Fly ash treatment in Japan and the new oxygen-enriched WTE in Sendai

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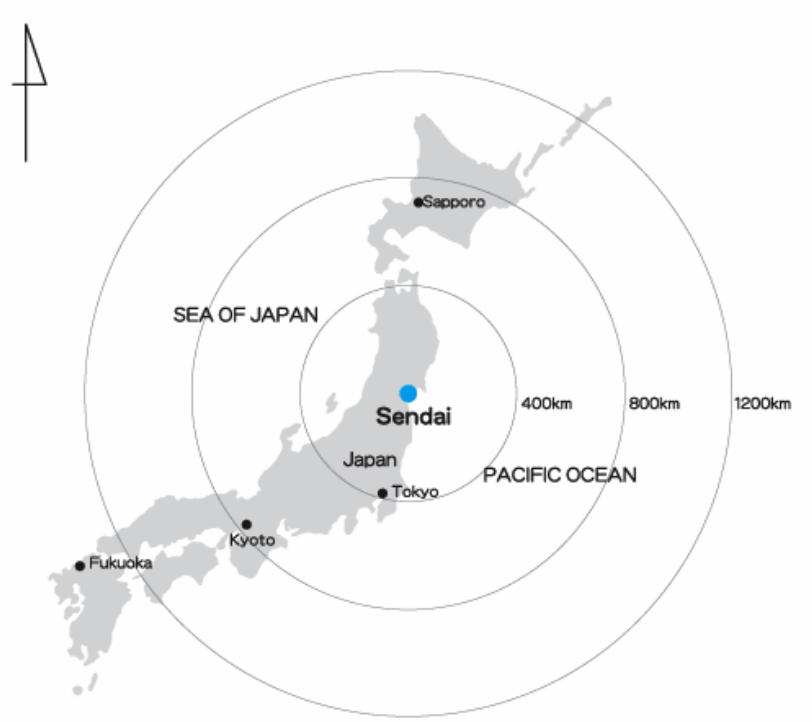
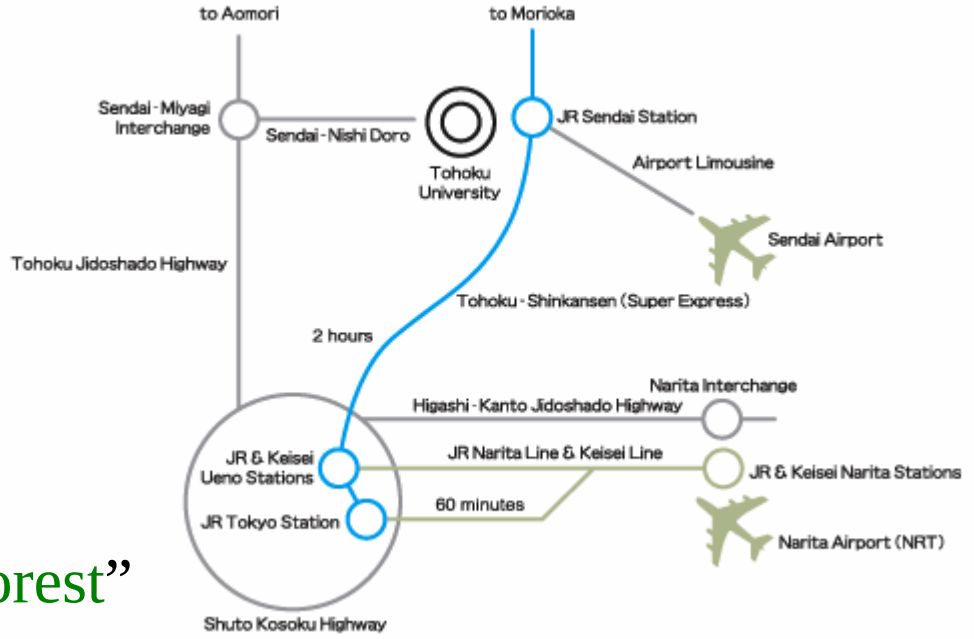
Location of Sendai City and Tohoku University



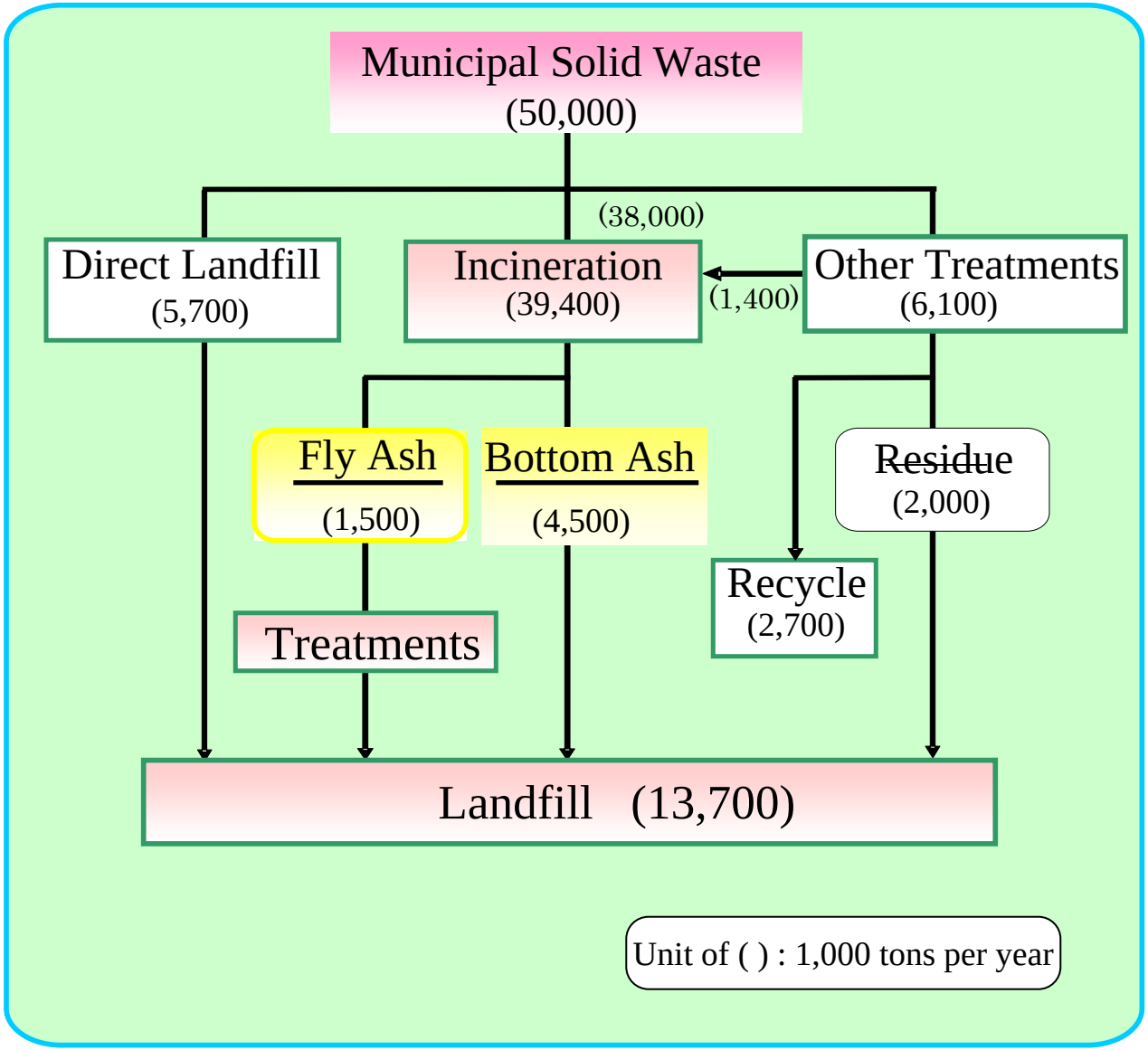


Sendai City is called “ Capital of Forest”

OUT LINE

- **Introduction**
- **The new oxygen-enriched WTE in Sendai**
- **Fly Ash Treatment in JAPAN**
- **New Technology for Fly Ash Treatment**
- **Conclusions**

