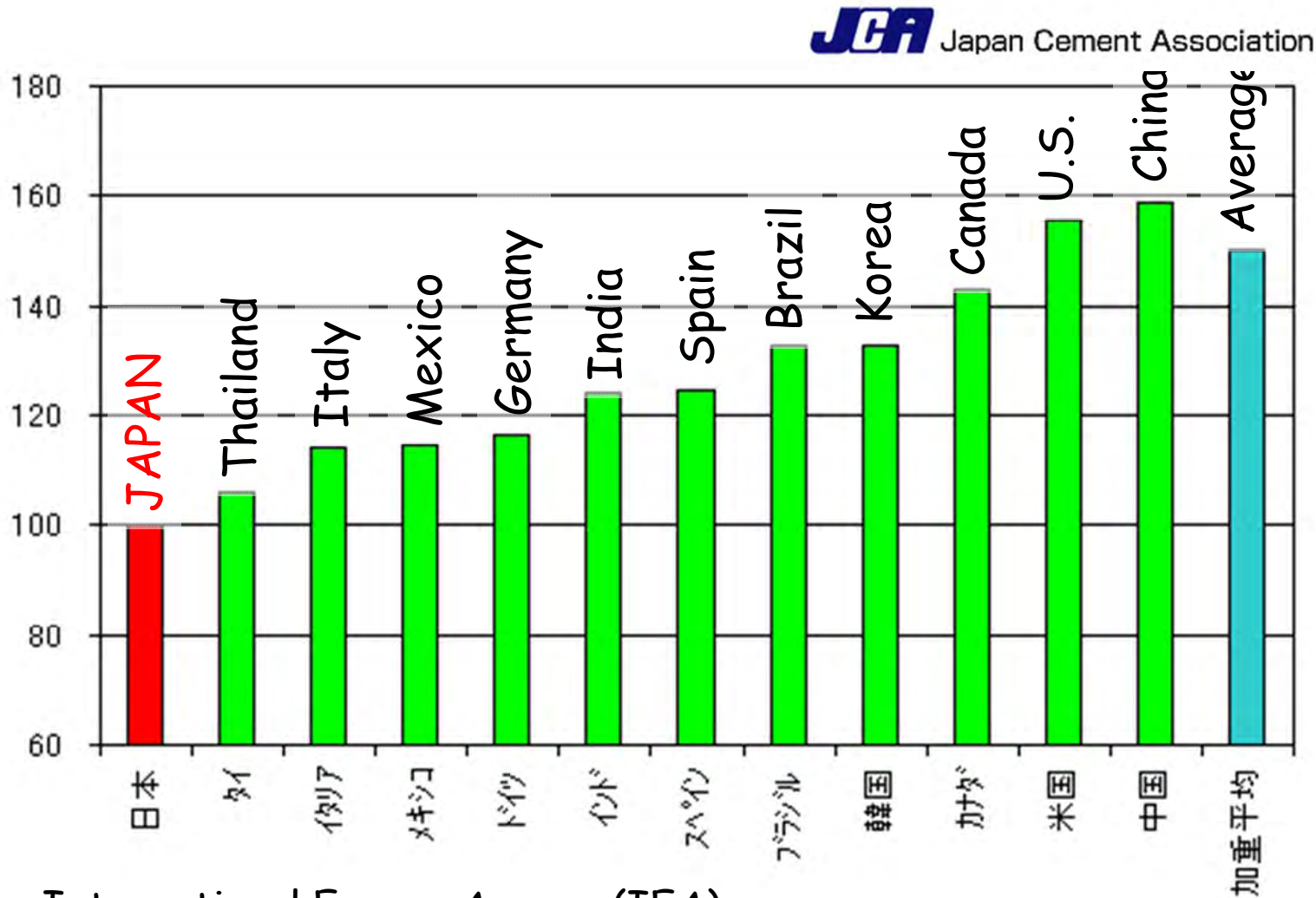☆Vaporization and Condensation, Dicomposition

　　　Chloride, Sulfate

Important Subjects for Cement Industries

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- **Reduce Energy consumption(Reduce Carbon Dioxide Emission)**

