Experience of Incinerator Development in Japan

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- Incineration as a disposal method of municipal solid wastes (MSW) in Japan –Changes in the last two decades
- Influence of dioxin issues on the disposal of MSW
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- Future development

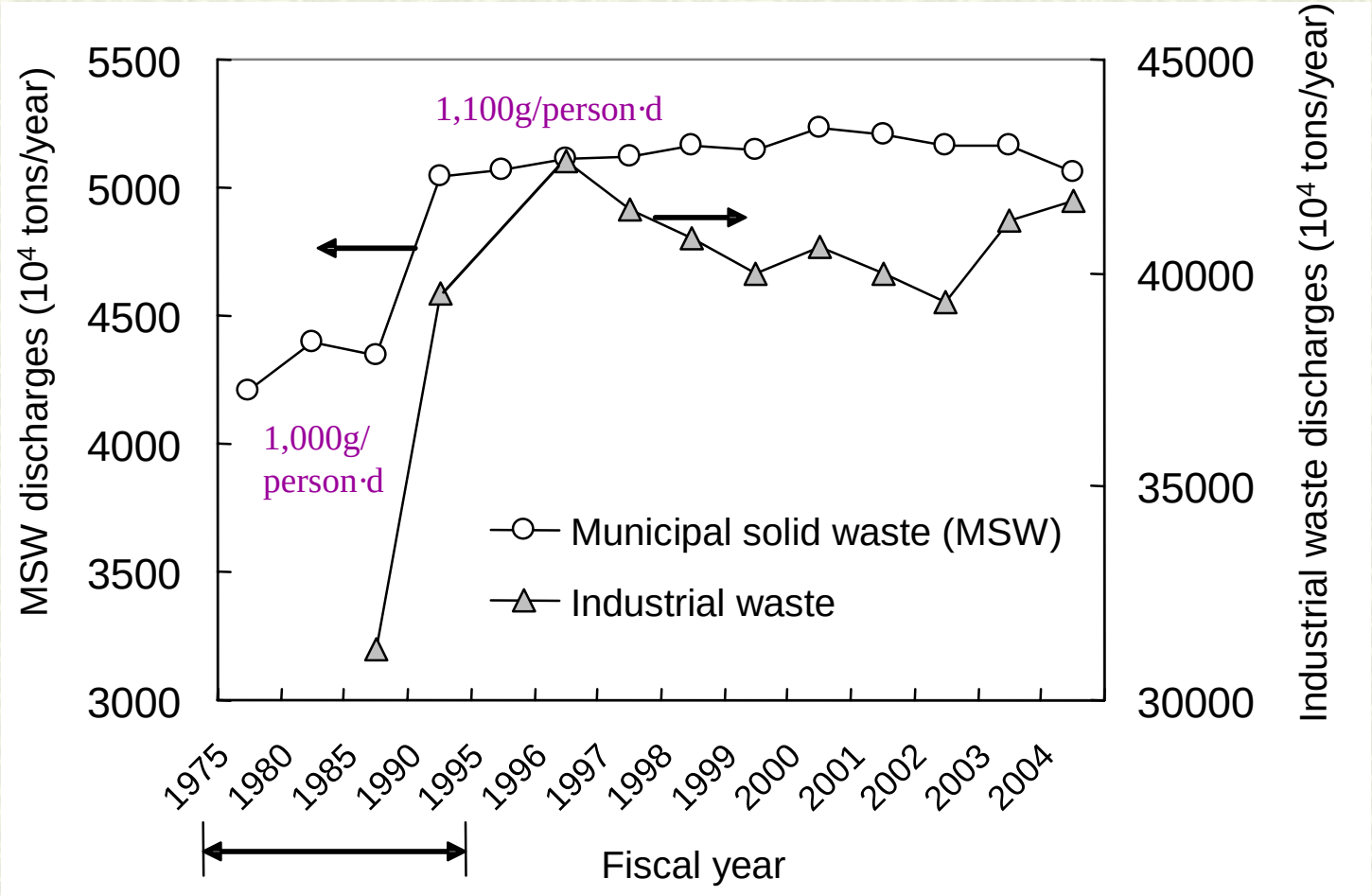
Introduction and overview -1

- Incineration plays an important role in disposing MSW in Japan, because it can reduce weight and volume of MSW with a good sanitation.
- However, it essentially has some problems such as air pollution as well as the emission of carbon dioxide. Dioxins have been attracting much concern as a hazardous pollutant emitted from the incinerator.
- Dioxin problems have caused big changes on MSW disposal. One of the changes is that efforts were made to improve incineration technology and to produce new type thermal treatment processes.

Introduction and overview -2

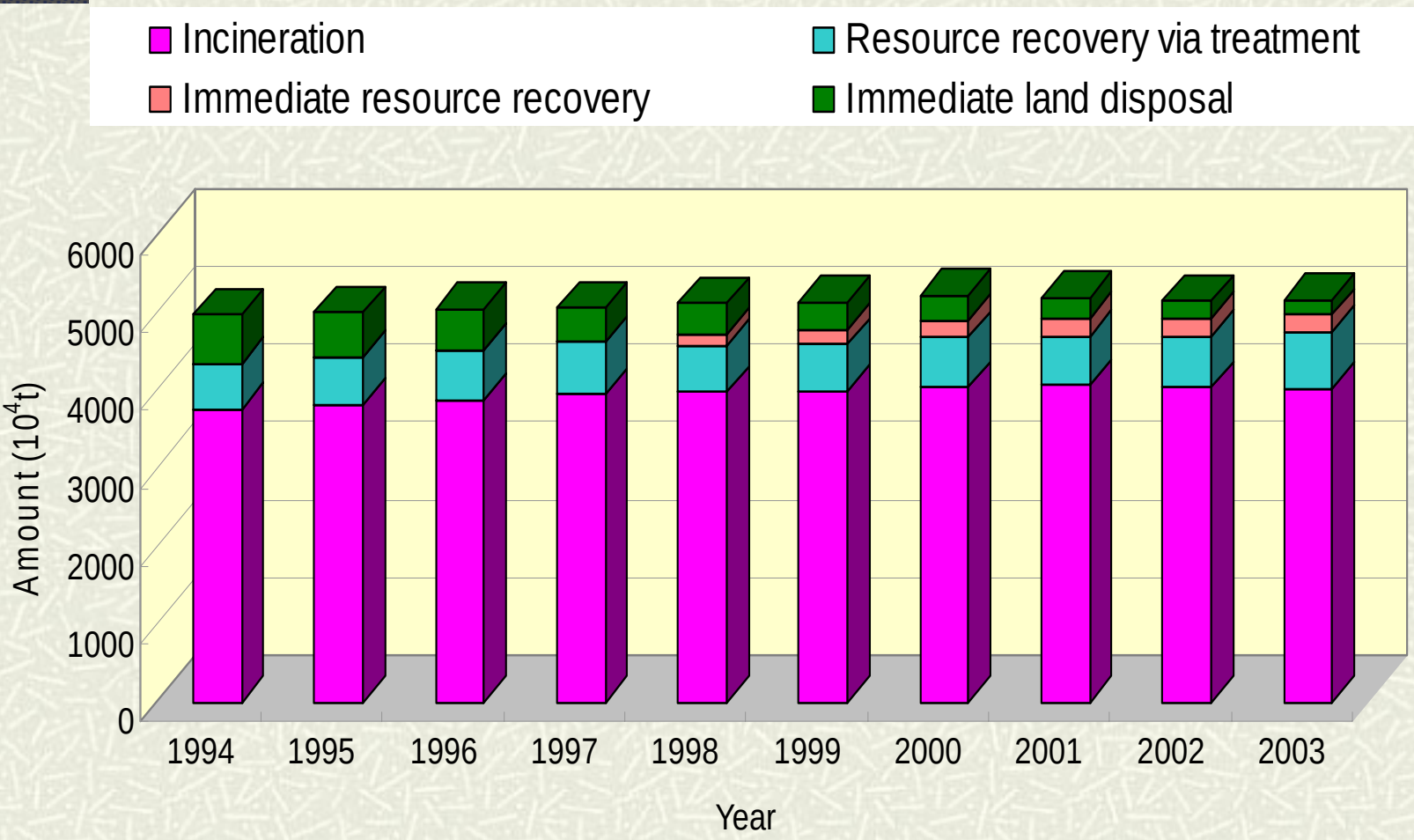
- Brand new incineration systems of pyrolysis/ gasification/melting processes have been introduced into Japan.
- They have some distinctive features that suite for sustainable society, which are reduction of environmental pollutant loads and recovery of material resources from wastes.
- There are a variety of movements for establishing a sound material-cycle society by many constituents.