The Flowchart of Municipal Solid Waste Treatment

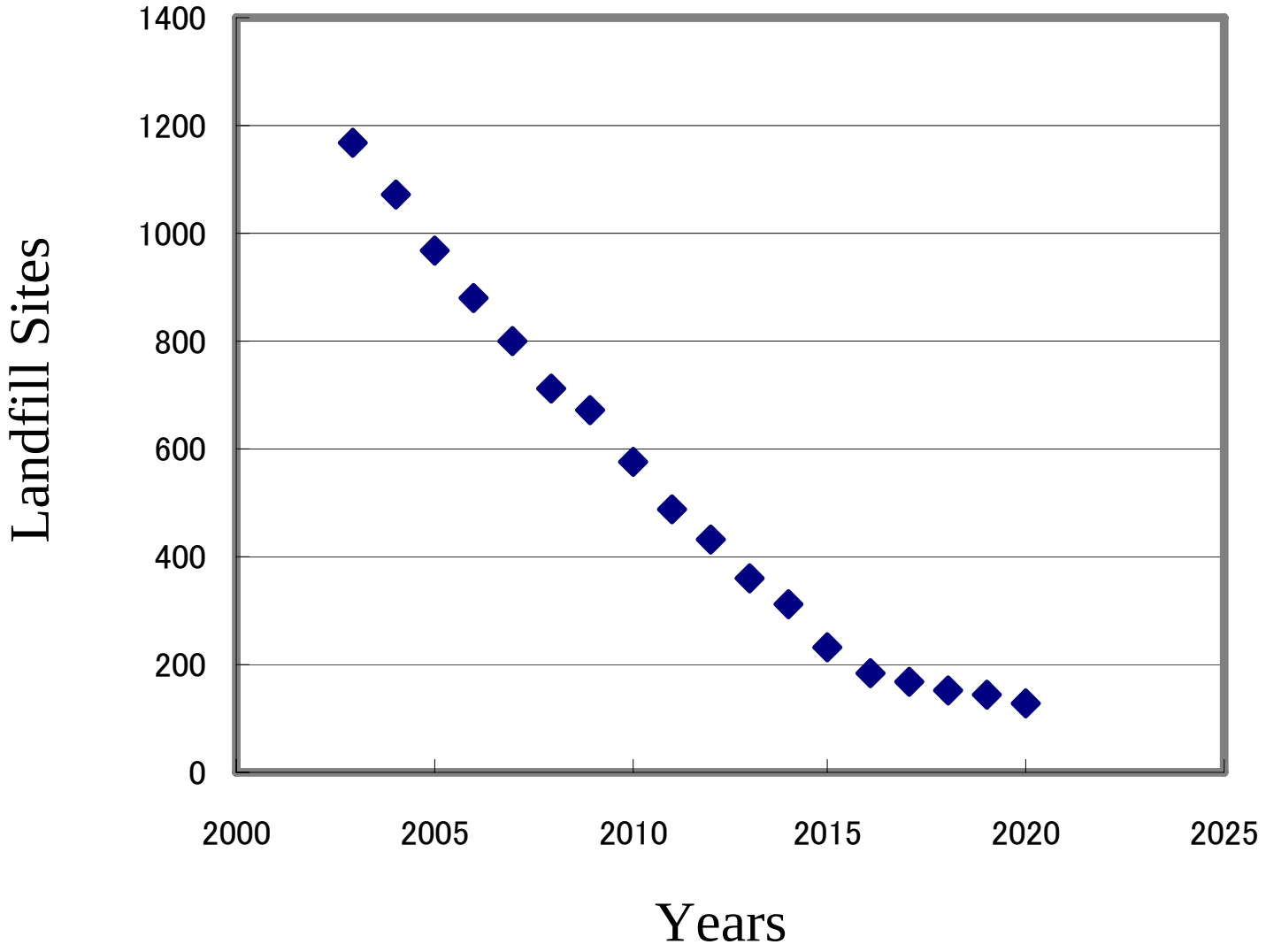


Requirements priority of the Japanese government are

①Making fly ash harmless

②Reducing the quantity of landfill

Decrease Trend of Landfill Sites



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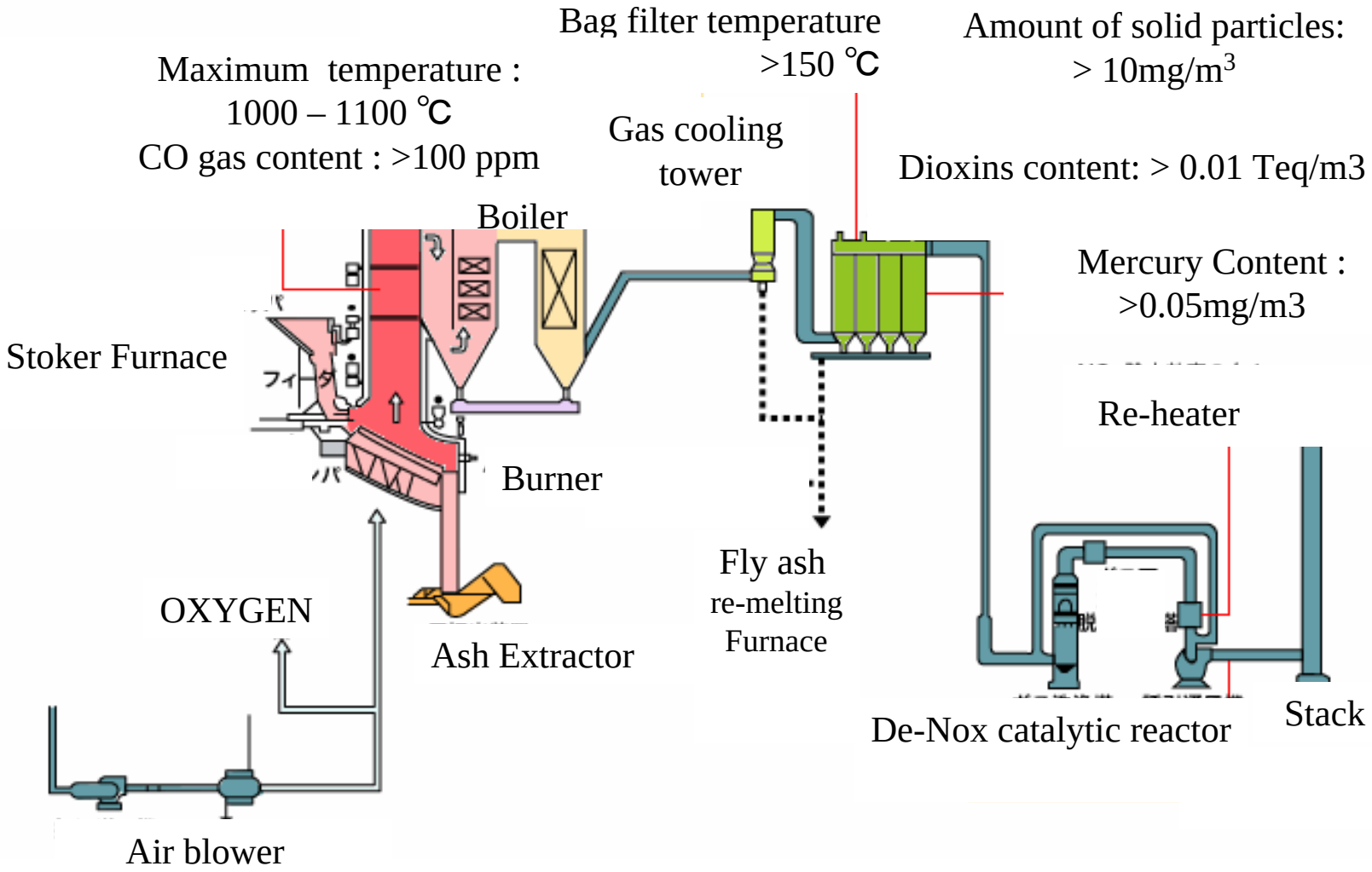
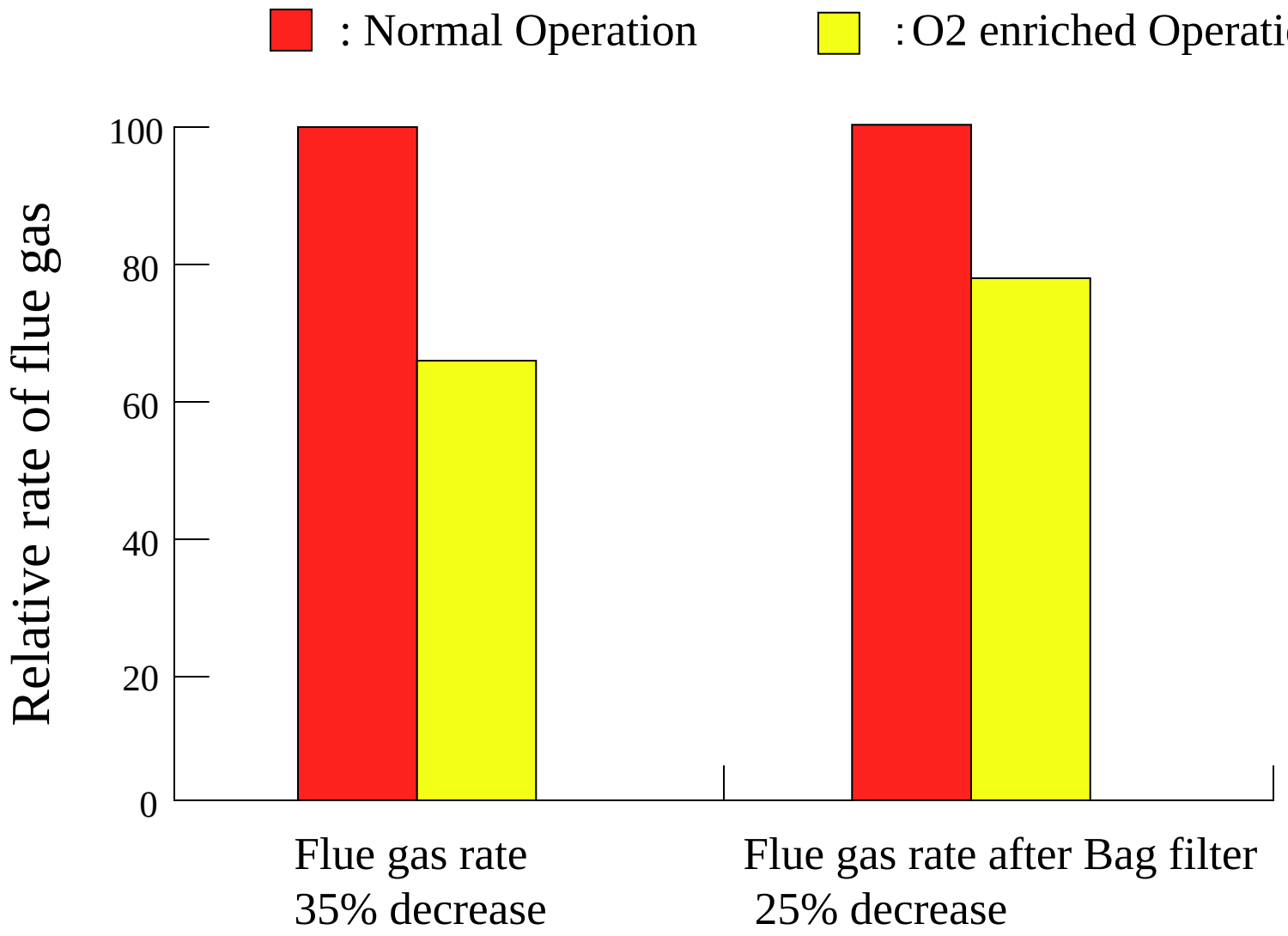
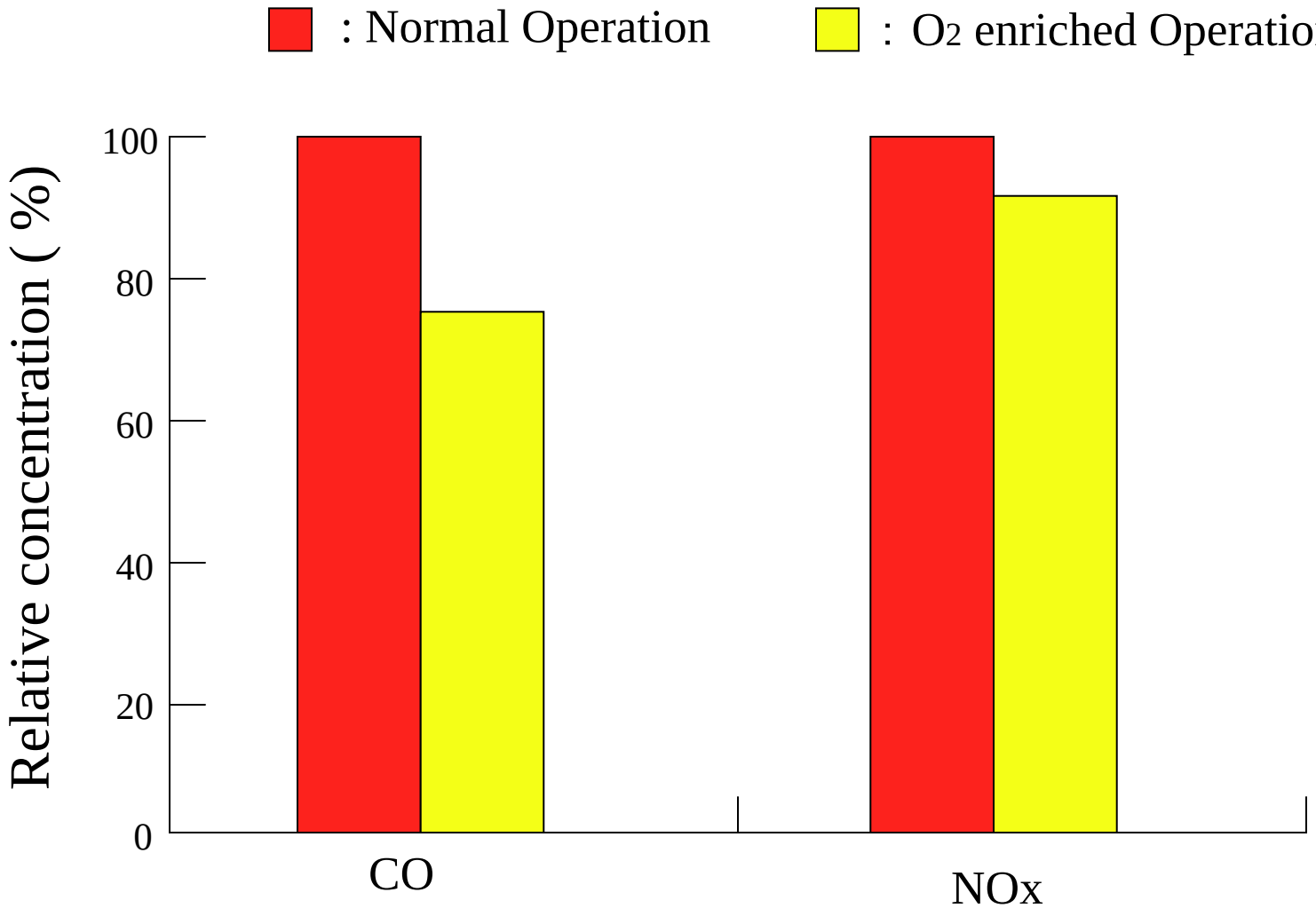
Outline of the Refuse Incineration Plant in Matsumori