- Increase Waste Usage in Cement making

- Reduce Electric Power consumption in Cement making
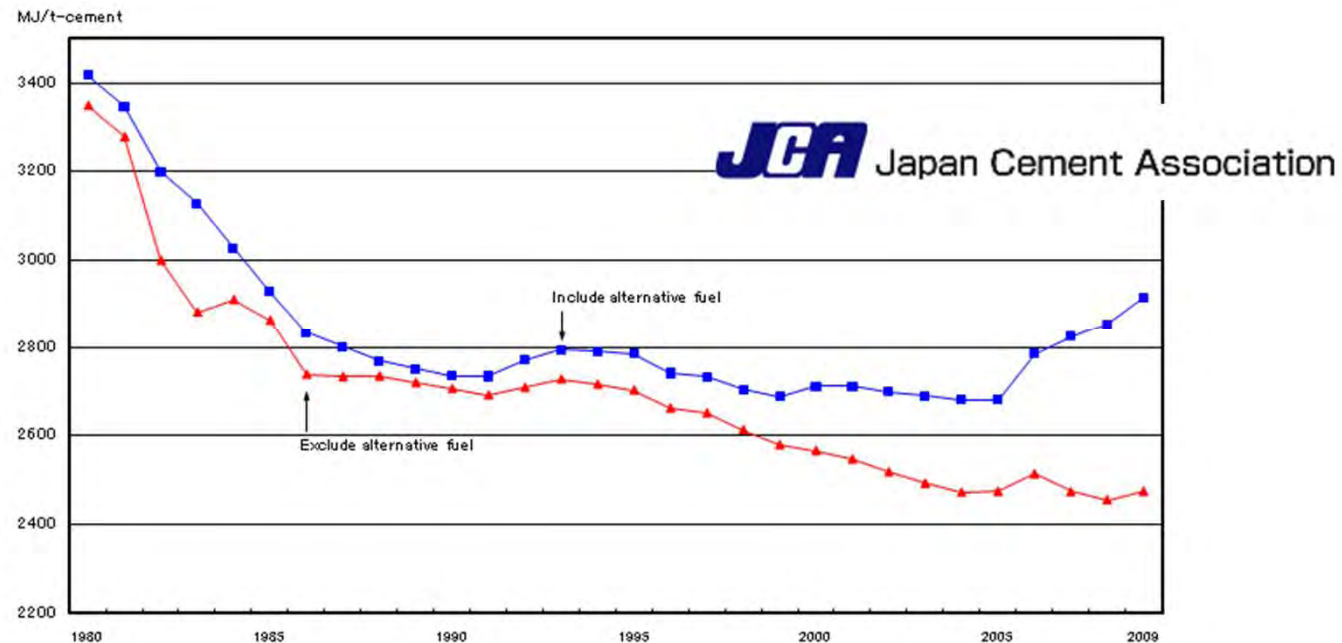
Relative Energy Consumption for Cement Making

The International Energy Agency (IEA)
「Worldwide Trends in Energy Use and Efficiency 2008」

![UBE]

Innovative Fundamental Technology Development for Cement making 2010～2014

METI : Ministry of Economy, Trade and Industry

R&D Formation for Project

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経済産業省
Ministry of Economy, Trade and Industry

Financial support

mineralizer

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
Clinka Composition for Energy Saving

MITSUBISHI MATERIALS

Temperature Measurements Technology in Kiln

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Research Items in this Project

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RAW Meal → Mill →

(1)Fundamental Technology Development

TAIHEIYO CEMENT CORPORATION

Mineralizer
Clinka Composition

SUMITOMO OSAKA CEMENT CO., LTD.

Reduced Energy Cement Production

Lower the Peak Temperature in Kiln

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Kiln

Burner

Cement Process Simulation Technology

SUMITOMO OSAKA CEMENT CO., LTD.

MITSUBISHI
MITSUBISHI MATERIALS

Estimation of Process condition

Cooler

Spectrum Measurement
Radiation Temperature Measurement

High precision Temparature
Masurmennt Inside of Kiln, Cooler

Tempareture Measurment technology

(2)Proposal for New Process and Products ⟹ **8% Energy Saving**

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KilnSimu

SIMULATION OF MULTI-PHASE PROCESSES IN COUNTERCURRENT ROTARY KILNS

THE KILNSIMU/RATEMIX MODEL OF THE KILN

Radial heat transfer:

Q_{gb} Convection & radiation from gas to bed

Q_{gi} Convection & radiation from gas to inner wall

Q_{ib} Conduction & radiation from inner wall to bed

Q_{io} Conduction from inner wall to outer wall

Q_{os} Convection and radiation from outer wall to surroundings

Gibbs Energy Minimizer

Thermodynamic Data

Mass transfer btw. volume elements:

Chemical reactions:

min(**G**) combined with kinetics of slow reactions (example: rutile formation)

$TiO_2(A)$ --> $TiO_2(R)$

$\xi_R = 1 - \exp(-k\, t^{\,n})$ (Suzuki 1969, Hishita &al. 1983)