Change over time in amounts of MSW and industrial waste



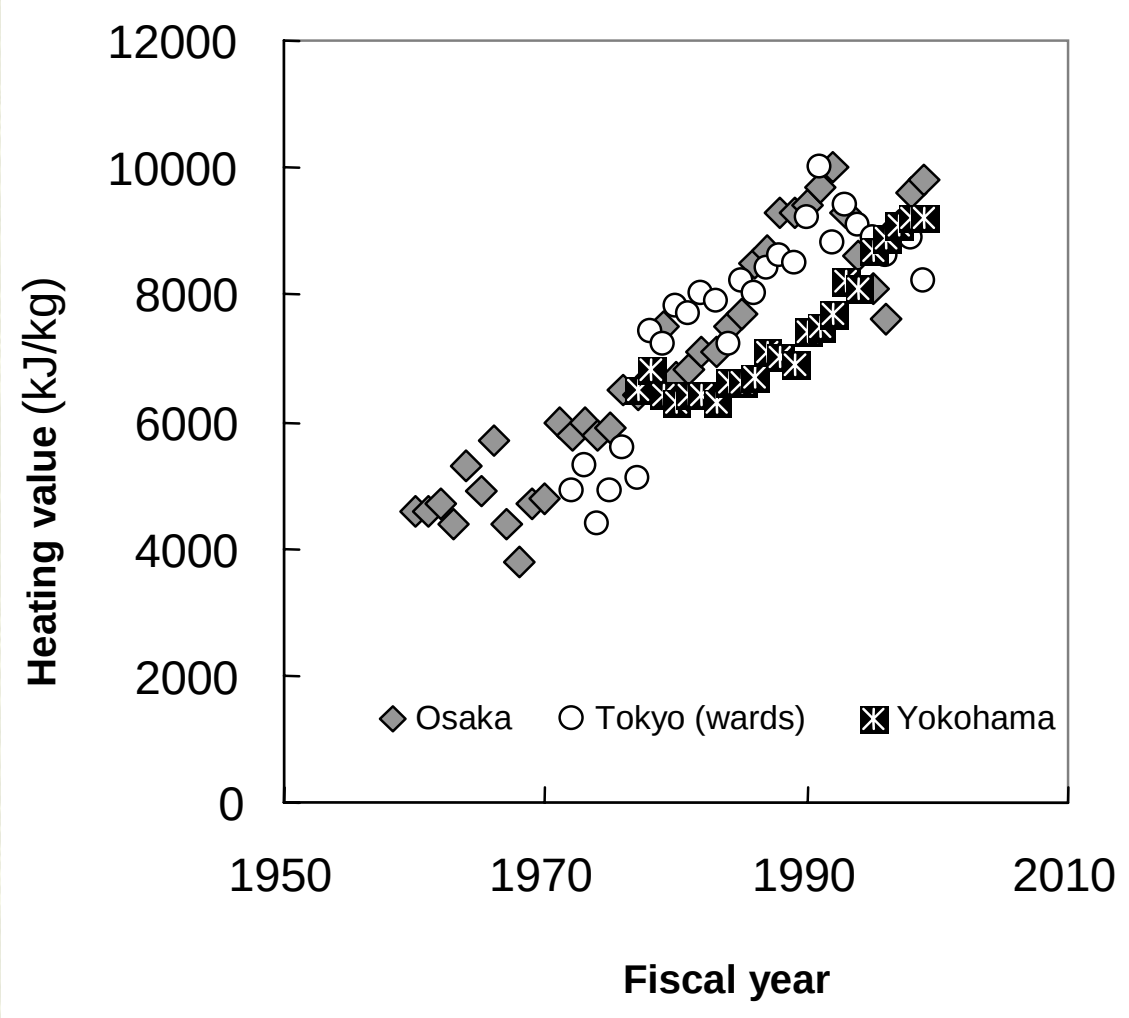
Data for 1975-1995 are for 5 year intervals.

Change of MSW in Japan

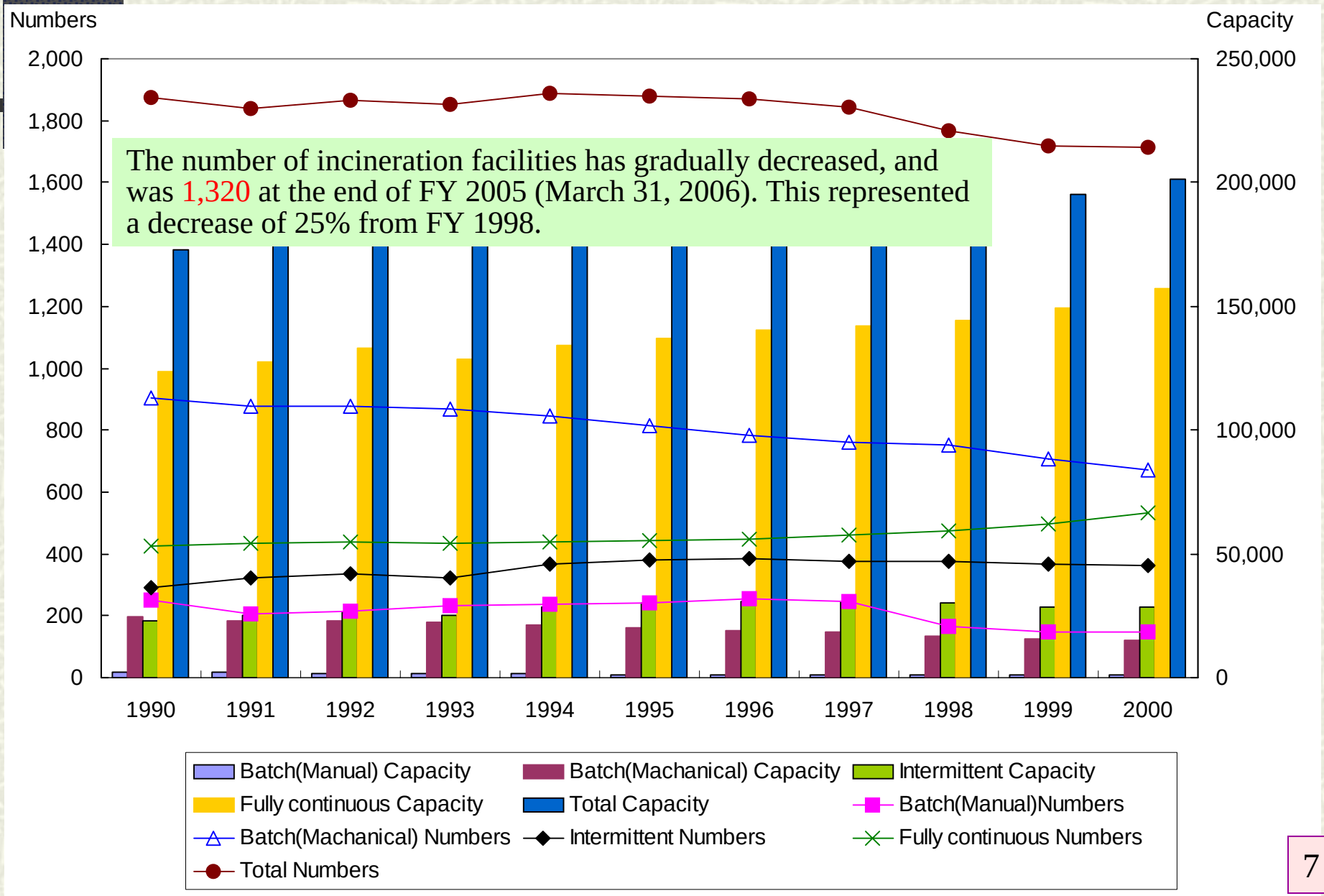


This figure also gives the breakdown of the treatment method of MSW.

Change over time in heating value of waste (lower heating value)



Change of nationwide incineration plants in Japan



Regulations on air pollutants in Japan

Air pollutants from incineration [a)]

	Pollutant
Flue gas components	Sulfur oxides (SOx)
	Dust
	Hydrochloric acid (HCl)
	Nitrogen oxides (NOx)
Hazardous air pollutants	Benzene
	Trichloroethylene
	Tetrachloroethylene
	Dioxins

a) Flue gas criteria are mainly determined based on "Air Pollution Control Law"

Regulation on dioxins (PCDDs, PCDFs and DL-PCBs) for incinerator of wastes [a)]

Capacity of furnace	Criteria for newly constructed incinerator [b)] ($ng\text{-}TEQ/m^3_N$)	Criteria for existing incinerator ($ng\text{-}TEQ/m^3_N$)
> 4 t/h (96 t/d)	0.1	1
2-4 t/h	1	5
< 2 t/h	5	10

a) Based on "Law Concerning Special Measures against Dioxins"

b) Facilities constructed after 16 Jan. 2000

Laws that proceed reduction, reuse and recycling of wastes

- Basic law for establishing a sound material-cycle society: 2000
- Law for promotion of effective utilization of resources: 1991
- Waste management and public cleansing law:1970
- Law concerning special measures against dioxins: 1999
- Separate collection and recycling of packaging waste promoting law : 1995
- Home appliance recycling law : 1998
- Construction material recycling act : 2000
- Food recycling law : 2000
- Motor vehicle recycling law : 2002 (enforcement-2004)

Transition of incineration treatment for MSW

Functions and roles widely required in incineration treatment (have changed in response to the needs of the times…)