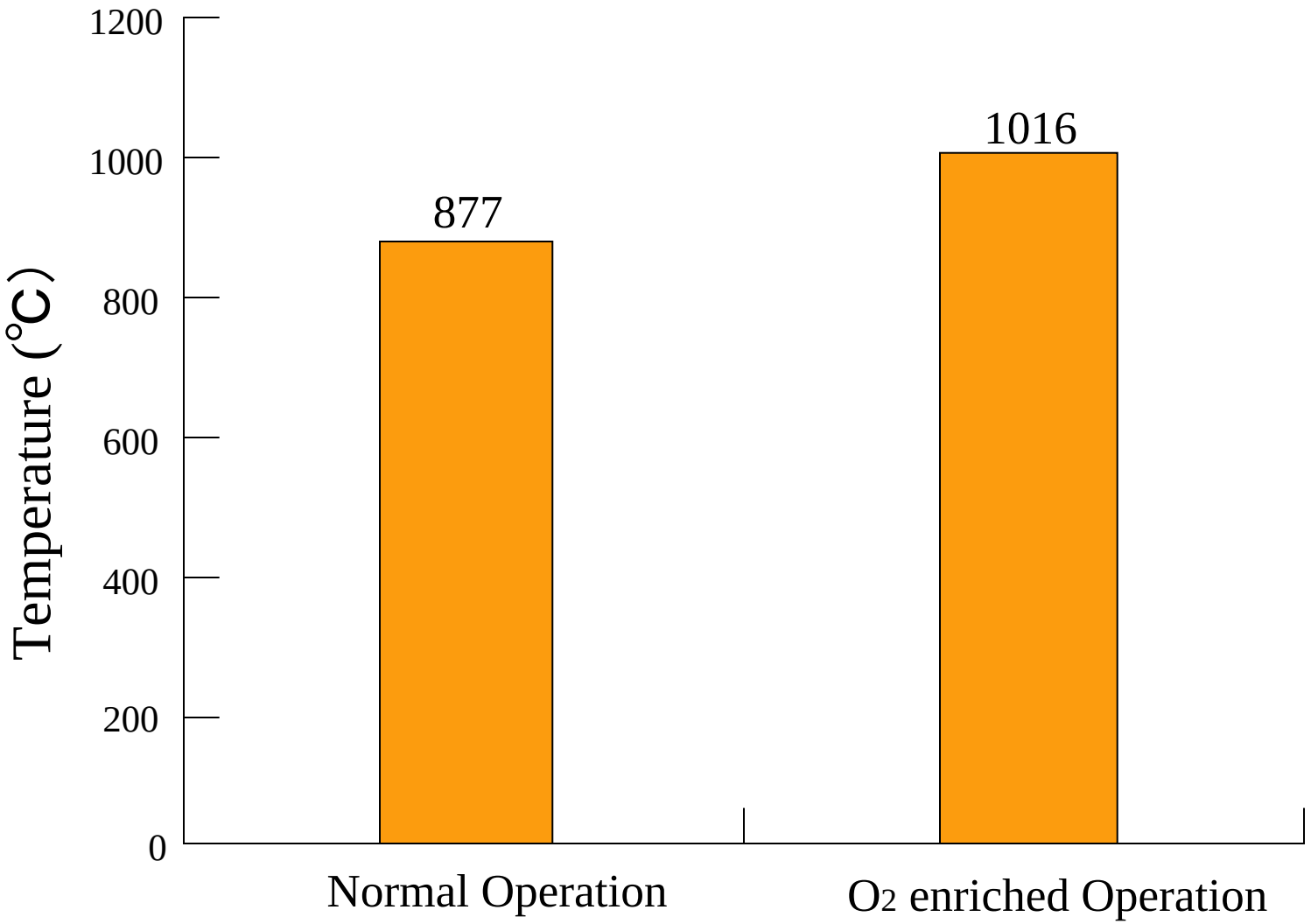




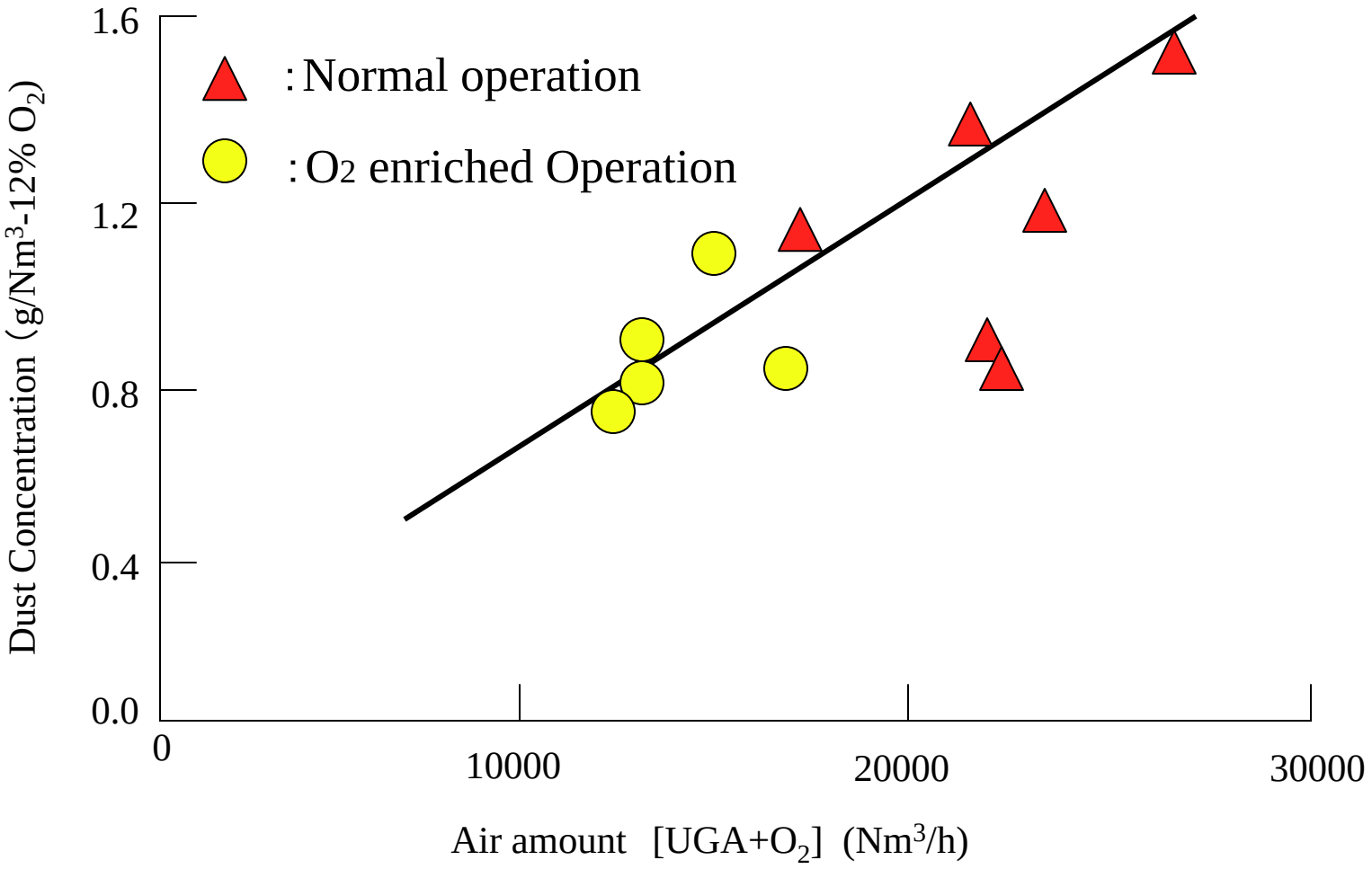
Relative comparison of flue gas flow rate