KilnSimu Extend version
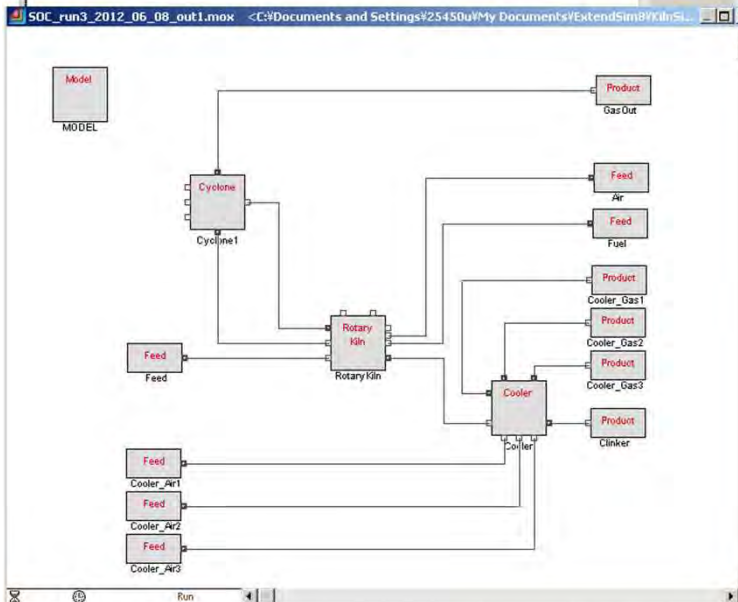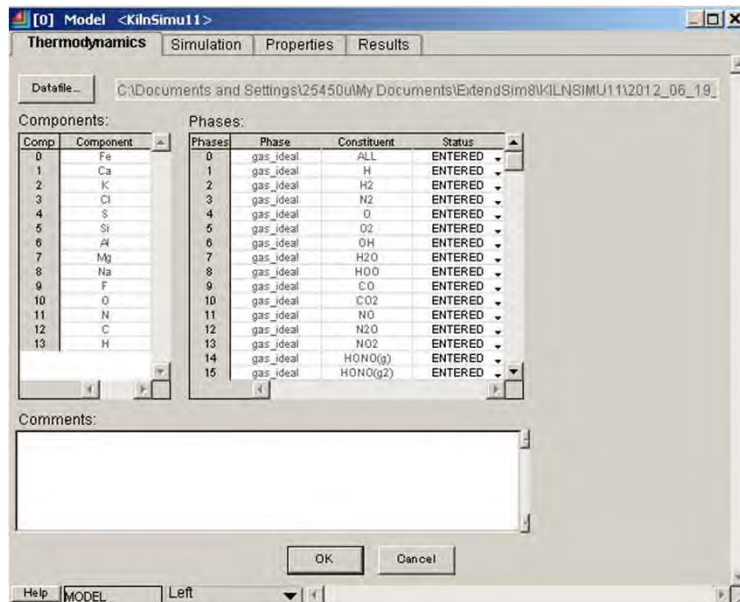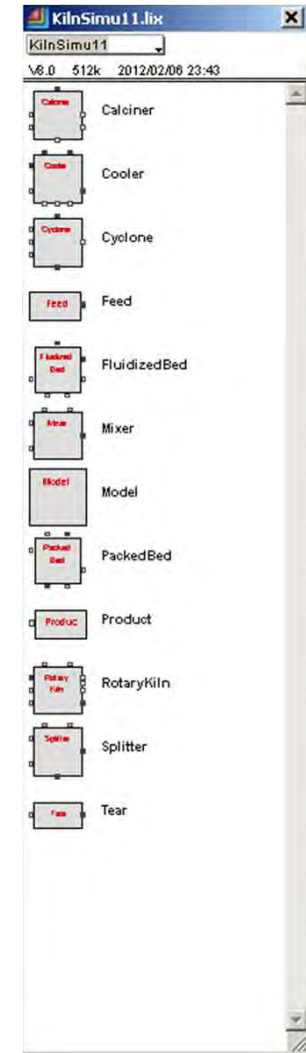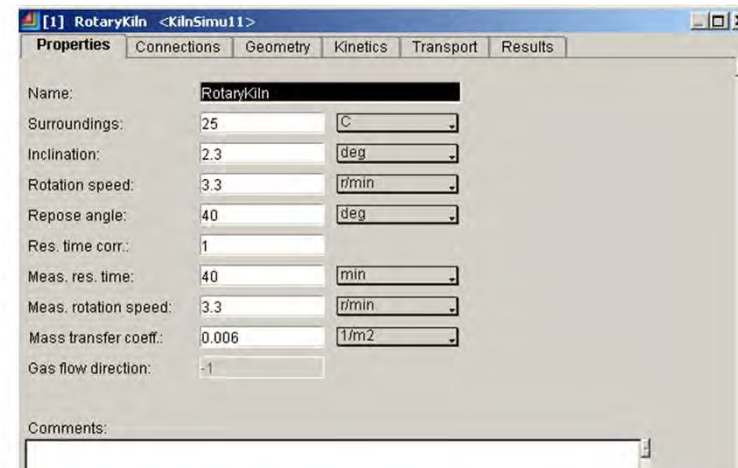
UBE NSP Process Full Model by Extend KilnSimu