Appropriate treatment for sanitation

↓

Weight/volume reduction

↓

Reduction of environment impacts

↓

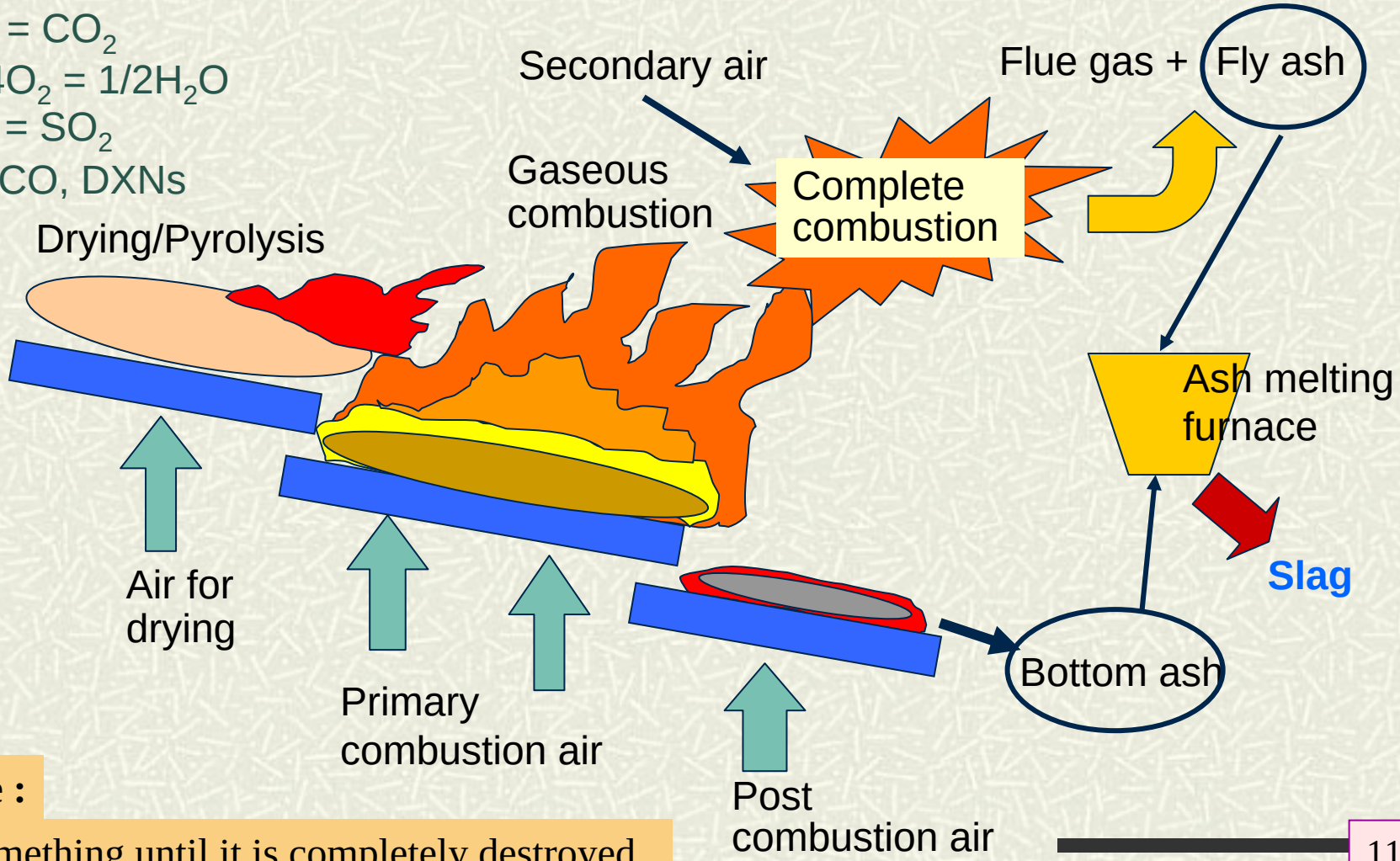
Recycling and resource recovery

In recent years, the dioxin problem brought about a particularly large change. In line with the movement toward a sound material-cycle society, heightened expectations were placed on resource recycling through the introduction of new methods such as the gasification and melting furnace and other technologies.

Incineration and incinerator

- Example of stoker type Incinerator

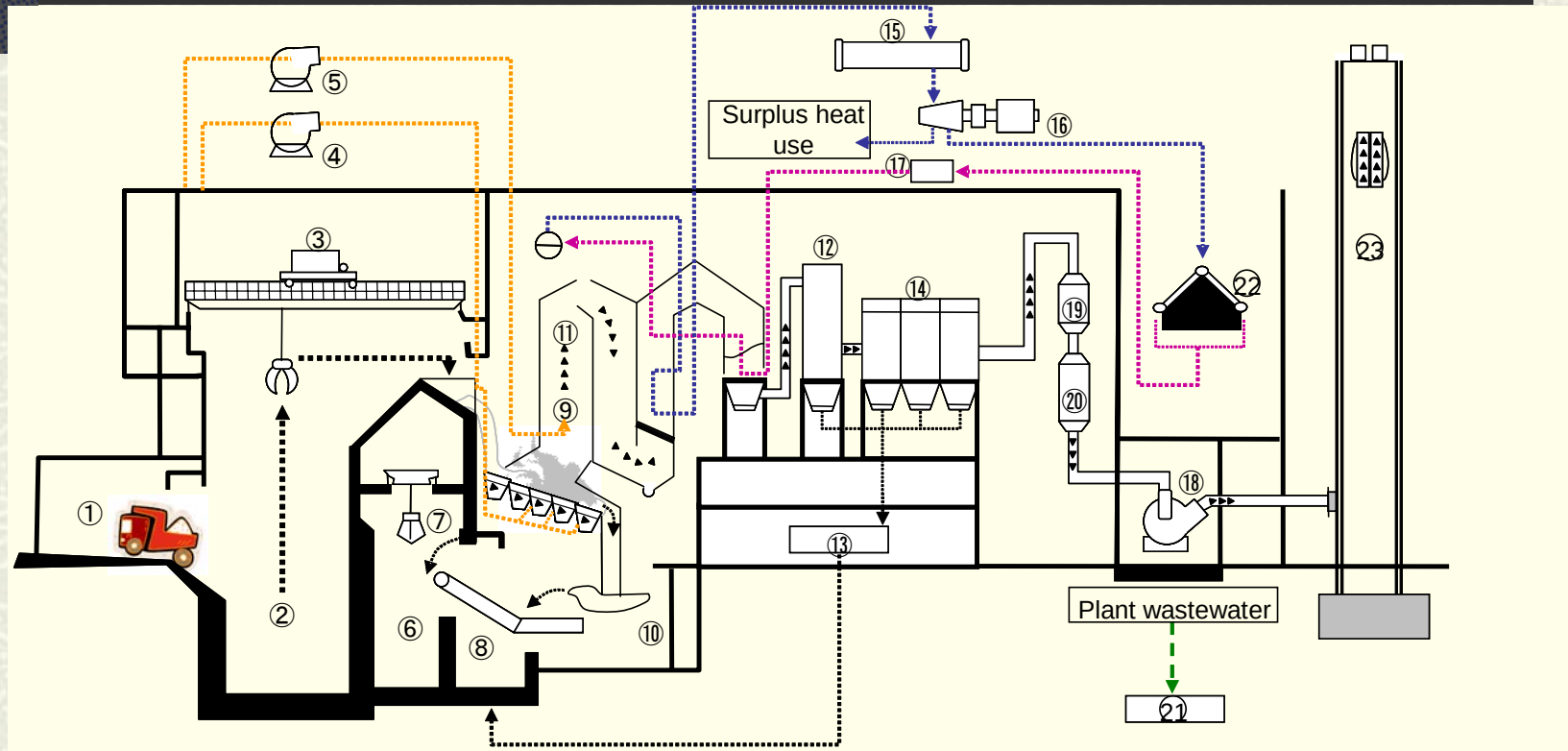
$C + O_2 = CO_2$
$H + 1/4O_2 = 1/2H_2O$
$S + O_2 = SO_2$
NOx, CO, DXNs



incinerate :

to burn something until it is completely destroyed

Example of configuration of typical fully-continuous stoker-type incinerator



◆Symbols◆
Waste flow / Steam flow
Ash flow / Condensate flow
Gas flow / Wastewater flow
Air flow

①Platform	⑦Ash crane	⑬Fly ash treatment equipment	⑲Steam-type gas reheater
②Waste pit	⑧Treated ash pit	⑭Filter-type dust collector	⑳Catalytic reactor
③Waste crane	⑨Incinerator	⑮Steam receiver	㉑ Wastewater treatment equipment
④Primary forced draft fan	⑩Ash pusher	⑯Turbine-generator	㉒ Steam condenser
⑤Secondary forced draft fan	⑪Boiler	⑰Condensate tank	㉓ Chimney
⑥Ash pit	⑫Cooling tower	⑱Induced draft fan	