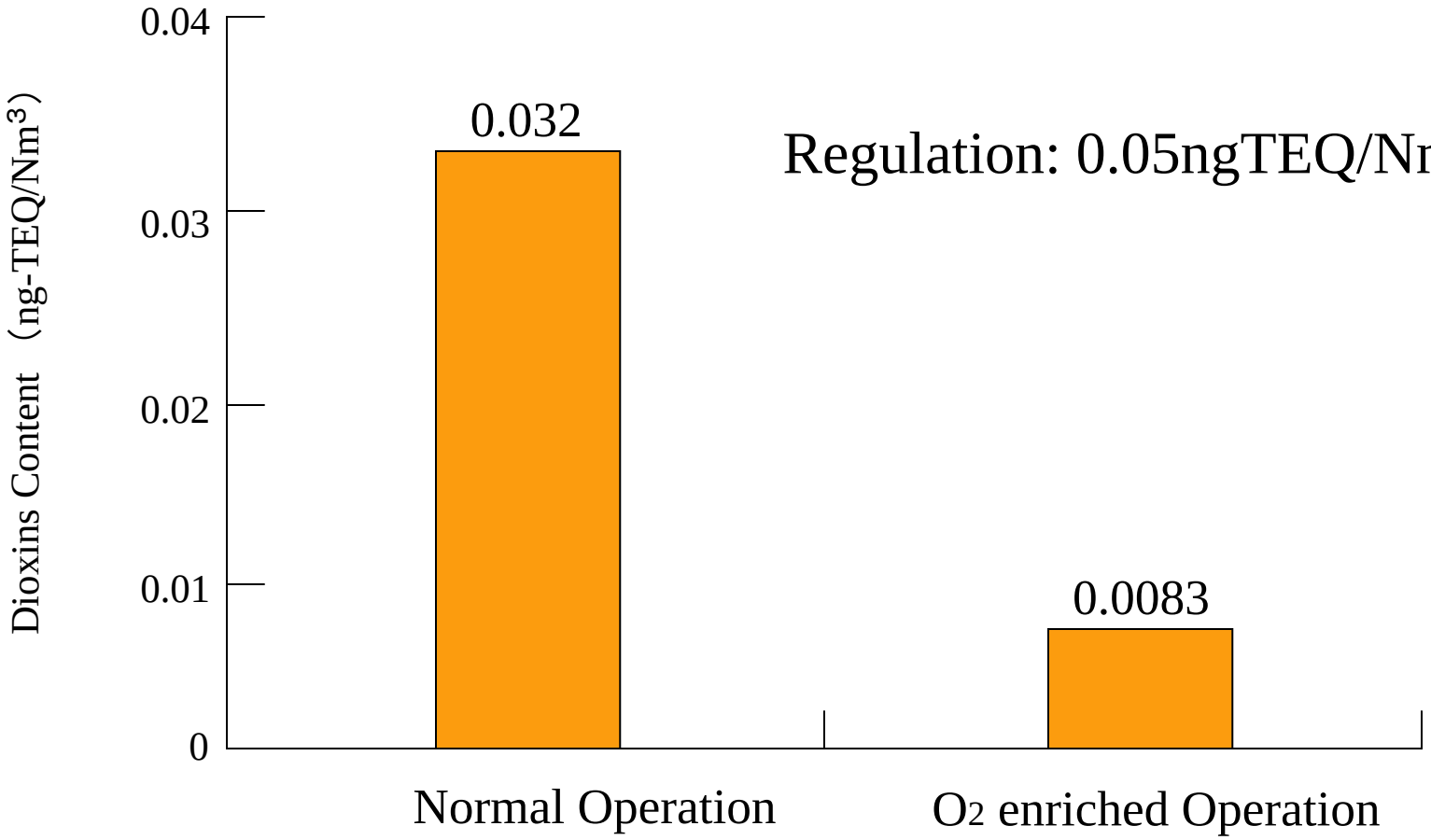
More than 20% reduction of CO while 10% reduction of NOx



Furnace temperature increases about 150℃ for oxygen enriched operation



Amount of Fly ash needing special treatment before being disposed of reduces as primary air flow rate decreases through oxygen enrichment



Dioxins concentration reduces to ¼ for oxygen enriched operation

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The Treatments of Fly Ash by Notification

（Detoxification Treatment）

Notified in April, 1995

- **Melting and Solidification**
- **Solidification with Cement**
- **Stabilization by Chemical Agents**
- **Stabilization by Acid or Solvents**

- **The long-term stability is questionable.**
- **Not recyclable**

Notified in January, 2000

Our Technology

- **Volatilization and Detoxification by Roasting**

Treatment Process for Fly Ash notified in Japan

Process	CONTENT
(a) Melting	Fly ash is melted by a melting facility and solidify to slag. Slag and secondary dust have to be treated by following processes (c),(d) and (e)
(b) Sintering	Fly ash is sintered by a sintering facility to obtain the stable sintered block. Sintered block and secondary dust have to be treated by following processes (c),(d) and (e)
(c) Fixation by Cement	Fly ash is solidified with a sufficient amount of cement and aged not to elute heavy metals
(d) Treatment by Chelate Agent	Fly ash is mixed with chelate agents to stabilize heavy metals and keep them to well controlled landfill place.
(e) Leaching by Acid	Fly ash is leached by acids or other solvent to remove heavy metals from it and heavy metals have to be recovered from the leach ant and deposit of heave metals have to treated in smelter.

Recent Targets of Fly Ash Treatment Technology

Detoxification

- Thorough removal of Heavy Metals
- Reliable stabilization of Residual Metals
- Decomposition of PCDDs

Recycling

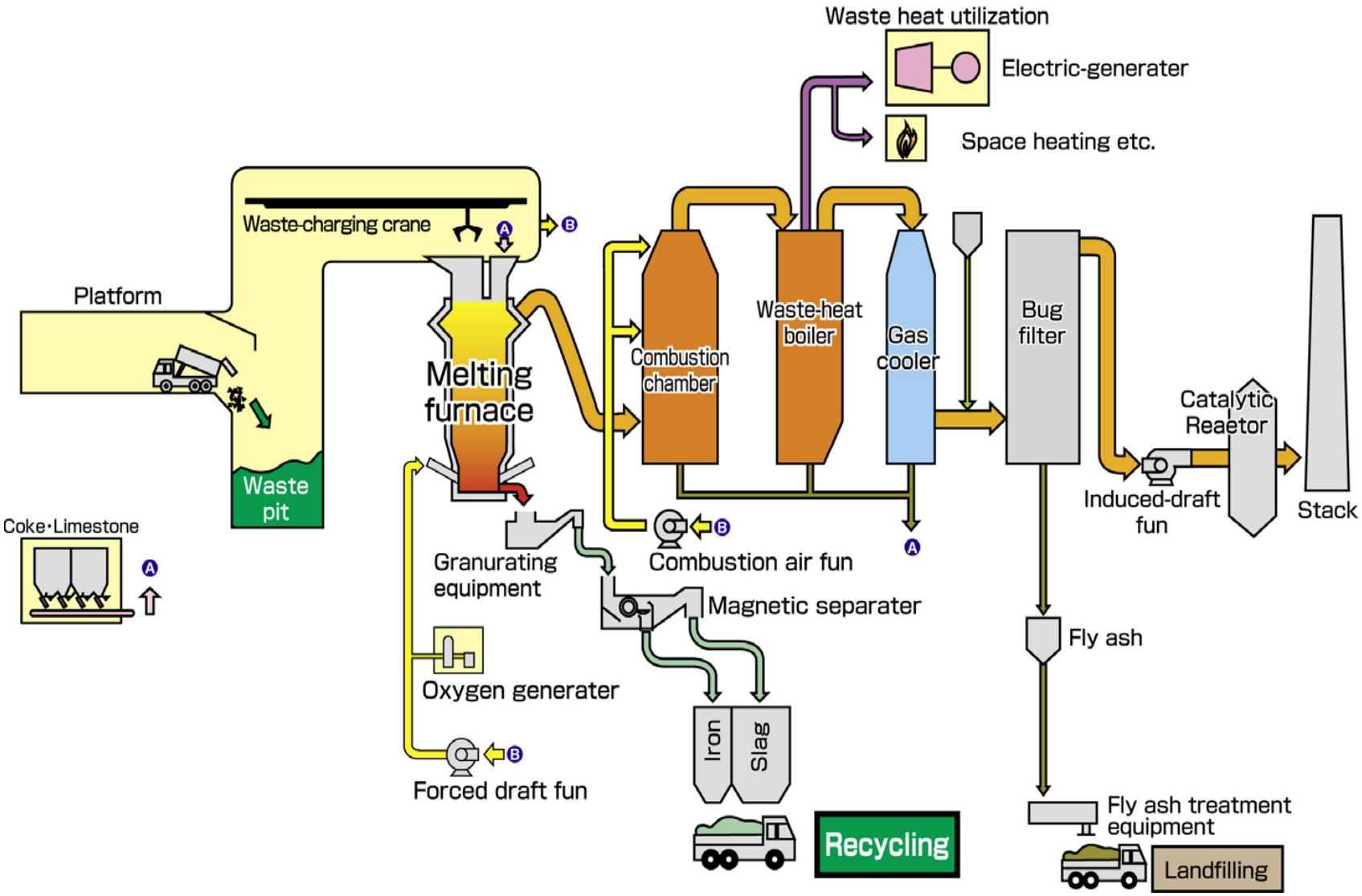
- Utilization of gangue components
- Recovering Zn as Smelting Resources

Environmental Quality Standards for Soil Pollution

Substance	Target level of soil quality examined through leaching test
cadmium	0.01 mg/l or less in sample solution
lead	0.01 mg/l or less in sample solution
chromium (VI)	0.05 mg/l or less in sample solution
arsenic	0.01 mg/l or less in sample solution
selenium	0.01 mg/l or less in sample solution

(partly extracted)