5Stage
Pre-Heater

Calciner

Rotary Kiln

Cooler
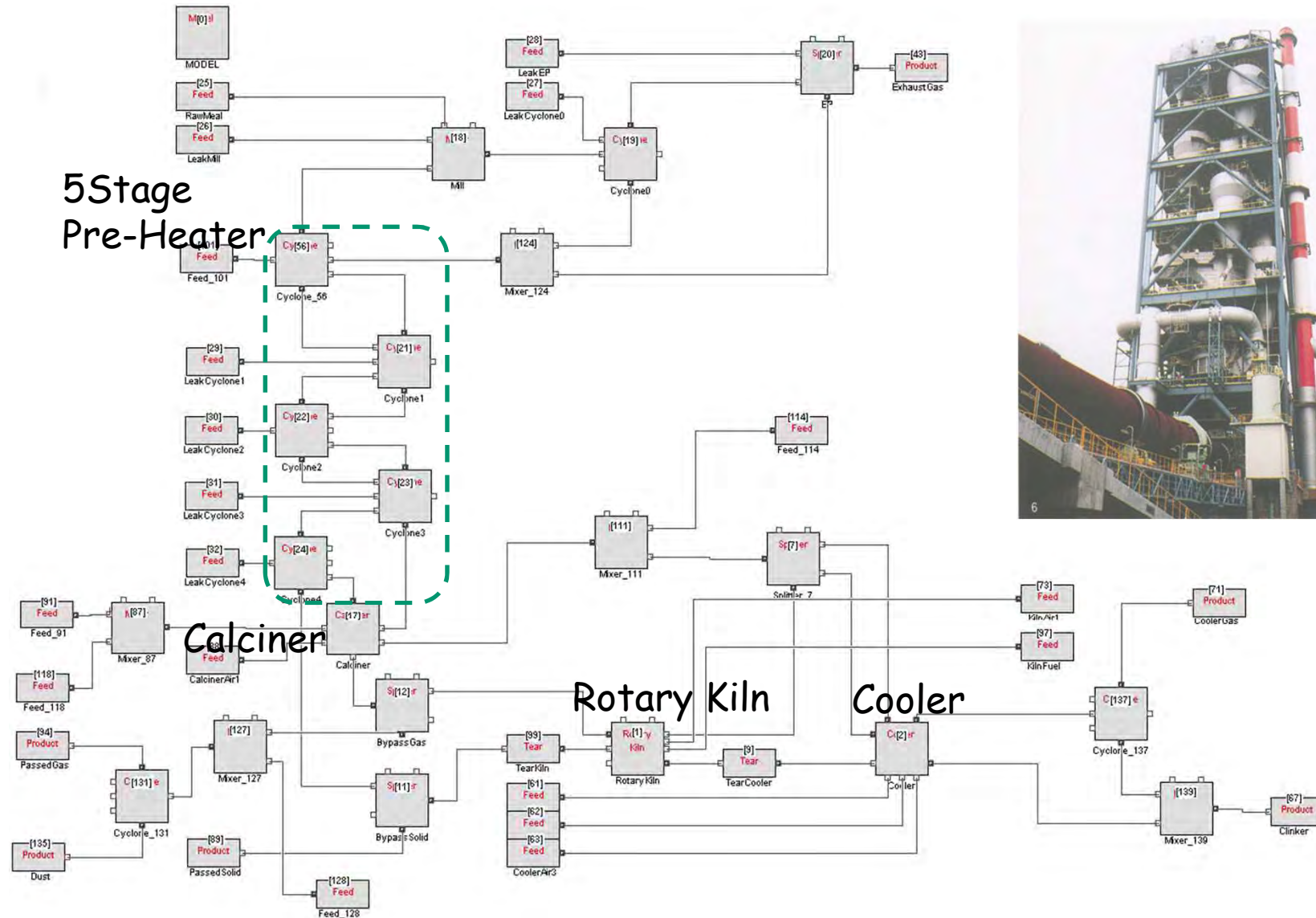
Temperature Profile