Important technical factors in incineration

3 Ts : Temperature
Time (residence time)
Turbulence (adequate mixing and stirring)

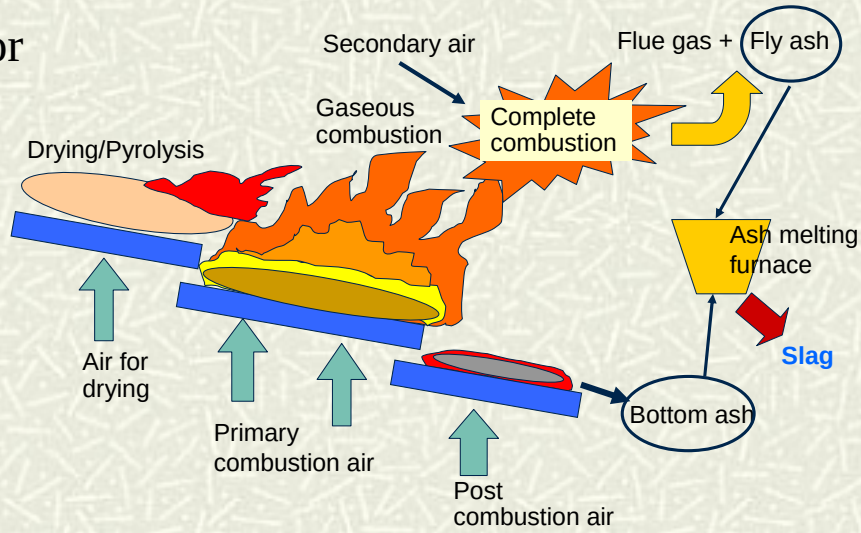
Technical innovations, including improvement of the secondary combustion air injection method, advanced control using artificial intelligence, etc.

Large-scale fully-continuous facilities account for 40% of the total number of incineration facilities and more than 80% of treatment capacity.

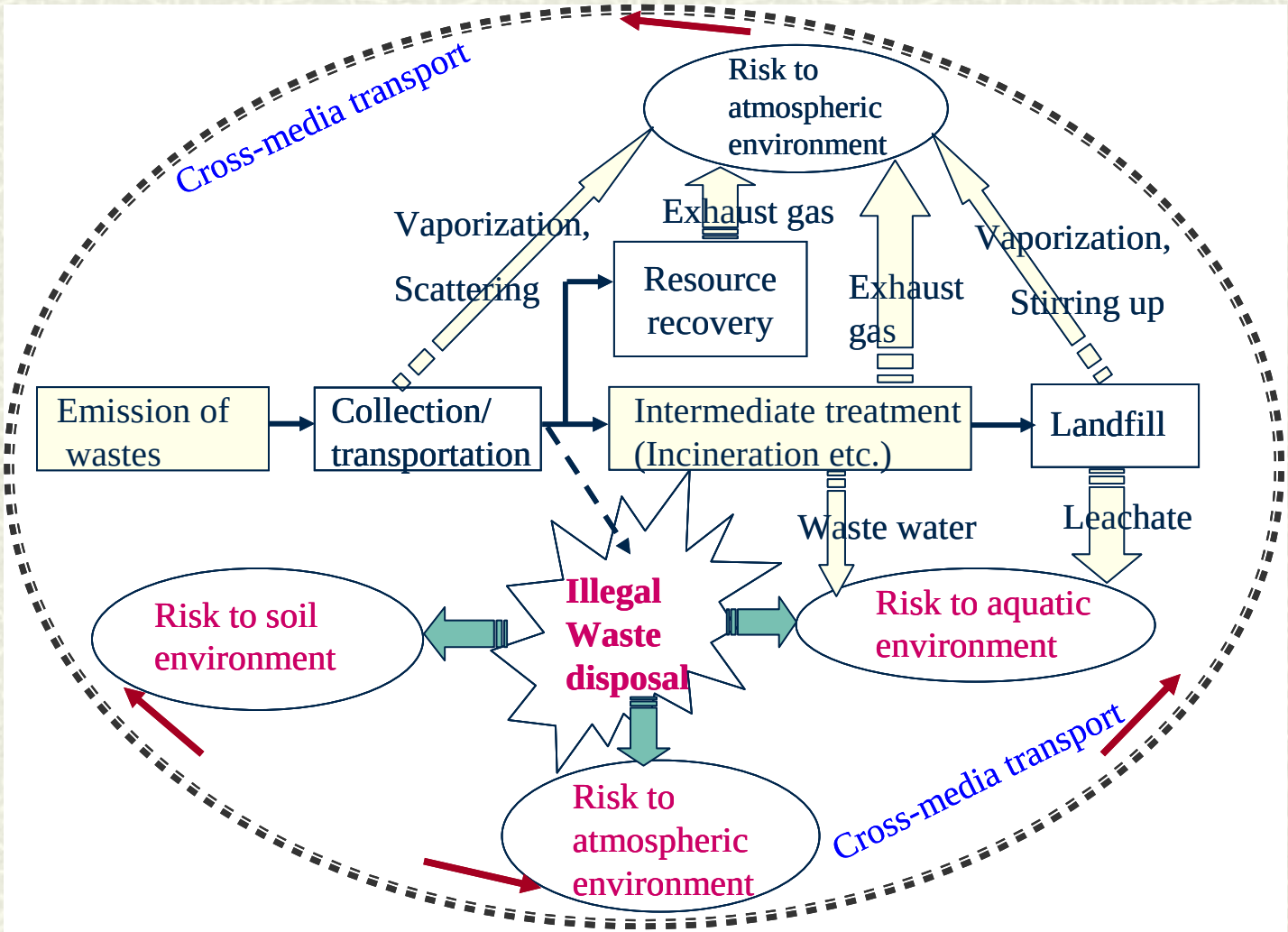
Number of incineration facilities

Stoker type incinerator : 70 %

Fluidized bed type incinerator and gasification-melting furnace etc.: 30%



Waste disposal and environmental potential risk caused by emission of hazardous materials



Influence of the dioxin problem

The dioxins became an extremely large problem in Japan from around the mid-1990s and this had a direct effect on improvement of the element technologies of incineration treatment processes.

Improvement of combustibility : 3Ts

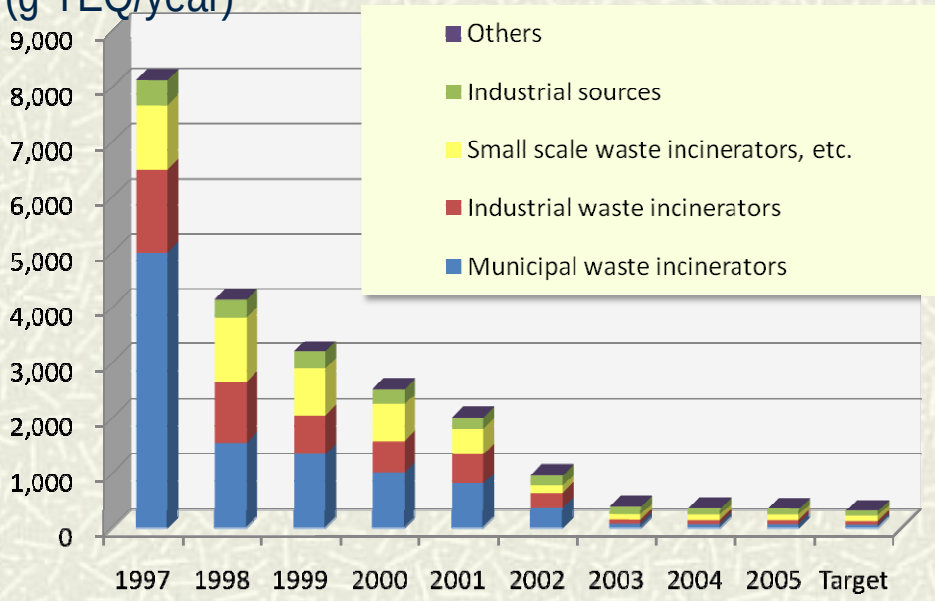
Power generation equipments w/higher efficiency

Improvement in flue gas treatment technologies such as changing dust collecting equipment to the bag filter

Regional MSW collection and treatment in areas spanning several municipal units (cities, towns, and villages