Basic Flow Chart of Direct Melting System



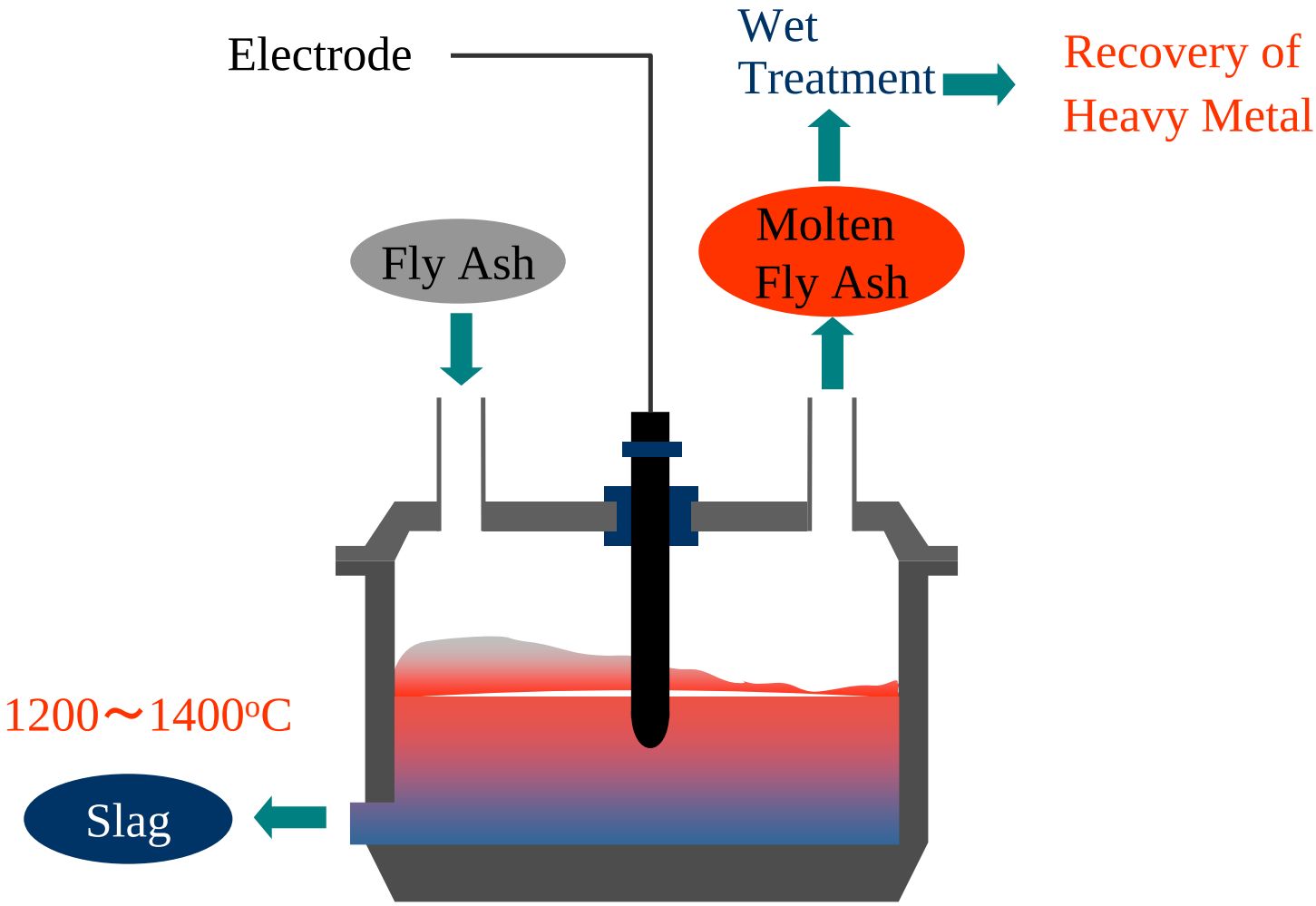
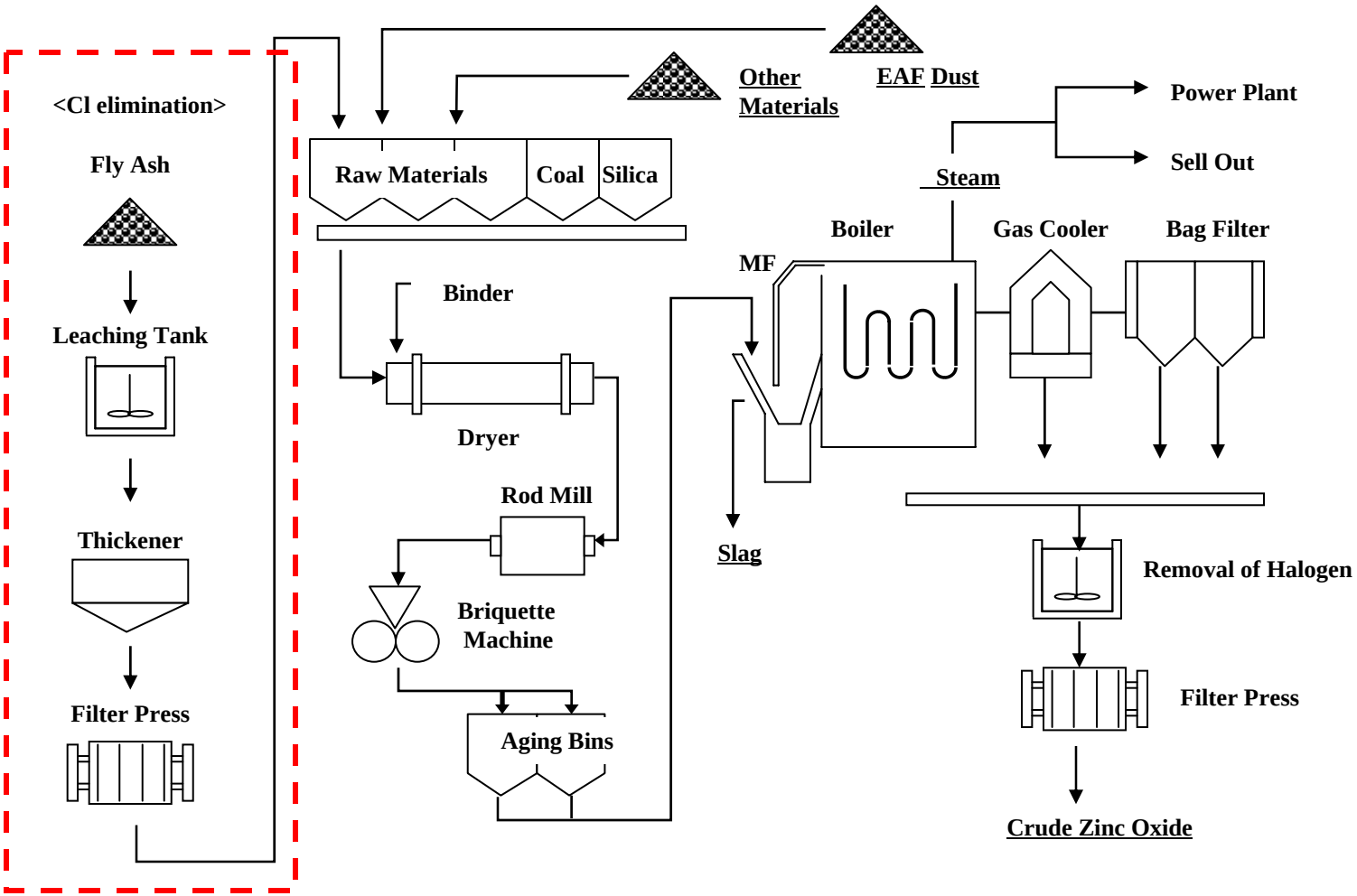


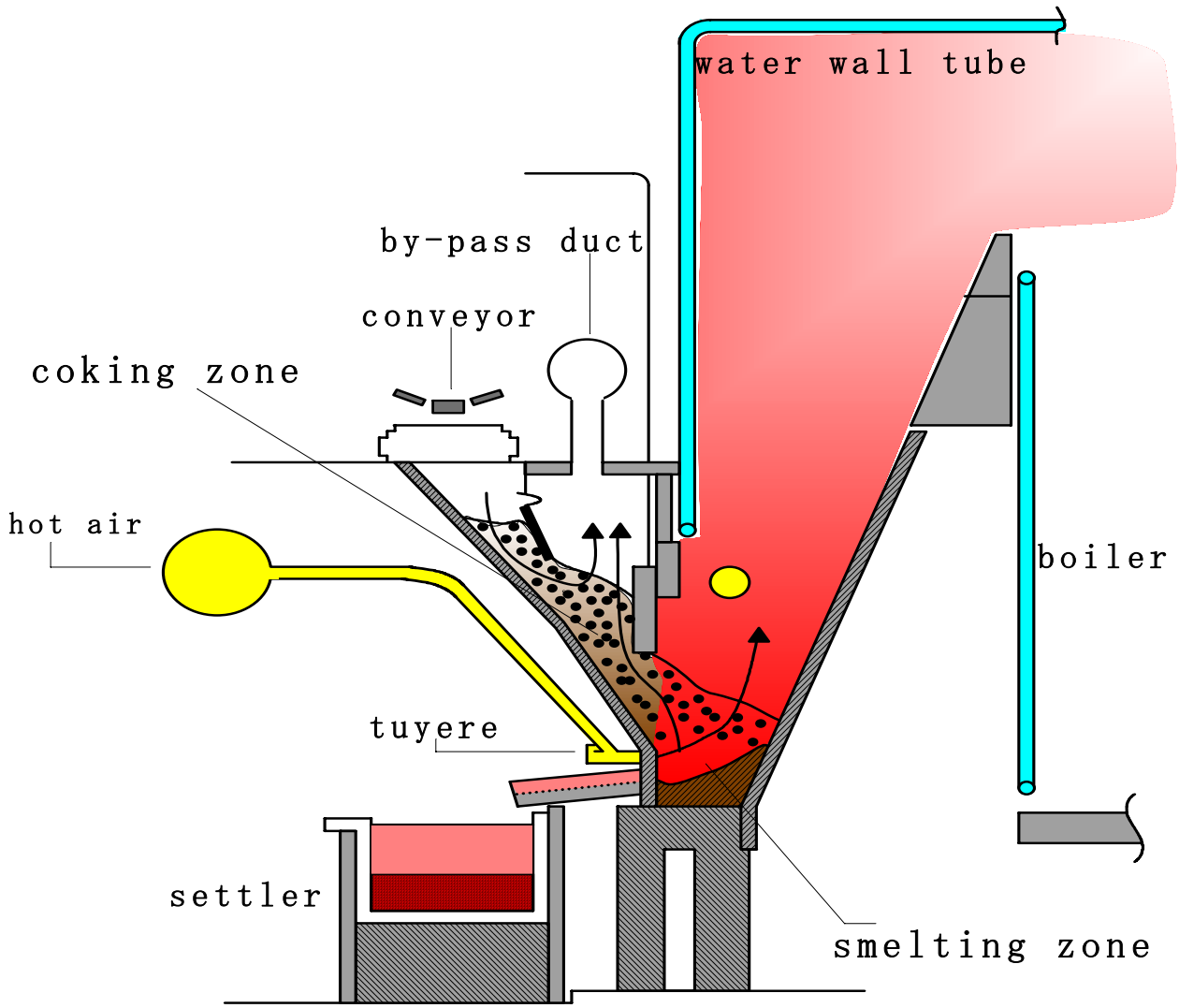
Fig. Fly ash melting furnace (Electric furnace).

Comparison of Fly Ash Treatment Processes and their Characteristics

Process	Cost	Energy Consumption	Recovery of Heavy Metals	Log term stability	others
Melting	×	×	△	○	Generation of secondary fly ash
Sintering	△	△	○	○	Reuse of sintering block
Fixation by Cement	○	△	×	△	Limitation of amount
Treatment by Chelate Agent	○	○ (?)	×	×	Stability of Chelate agent
Leaching by Acid	×	△	○	○	High cost and reuse of final deposit



Fly Ash Treatment Process by MF furnace



Conceptual Figure of MF Furnace

Contribution of Non-ferrous Industry to Fly Ash Treatments

(1) Miike Smelting Corporation

Fly ash is rinsed by water and residue is treated by MF furnace to recover crude ZnO.

(2) Mitsubishi Materials Corporation

Naoshima Smelting Fly ash is rinsed by water and residue is treated by lead furnace.

(2) Kowa Seiko Corporation

Fly ash is treated by Kowa process to recover non-ferrous metals. Principle of Kowa process is chlorination roasting using a rotary kiln.

(3) Sumitomo Metals and Mining Corporation

Fly ash is treated by a sintering process with a rotary kiln. They produce artificial rock materials and secondary fly ash which is suitable for resource of Zn and Pb.