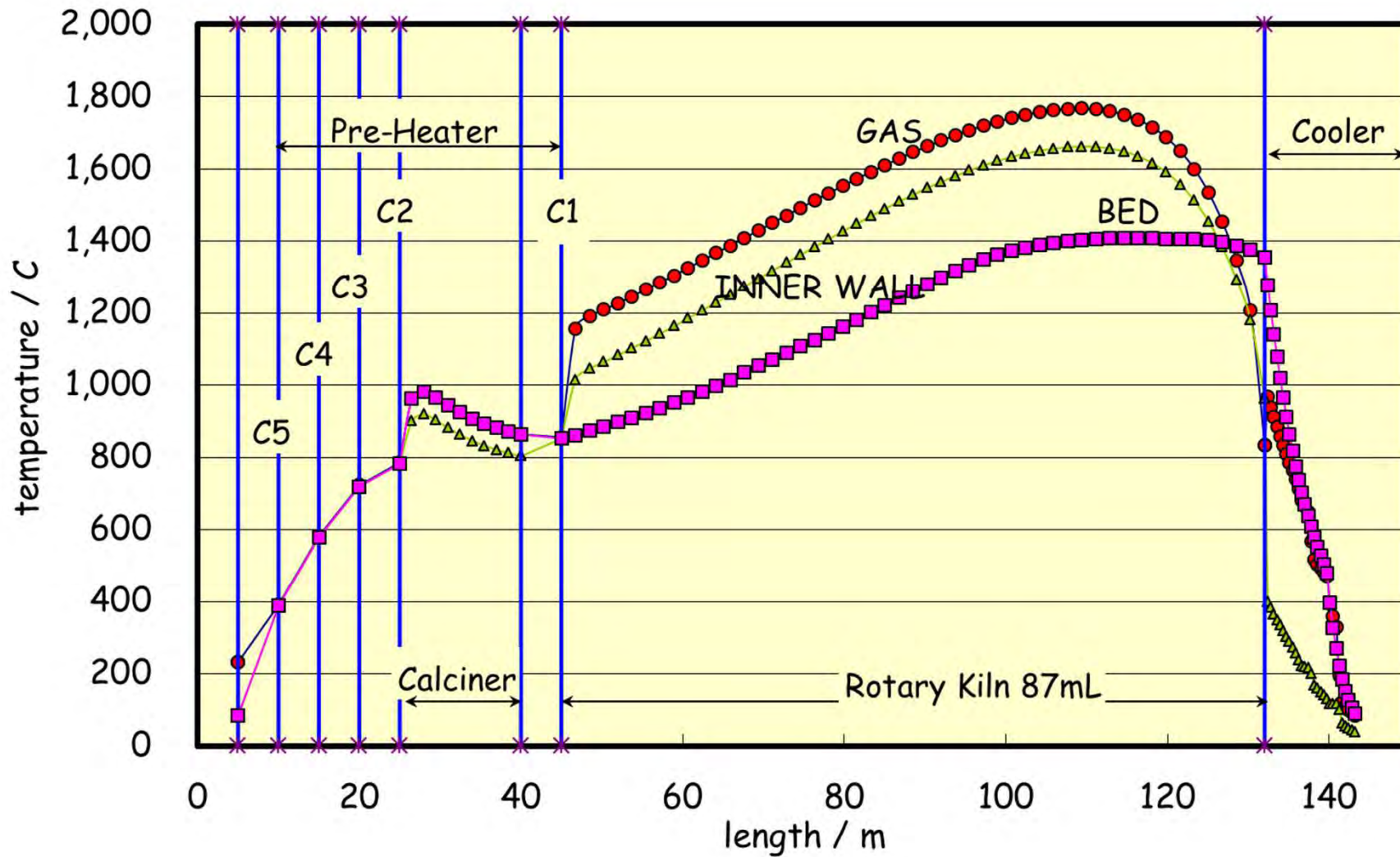
Compounds Profile
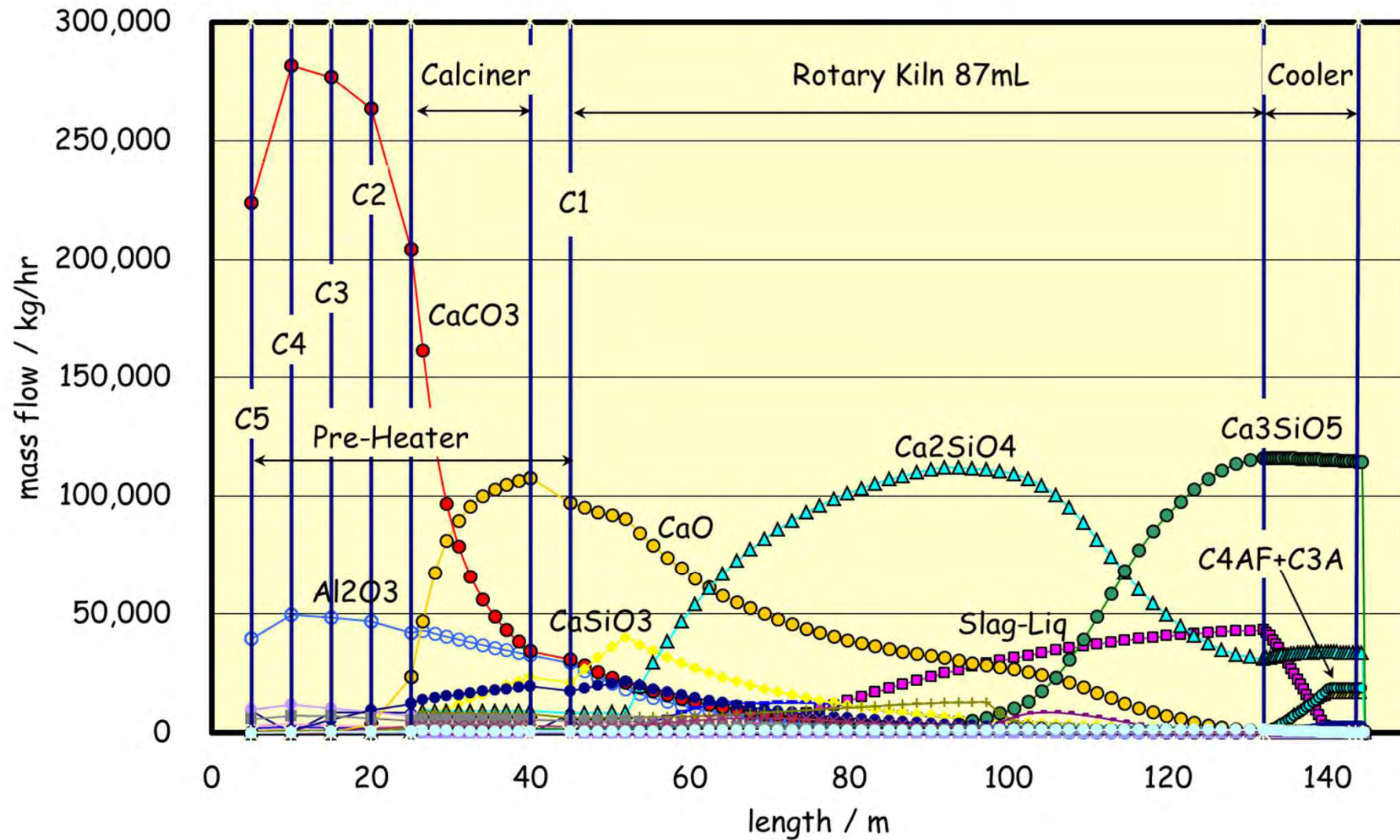
Parameter Studies by KilnSimu Model