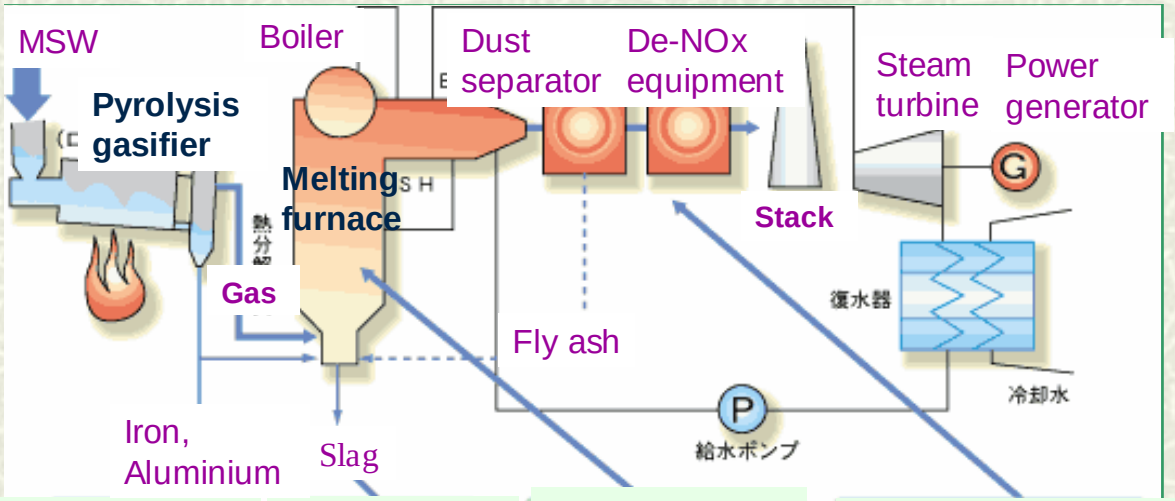
Encouraged efforts to create a recycling society

Total Emissions of dioxins in Japan



Basic concepts of gasification and melting system

- Low emission of dioxins because of high temperature combustion
- Low air ratio combustion and simplification of flue gas treatment system
- Melting only by own possessing energy (It does not need to put energy from outside.)
- Recycling of valuable materials (Fe and Al) in high quality because of reductive atmosphere
- Minimization of the quantity and volume of residues that are transferred to landfill site



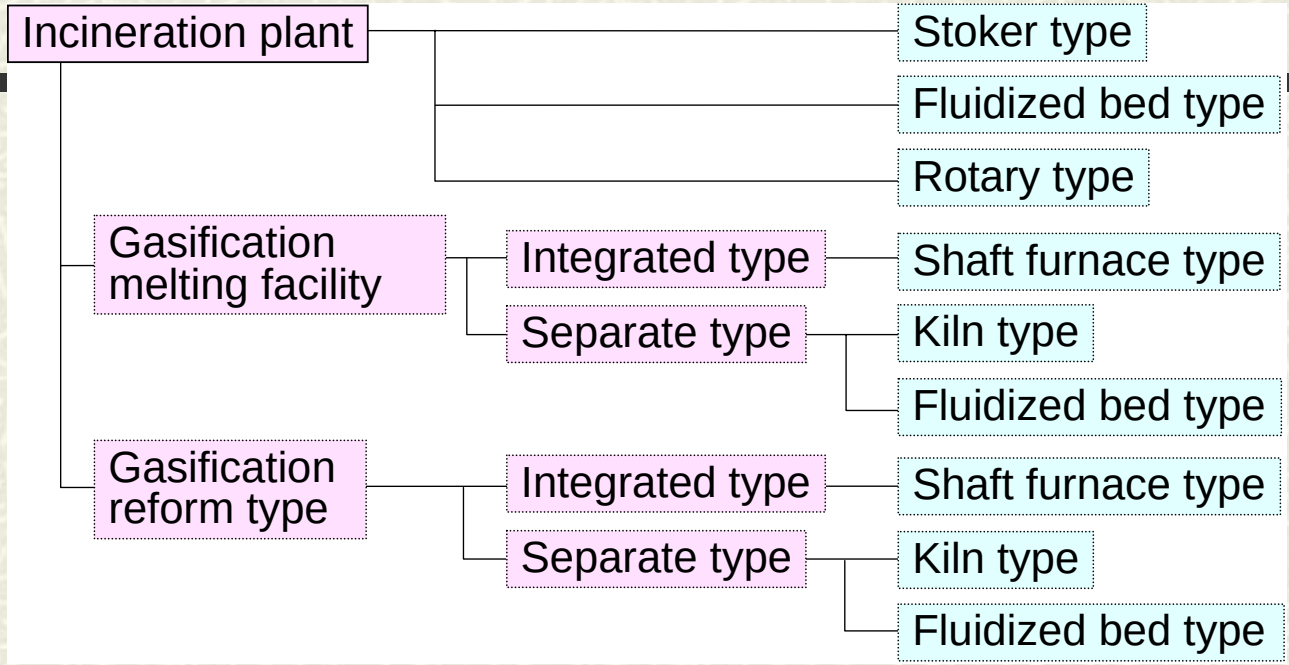
Fe and Al can be recovered in the state not to be oxidized.

Ash is highly reduced and can be changed to resources.

Dioxins can be highly reduced because of high temperature.

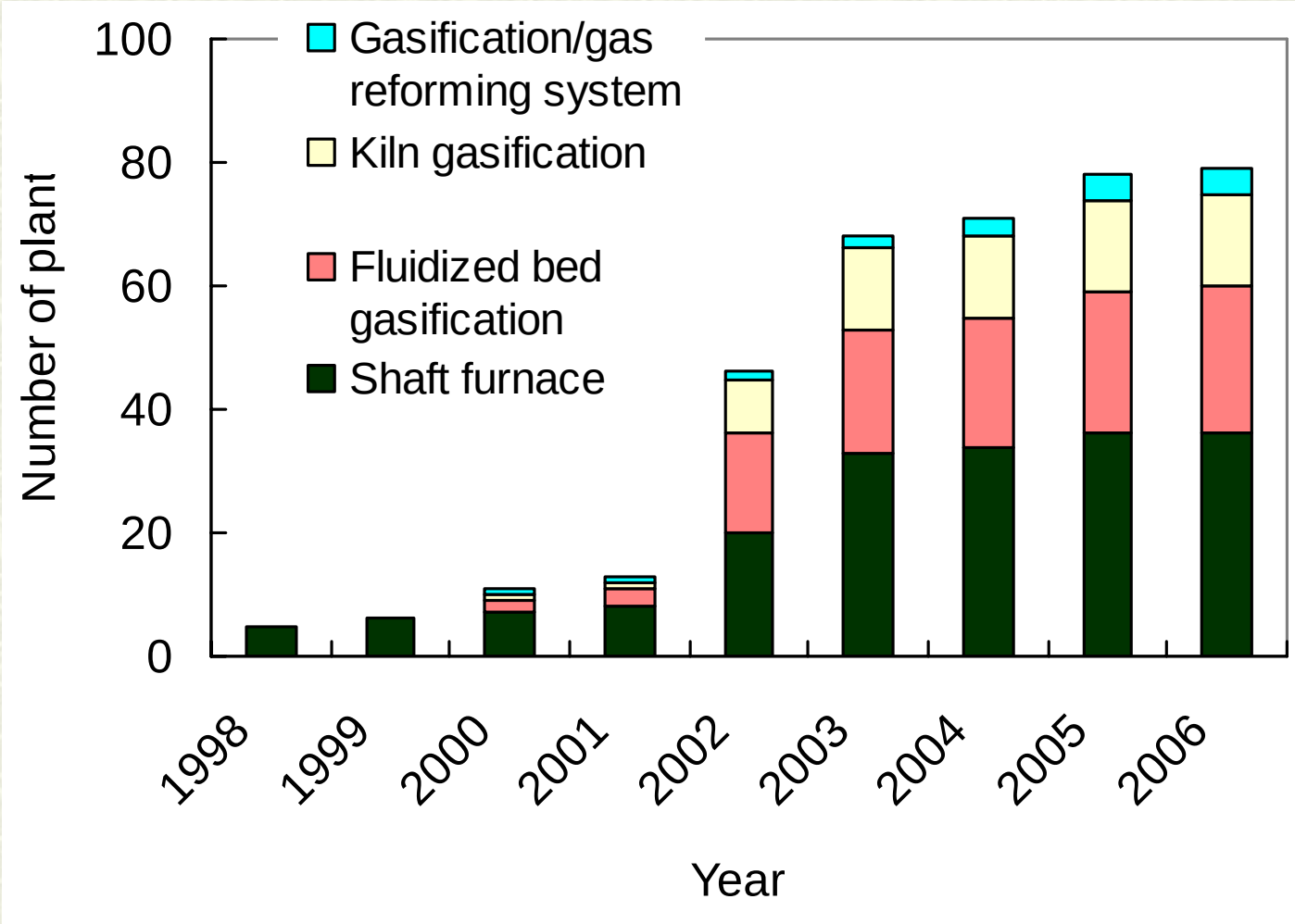
Low air ratio combustion → Simplification and minimization of flue gas treatment