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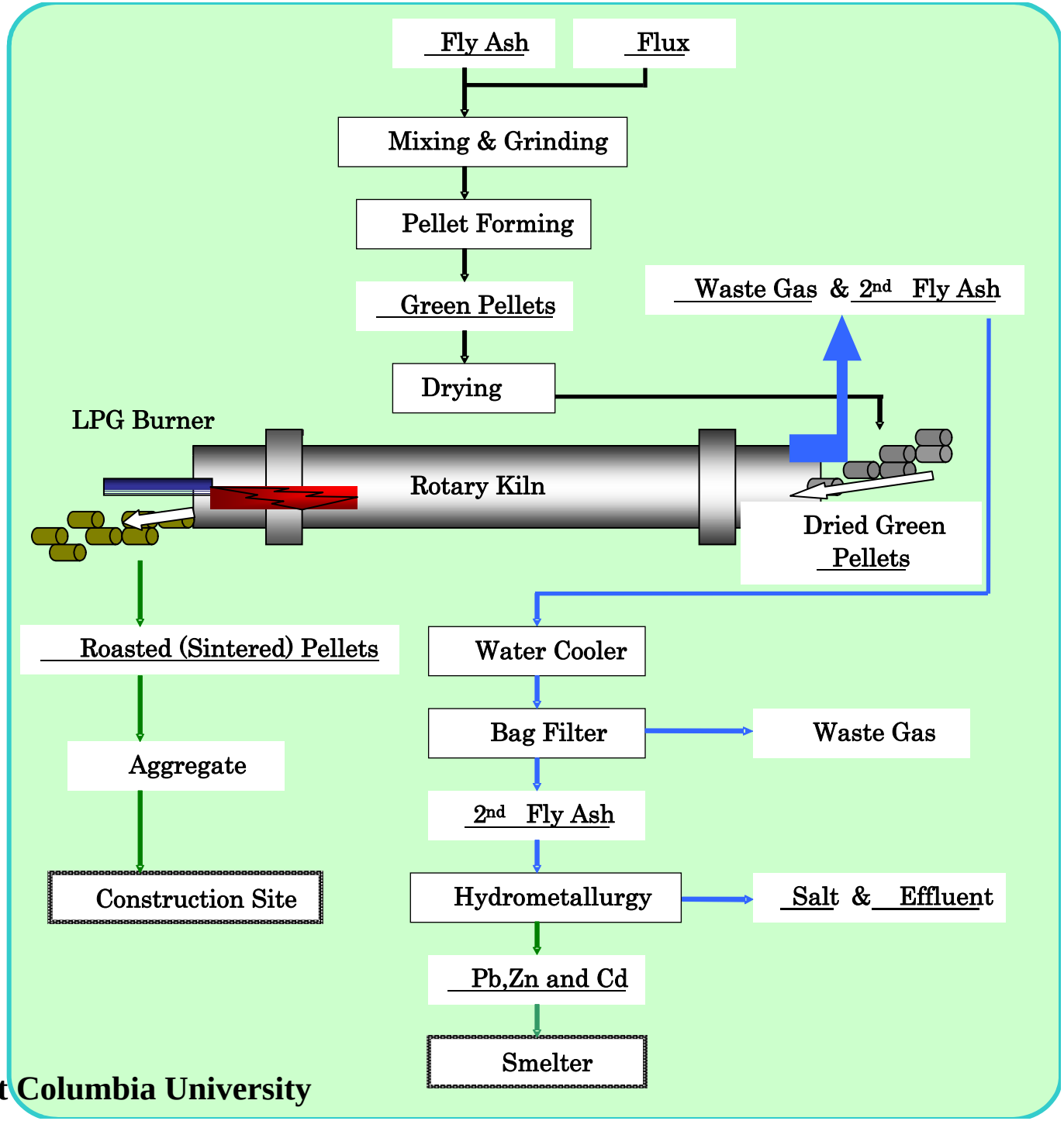
From Melting Process to Sintering Process

- Melting process needs high energy

- Sintering process produces more valuable by-products like Pellets for Construction materials and secondary fly ash from sintering process is more suitable for resources for Zn and Pb smelting.

Flow Sheet of The Fly Ash Treatment Process



Capacity:100kg/h

Rotary Kiln

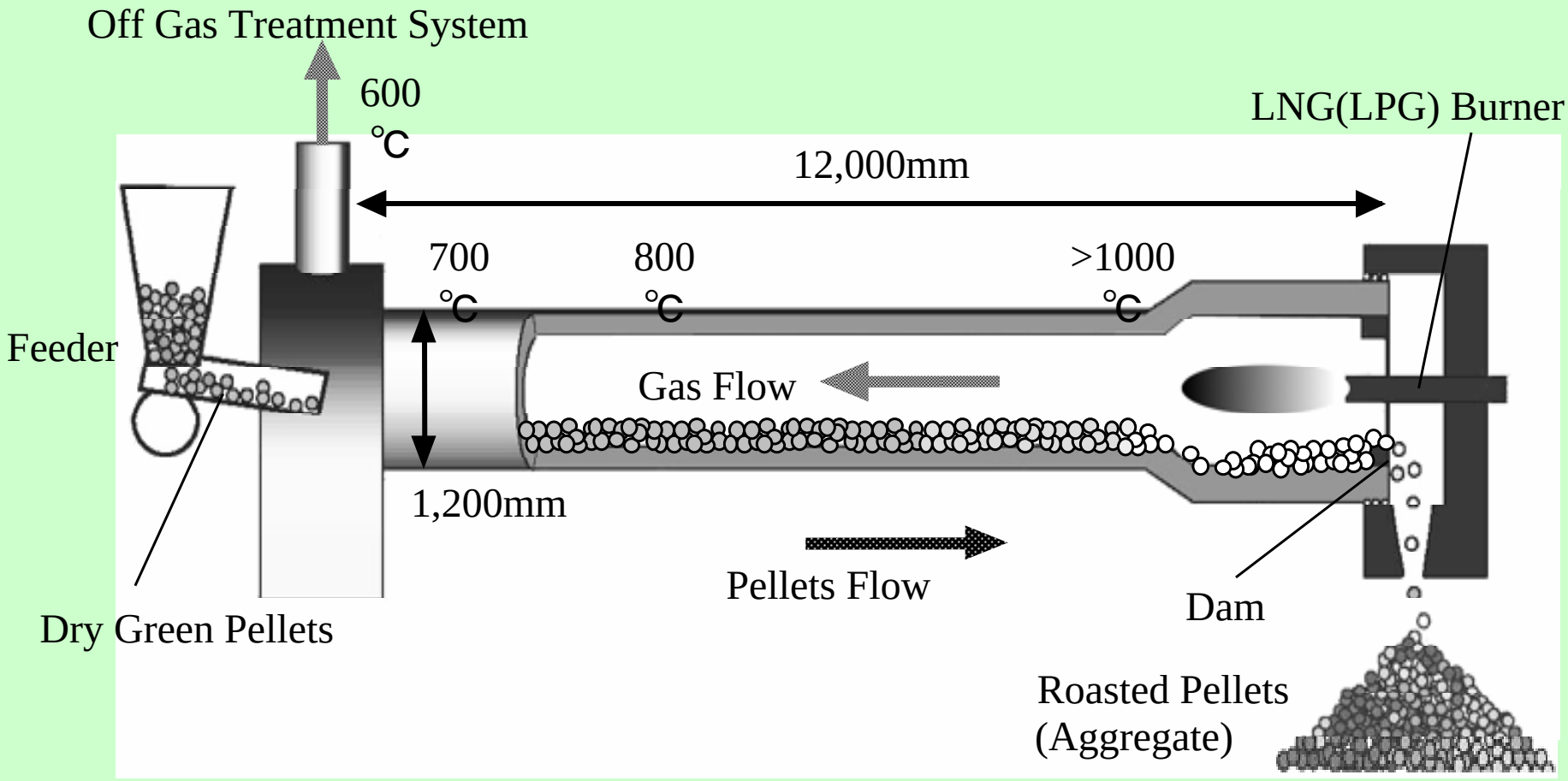
Inner Diameter : 900$^{mm\,\Phi}$

Length : 12^{mL}

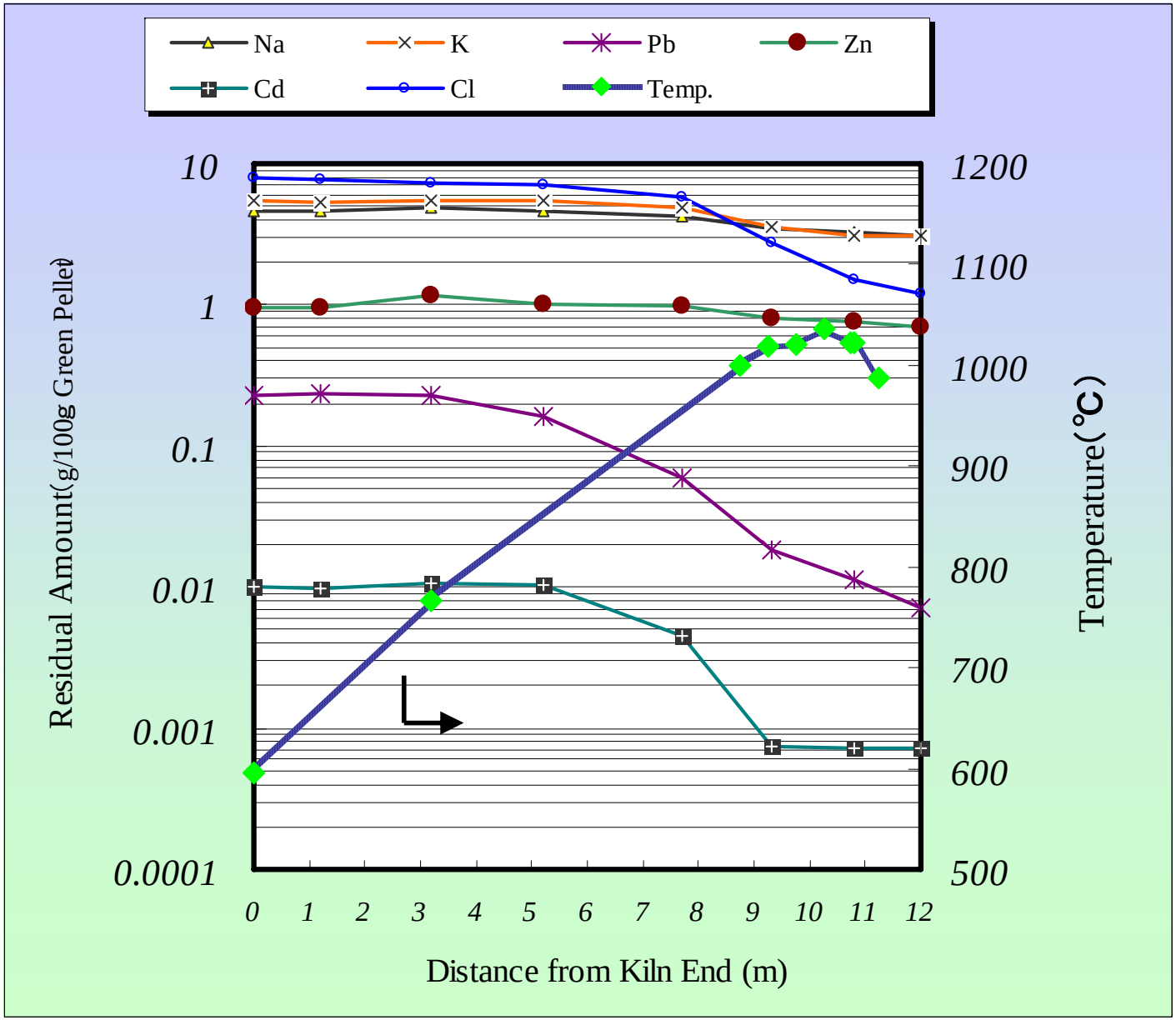
Composition of Fly Ash Used in Experiments

	Contents(%)		
	A-City	B-City1	B-City2
SiO_2	21.0	10.8	1.9
Al_2O_3	12.5	6.2	2.4
Fe_2O_3	1.39	1.37	0.37
CaO	18.2	15.4	53.5
Na	7.18	8.51	2.49
K	8.91	9.40	3.04
Cl	11.3	25.1	15.0
SO_3	4.94	8.28	3.38
Pb	0.52	0.18	0.06
Zn	2.29	1.04	0.24
Cd	0.019	0.015	0.0027
T-Cr	0.039	0.015	0.011
As	0.002	0.0022	0.0004
Hg	-	0.0002	<0.0001
Se	-	0.0006	0.0002
C	2.3	0.44	2.43