- Rotary Drum Speed(residence time of Bed)
- Calciner/Rotary Kiln Fuel Ratio
- Fuel Combustion Rate
- Fuel Sulfur Contents

    (Calciner Fuel, Rotary Kiln Fuel)
- Rotary Kiln Design (L/D length/Diameter)
- Effect of Leakage Air
- Effect of Water containing Waste

Reduced Energy Cement
- ✓ Effect of Mineralizer
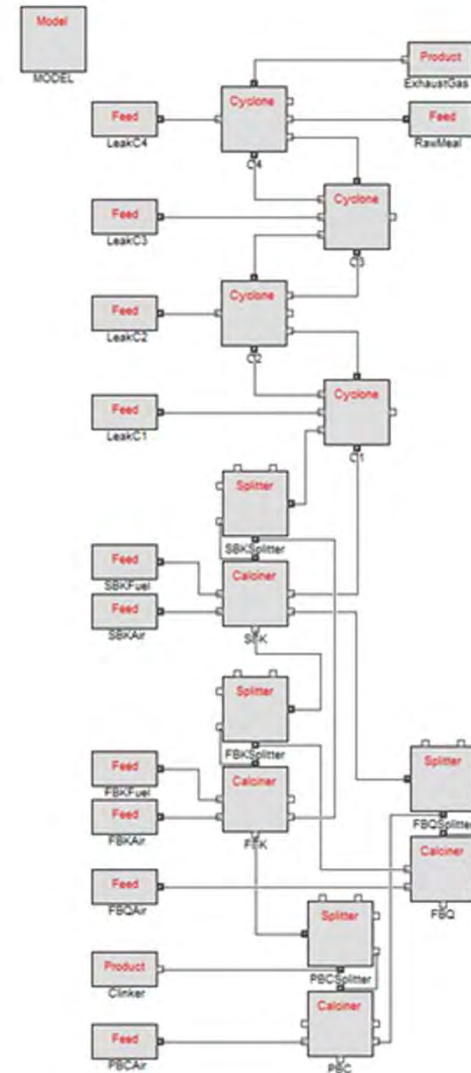- ✓ Effect of Clinka Composition
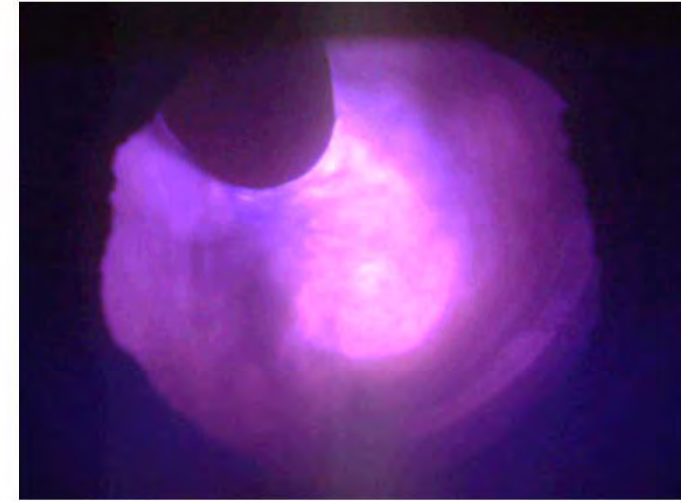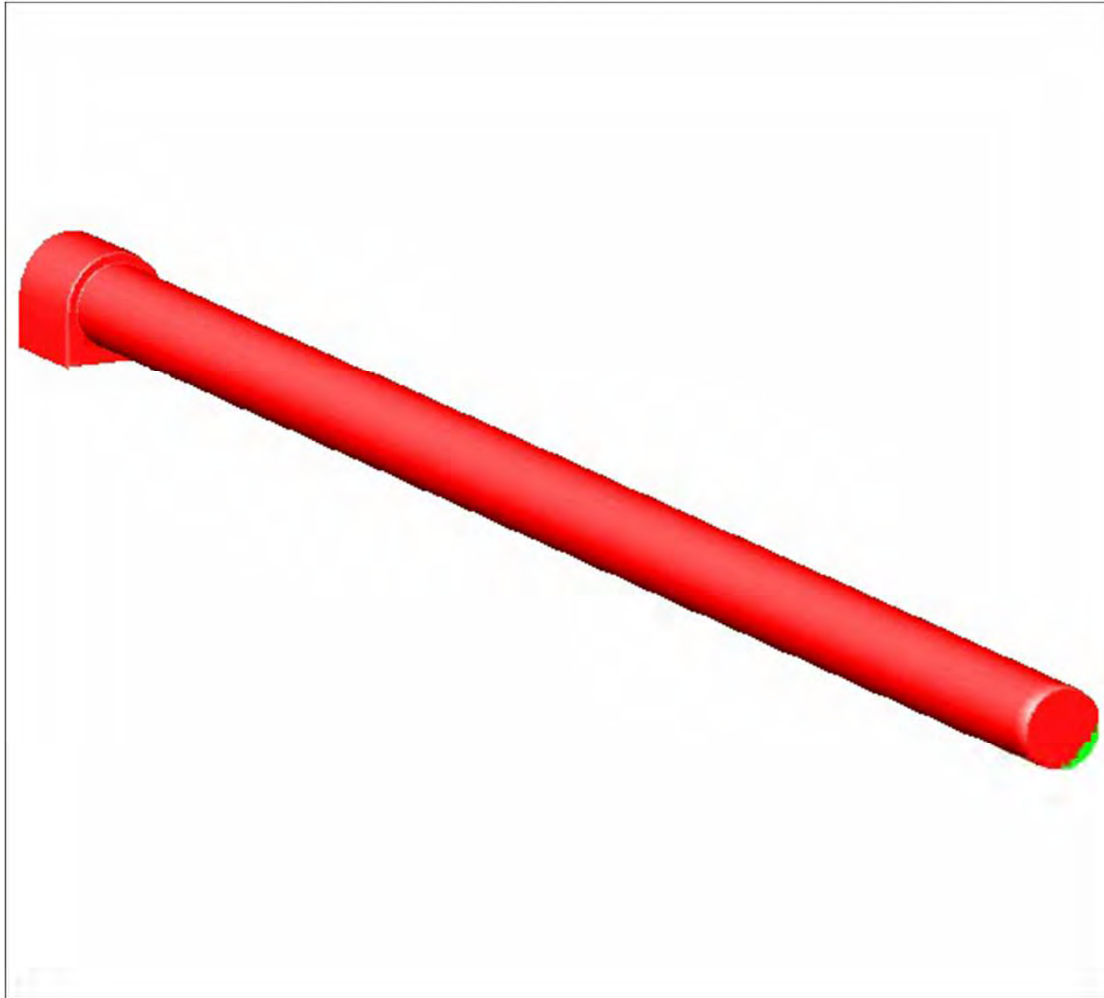
Fluidized Bed Process and its Modeling
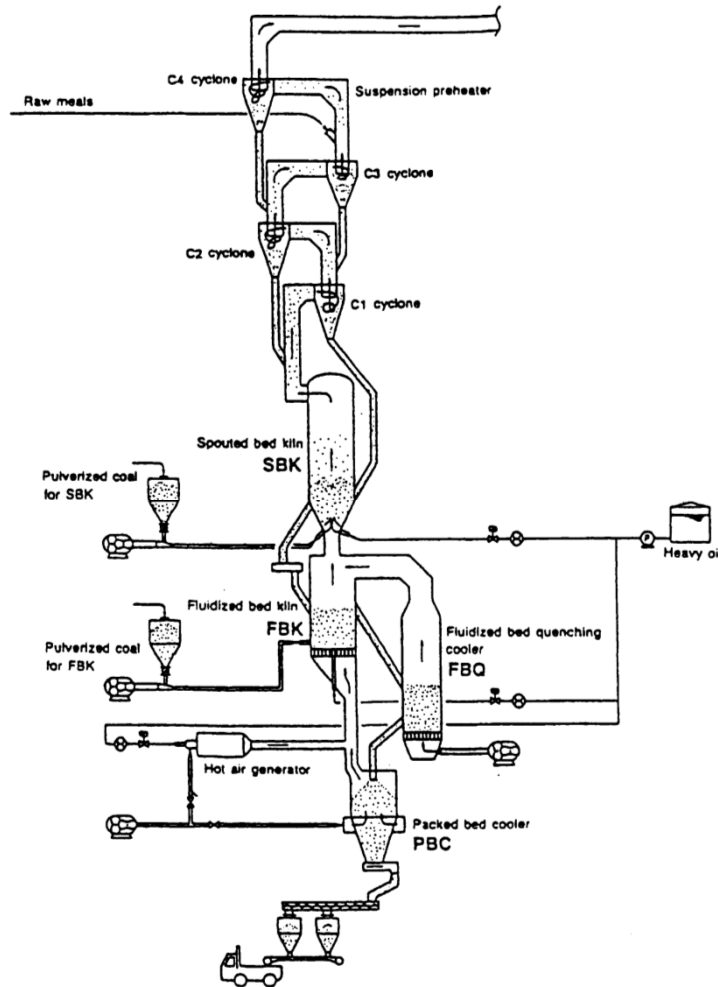
Fig. 1 Fluidized bed cement kiln system