Classification of incineration and gasification/melting system

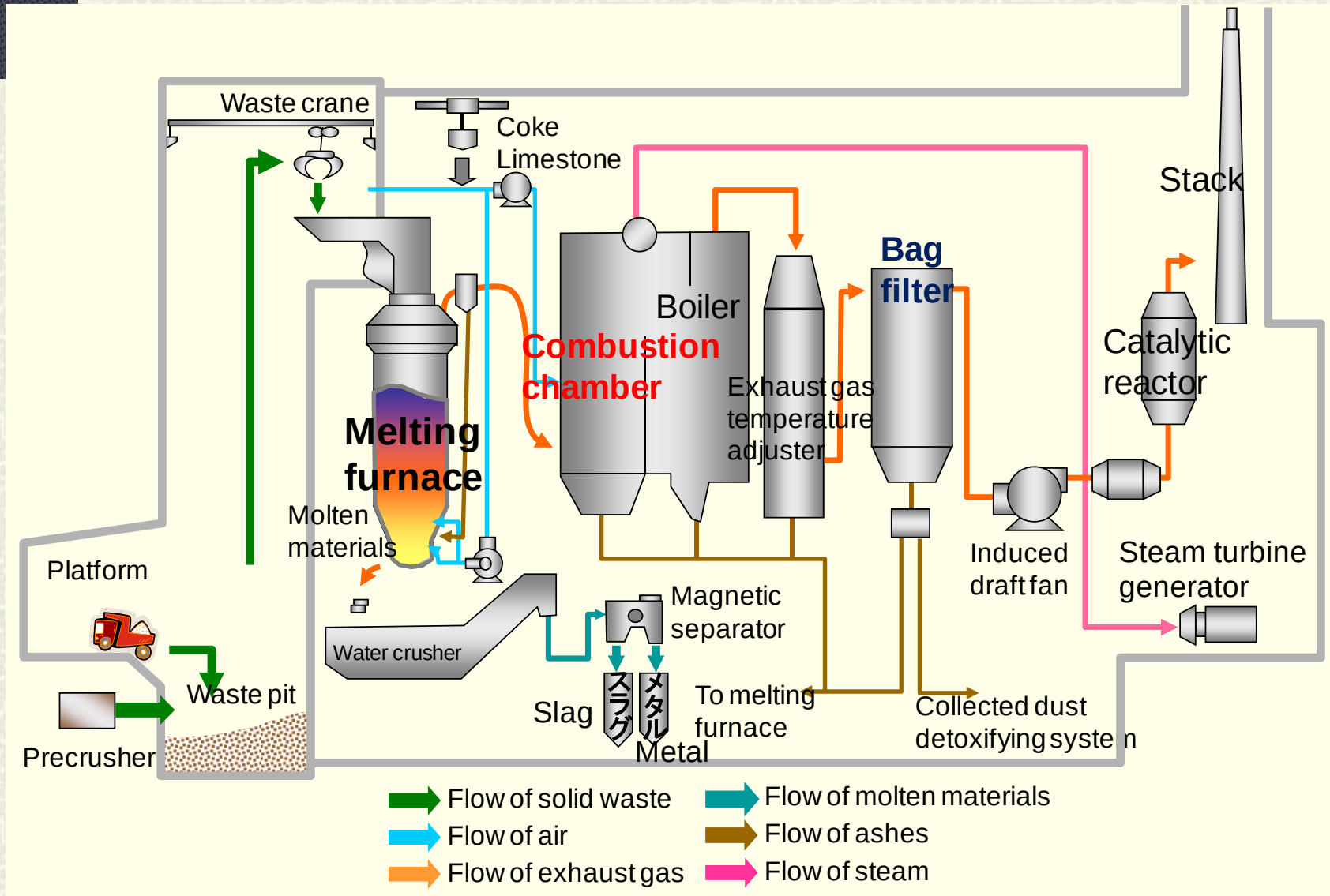


Gasification type	Melting furnace type	Manufacturer in Japan
Shaft furnace (Melting is done in the same furnace.)		· Nippon Steel Engineering Co., Ltd. · JFE Engineering Corporation
Kiln type	Circular flow melting	· Mitsui Engineering & Shipbuilding Co., Ltd. · Takuma Co., Ltd.
Fluidized bed	Circular flow melting	· Ebara Corporation · Kobelco Eco-Solutions Co., Ltd. · Hitachi Zosen Corporation · Others

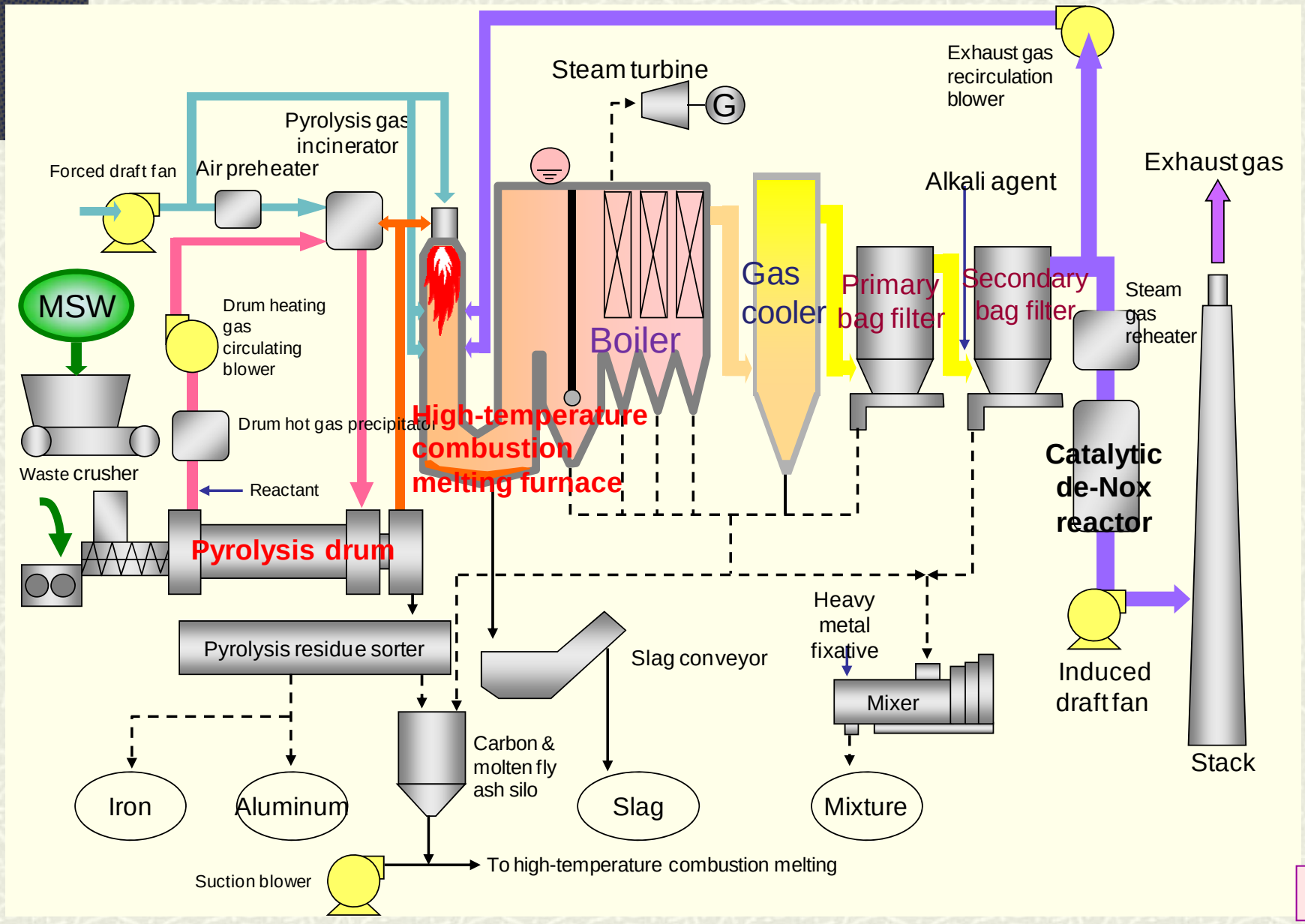
Change of the number of gasification/ melting plant in operation