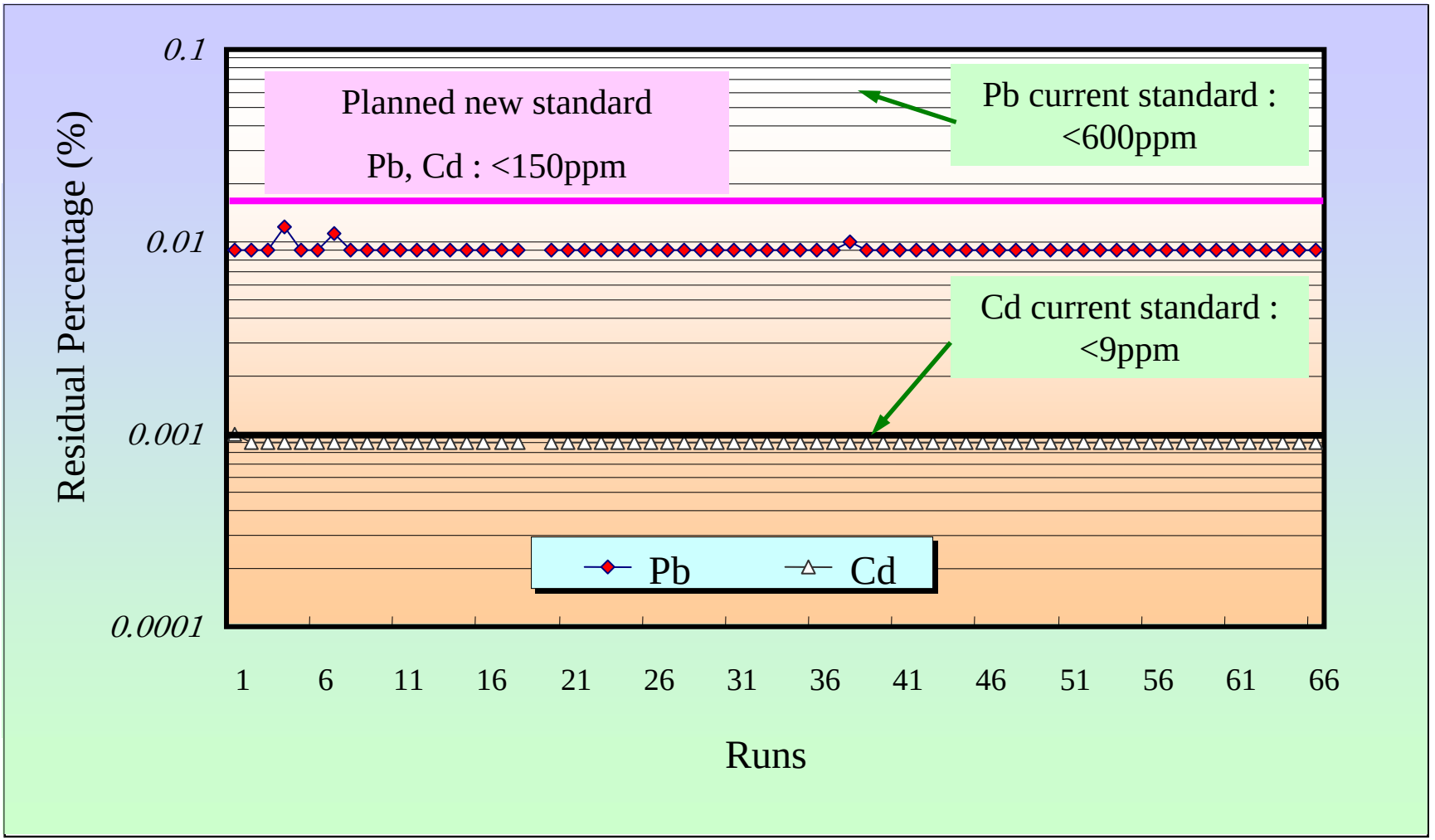
Schematic Diagram of Kiln



Residual Amount Change of Elementals in Pellets Through Rotary Kiln



Residual Amount of Pb, Cd in Roasted Pellet



Residual metals could be reduced at any conditions.

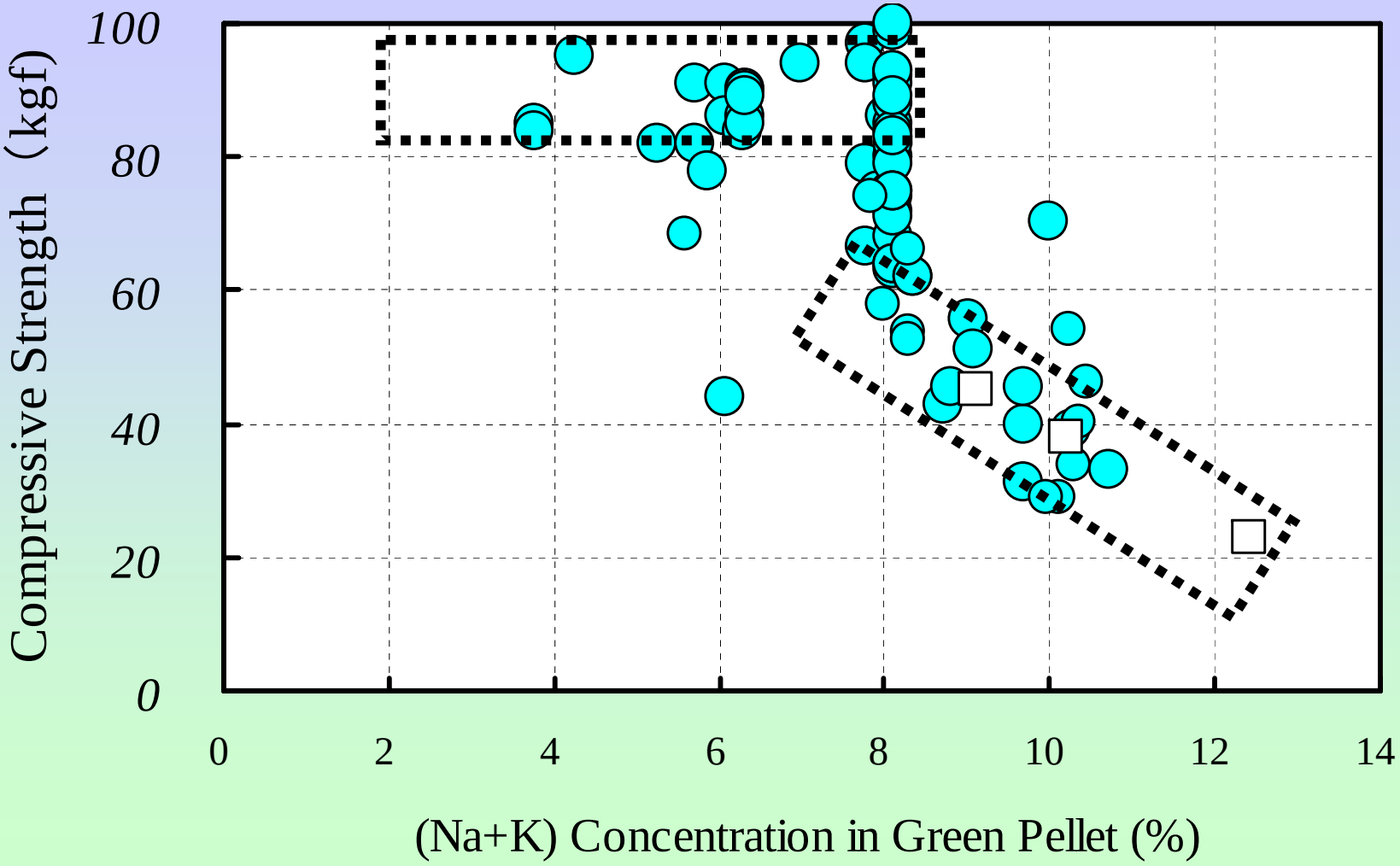
Results of TCLP and Estimation of Pb stabilization

Sample No.	Elution of Pb (mg/l) USA(TCLP) (note 1) **(a)**	Residual Amount (%)	Lead Concentration when all residual is dissolved. (mg/l) (note 2) **(b)**	Stabilization rate of residual Pb **1-(a)/(b)**
F−1	0.10	0.006	3	97
F−2	0.53	0.009	4.5	88
L−1	0.15	0.006	3	95
L−2	0.065	0.004	2	97

(note 1) TCLP:Toxicity Characteristic Leaching Procedure
(note 2) The estimated concentration when residual Pb dissolved all the quantity on the dissolution condition (100g is dissolved in 2000m/ l) of TCLP.

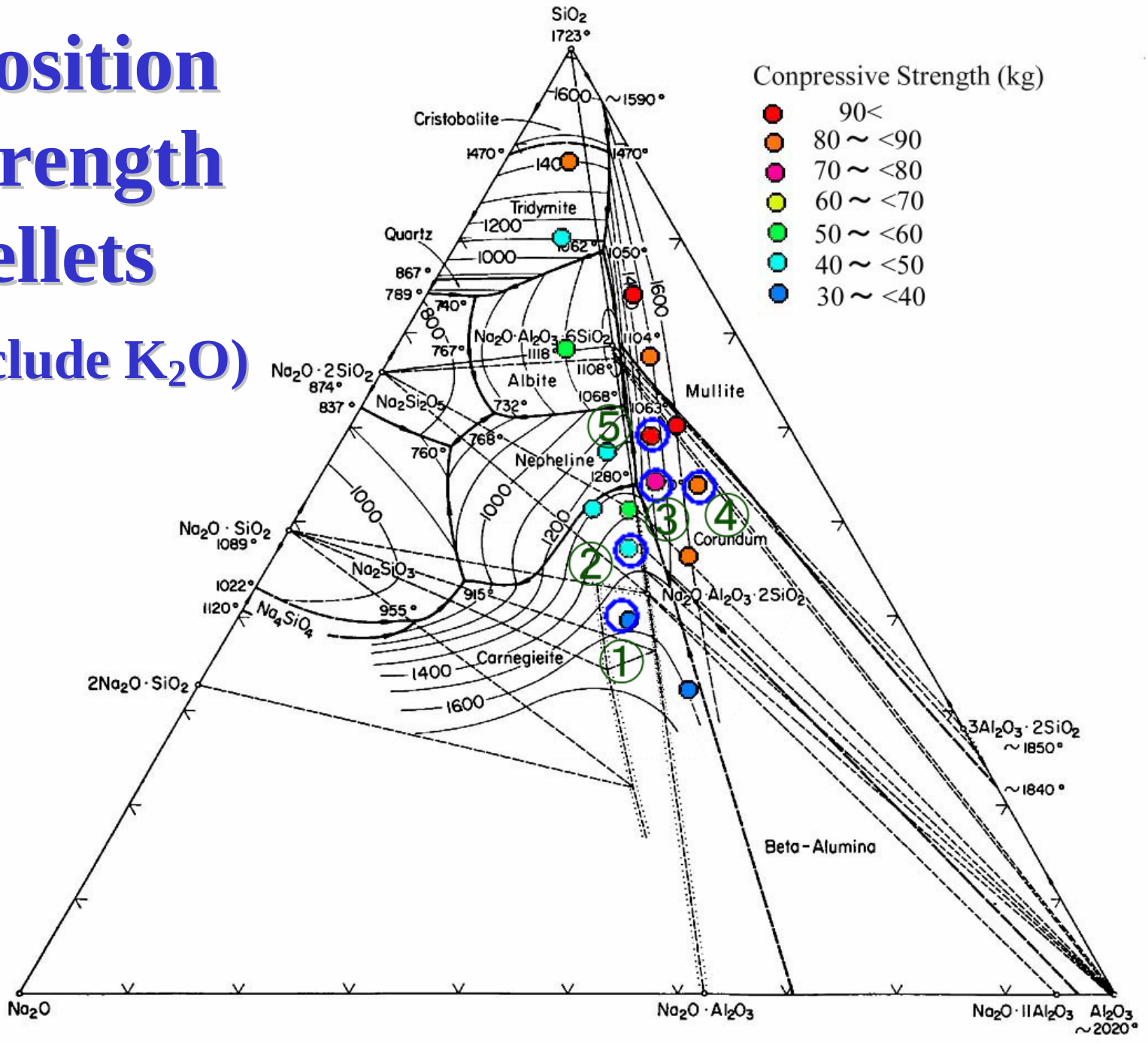
Under the proper condition, 95% of residual Pb can be stable.