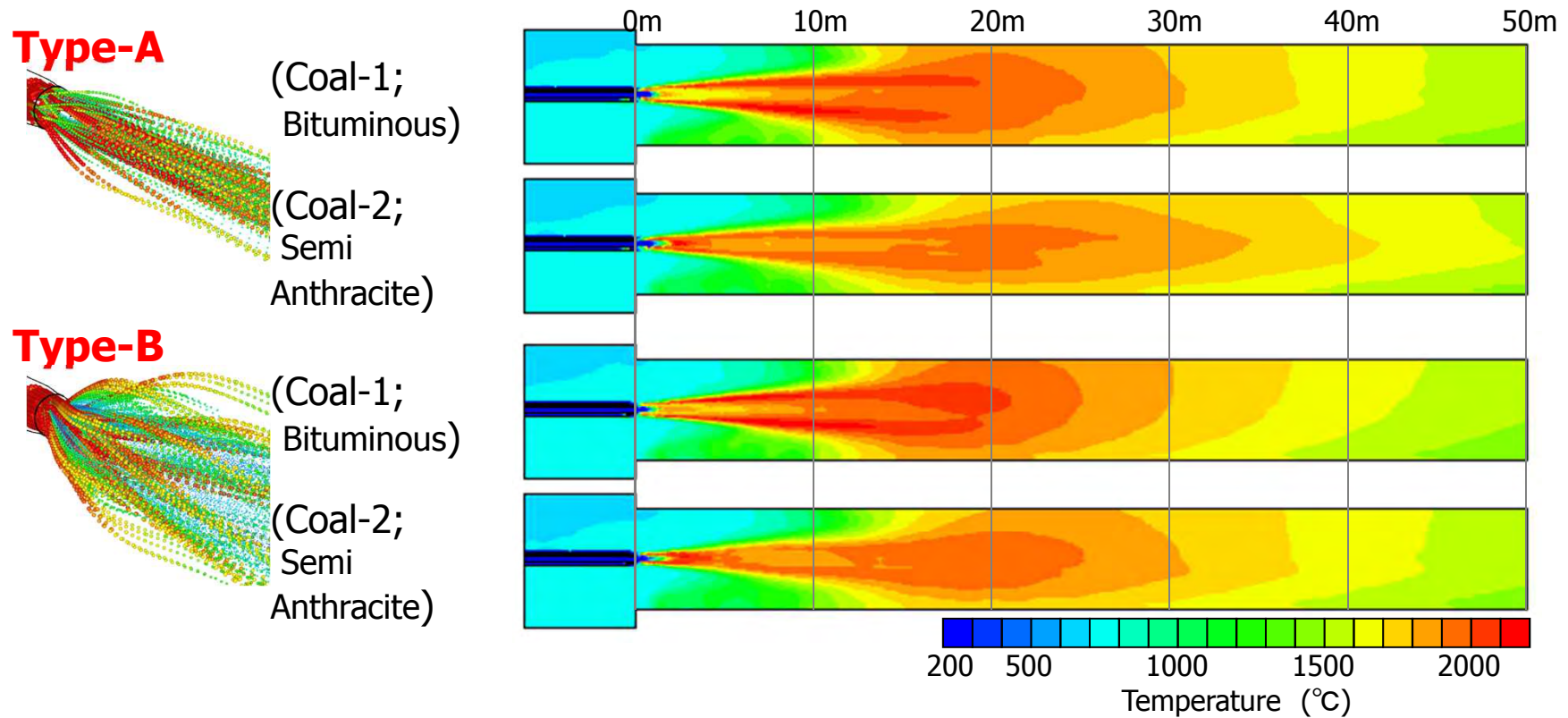# Cement Kiln Coal Burner
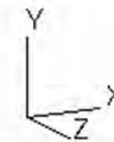
Effect of Coal Burner Design and Coal Species