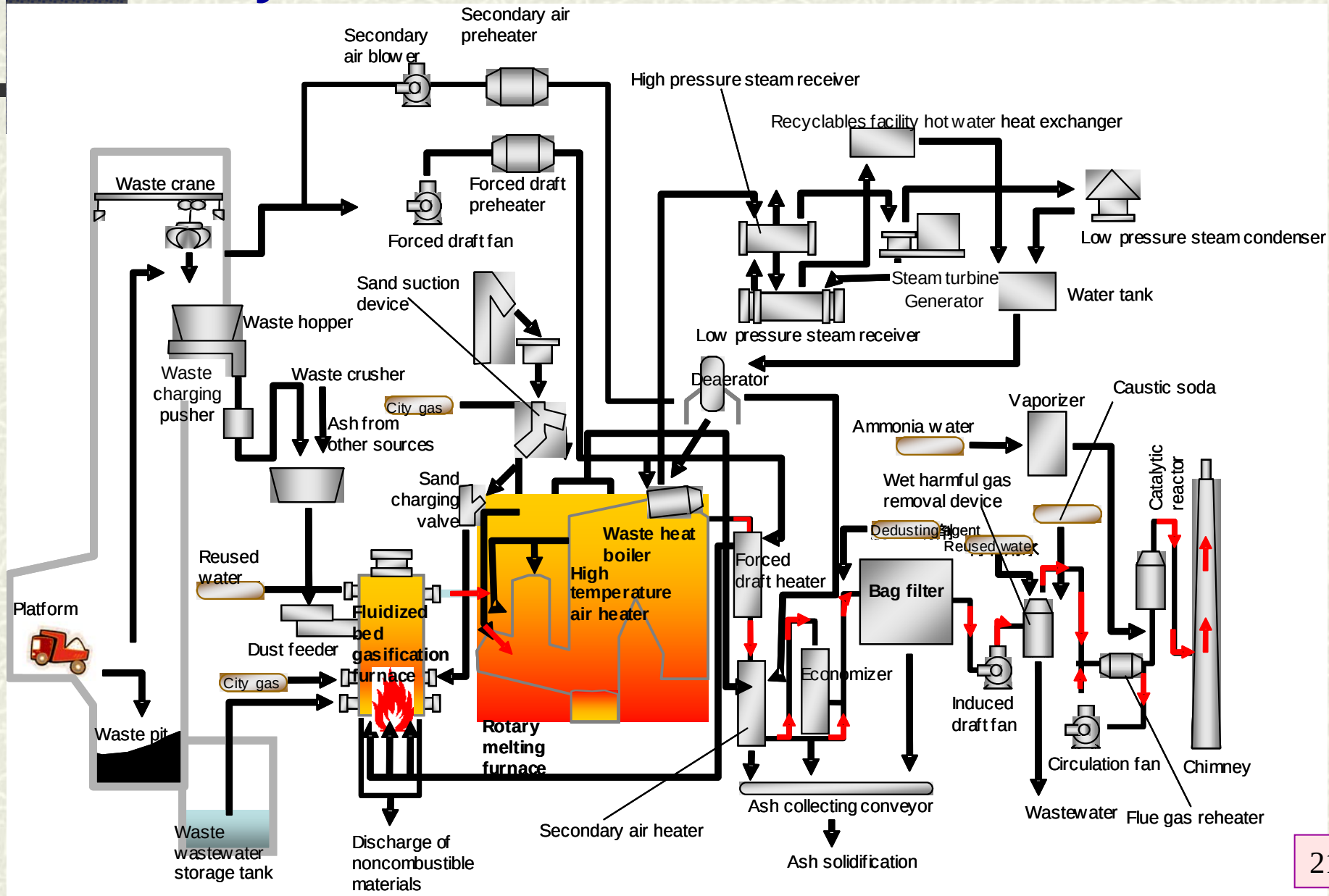
Shaft furnace type gasification/ melting system



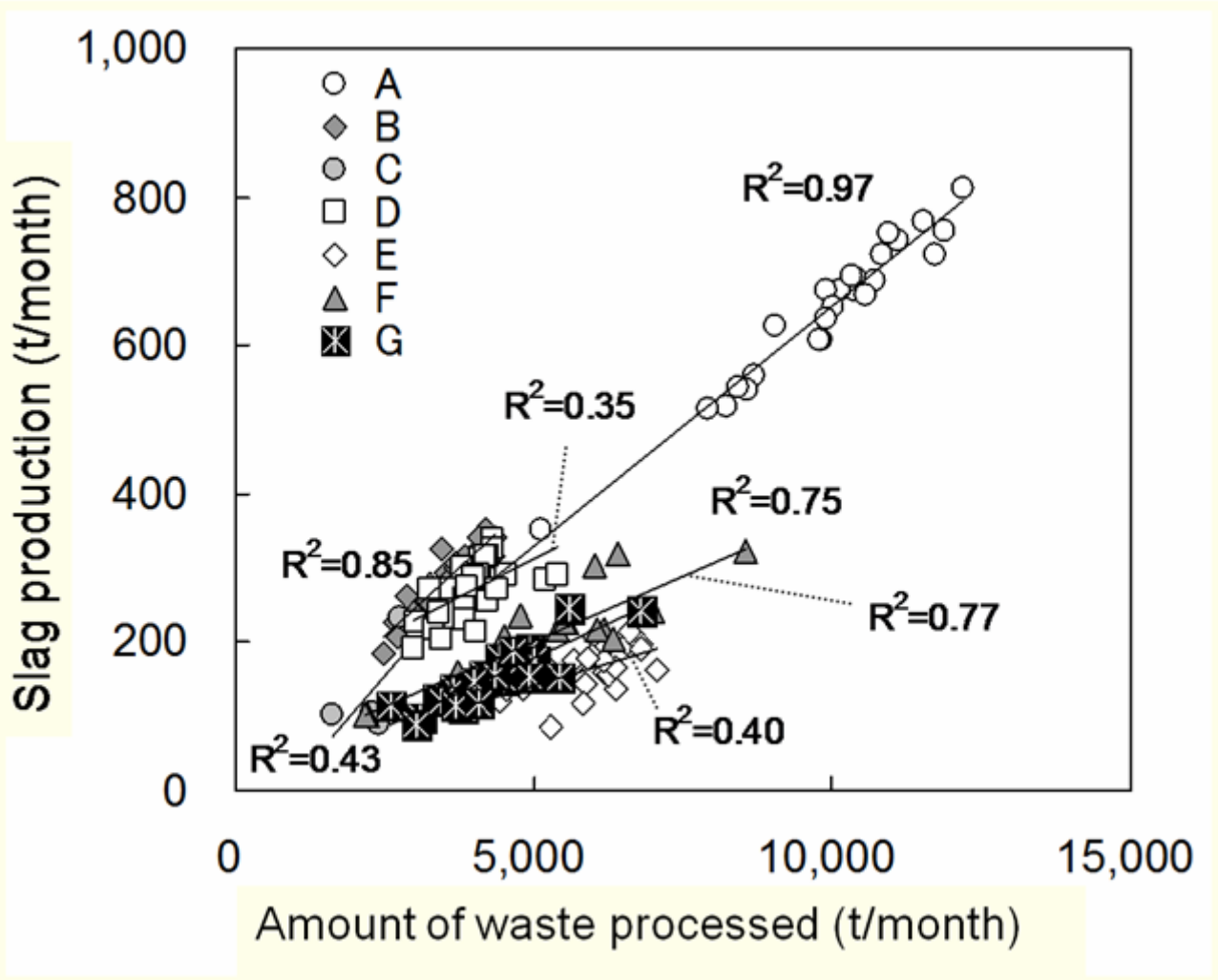
Kiln type gasification/melting system



Fluidized bed gasification/melting system



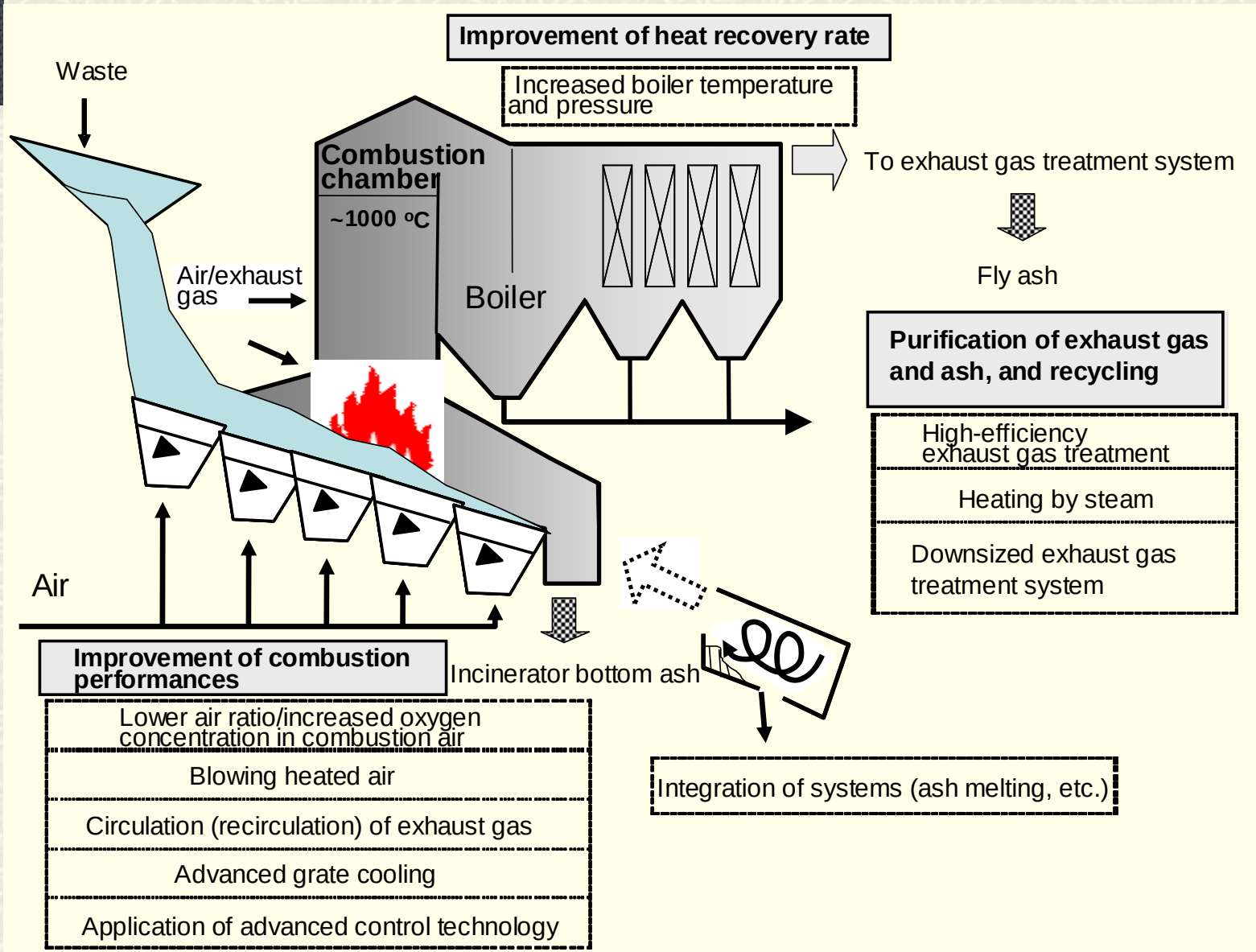
Performance of gasification/melting furnace system : Relationship between amount of waste processed and slag production



A~G shows each plant surveyed.