Relationship between Compressive Strength of Sintered Pellet and (Na+K)Concentration in Green Pellet



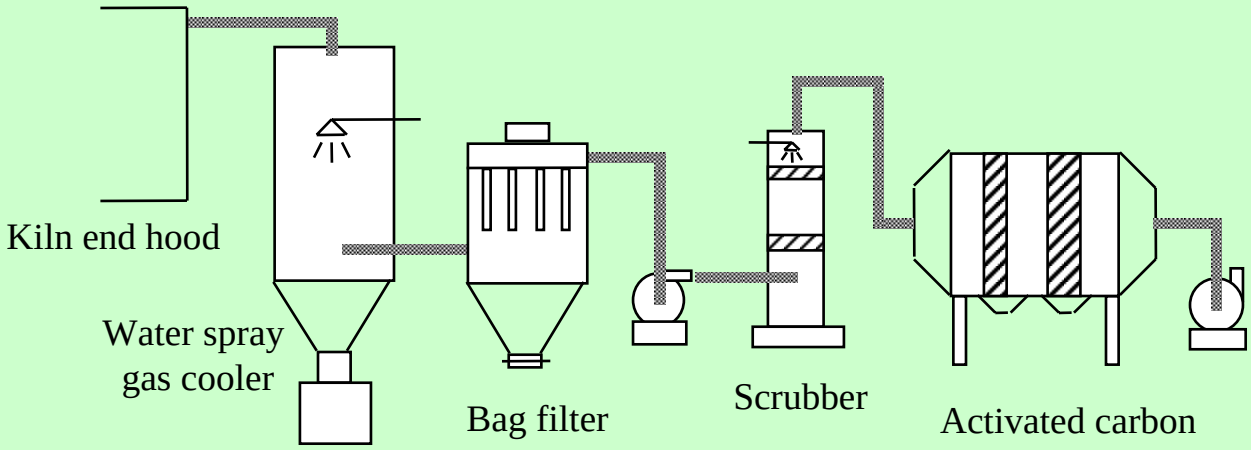
Composition and Strength of Pellets

(Na_2O include K_2O)

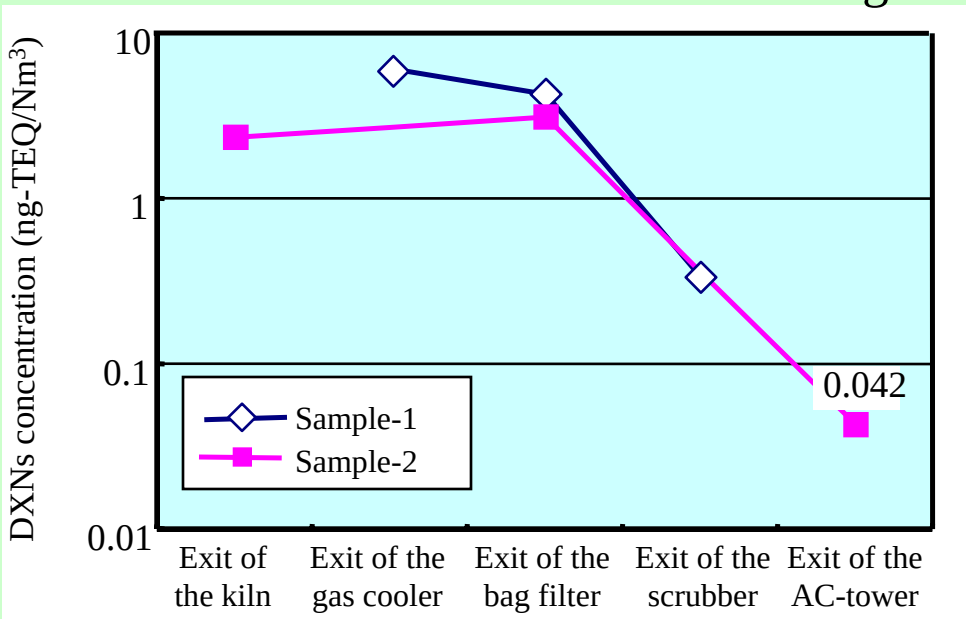


Dioxins

Schematic Diagram of The Waste Gas Treatment



Dioxins concentrations in the waste gas



With AC-adsorption,

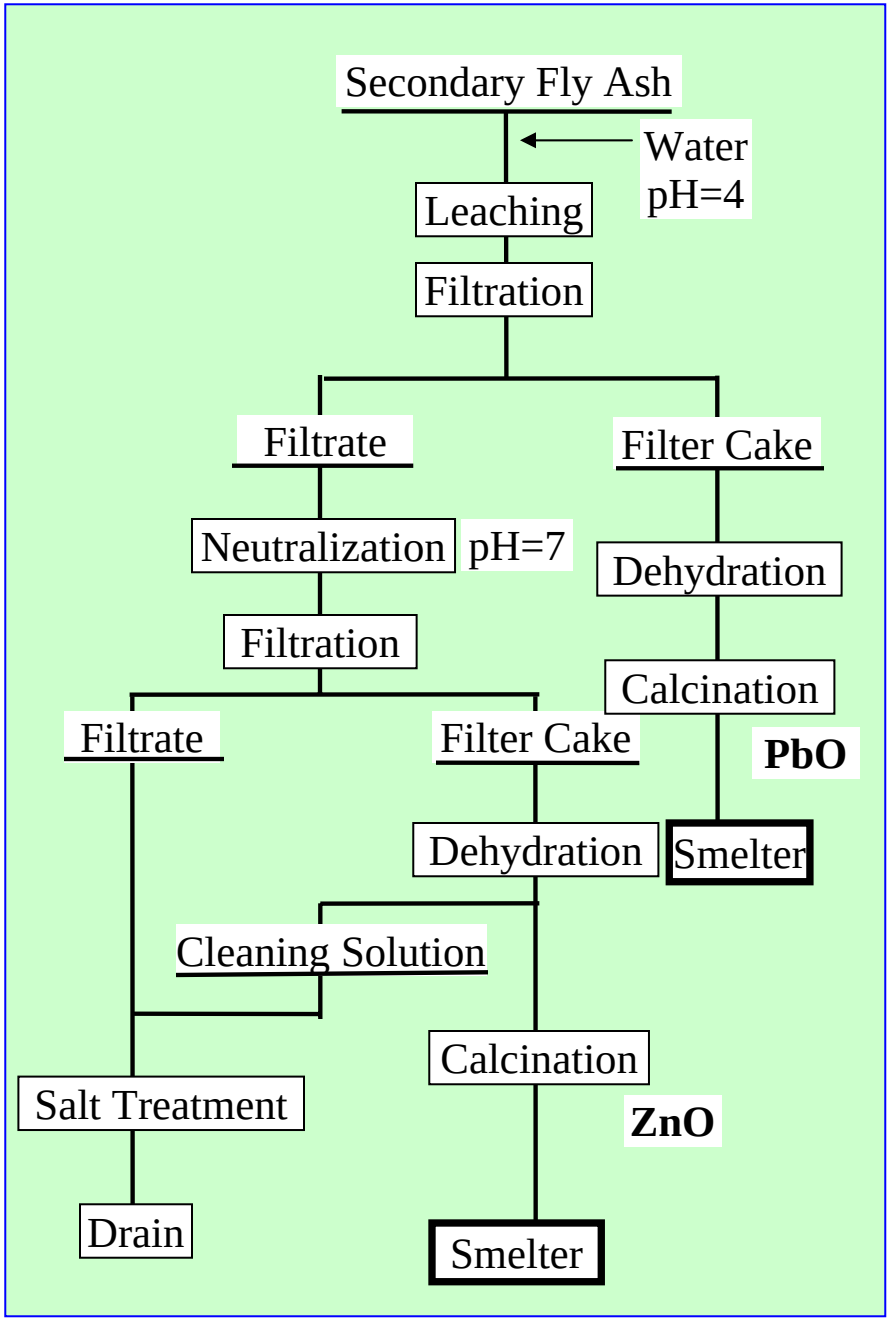
the new Japanese guideline can be satisfied;

<0.1 ng-TEQ/Nm^3.

Composition of Secondary Fly Ash

Elements	Contents(%)	
	2nd. Fly Ash-1	2nd. Fly Ash-2
Zn	2.15	2.25
Pb	1.99	0.75
Fe	2.95	0.59
Cu	0.35	0.33
Cd	0.11	0.04
Cr	0.04	0.02
Hg	<0.0001	<0.0001
Sb	0.097	0.04
Cl	39.5	40.0

Flow Sheet of Secondary Fly Ash Treatment Test



Composition of Recoveries (Metal Containing Materials)

Elements	Contents(%)	
	Zn-Concentrated Recovery	Pb-Concentrated Recovery
Zn	42.8	1.21
Pb	0.61	14.2
Fe	0.50	11.6
Cu	6.57	0.17
Cd	0.12	<0.01
Cr	0.03	0.34
Hg	<0.0001	<0.0001
K	0.08	5.62
Na	1.00	1.1
Sb	0.02	0.73
Sn	<0.01	1.39
Cl	1.50	1.66
F	0.04	0.14
Ca	0.25	4.56
Si	1.02	8.32
Al	0.56	4.84

Use Development Samples

Decollation fence block

Car tire block

Curbstone block

Sub-base

Soil improvement material

Filter medium

CONCLUSIONS

1. Detoxification and recycling of heavy metals are strongly required with low energy consumption.
2. Sintering Process will be next main process for fly ash treatment in Japan.
3. Secondary Fly ash are finally treated in primary non-ferrous smelter

Thank you for your kind attention

Welcome to Sendai and TOHOKU University