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Type-A

(Coal-1; Bituminous)

(Coal-2; Semi Anthracite)

Type-B

(Coal-1; Bituminous)

(Coal-2; Semi Anthracite)

0m   10m   20m   30m   40m   50m

200 500 1000 1500 2000

Temperature (°C)

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Fluent KilnSimu Link

KilnSimu-FKS is an advanced simulation software package, which facilitates an accurate and in-depth understanding as well as optimization of the operation of rotary kilns. The package seamlessly combines KilnSimu - a multiphase equilibrium chemistry solver based on ChemApp - with the high-end CFD simulation environment provided by ANSYS Fluent.

http://www.kilnsimu-fks.com/

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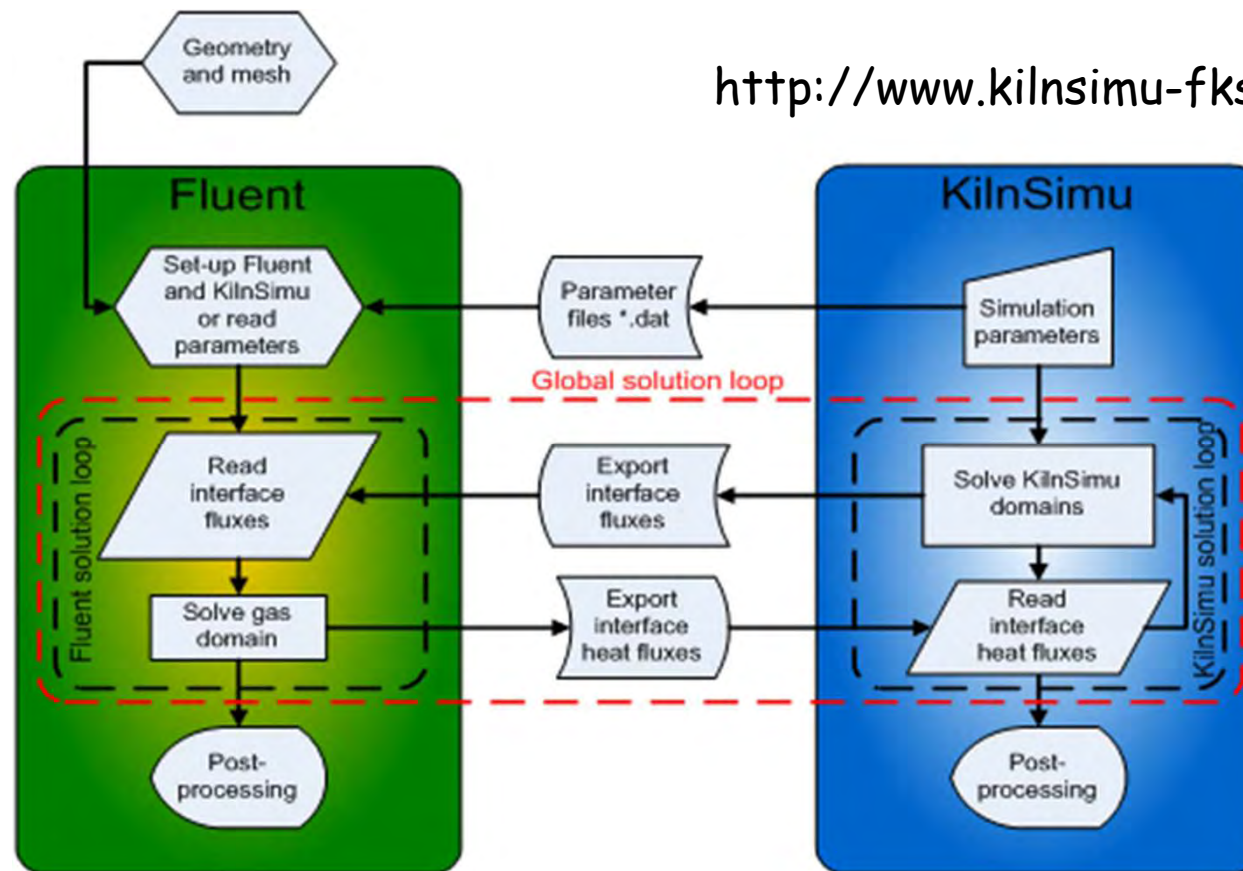
Thank You for your Attention