Next-generation stoker furnace

- Concept and characteristics of the next-generation stoker furnace



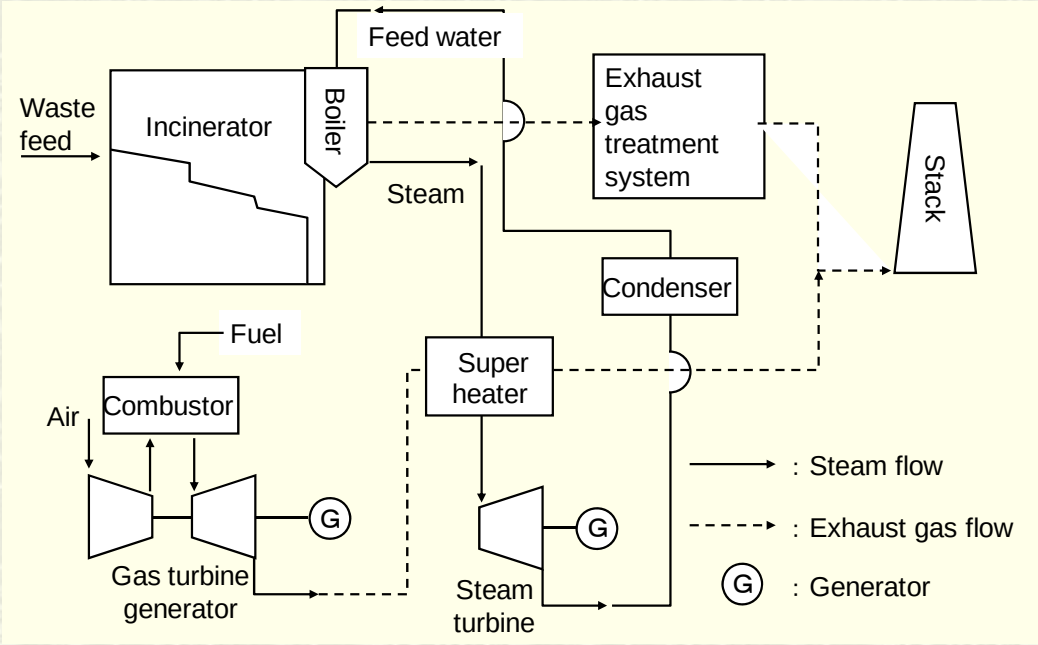
Power generation by incineration

"Refuse (Waste) to energy"

Use of residual heat in waste incineration plantsX

Use of residual heat	Use of residual heat					Residual heat is not used.
	Total	Hot water	Steam	Power generation	Other	
Number of plants	995* (1,035)	923 (966)	244 (244)	271 (263)	79 (85)	401 (455)

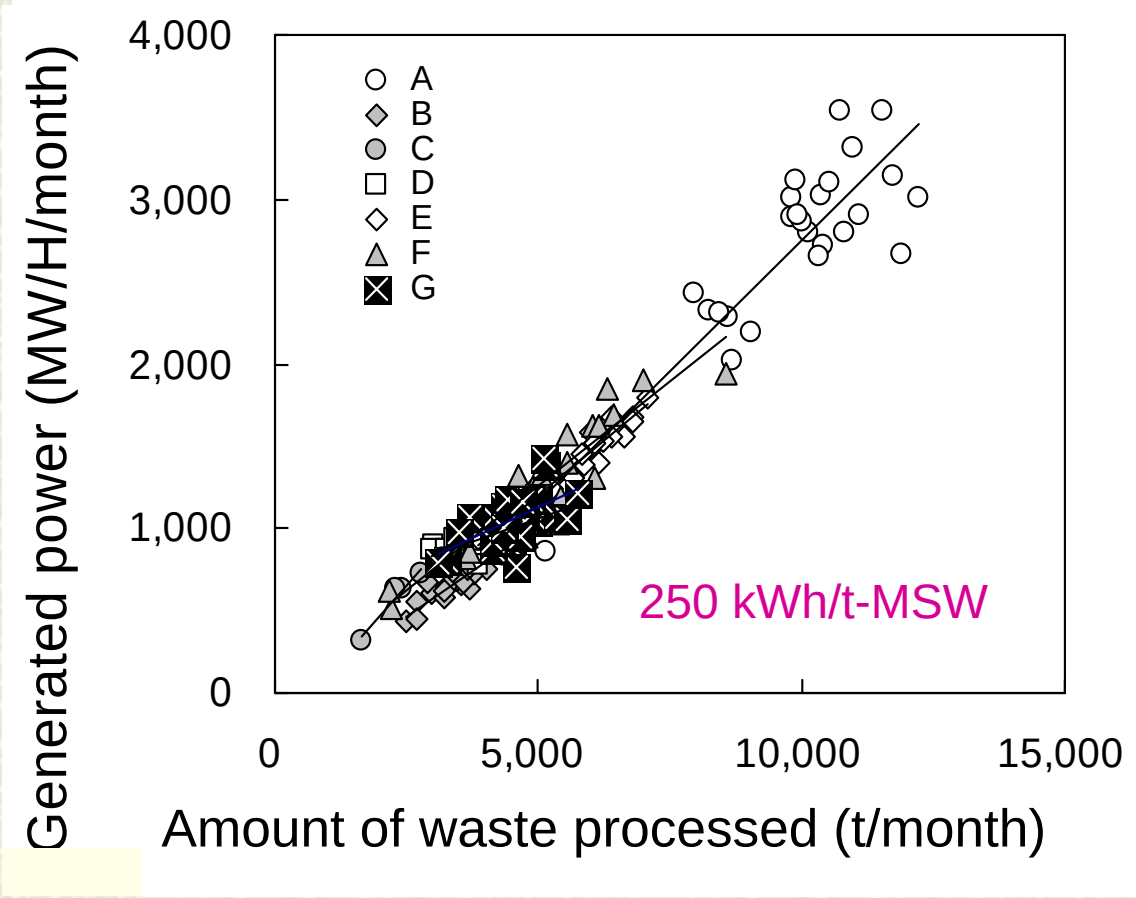
*Value of 2003.
The numbers may be counted repeatedly and the ones in the parentheses indicate data for 2002.

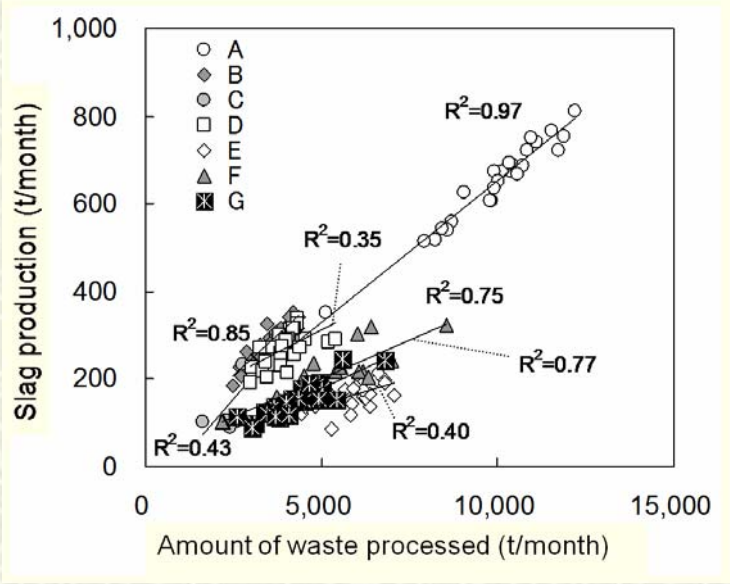


⇦ Combined and repowered system for power generation in incineration facility

Current status on power generation in gasification/melting plant

Relationship between amount of waste processed and power generation

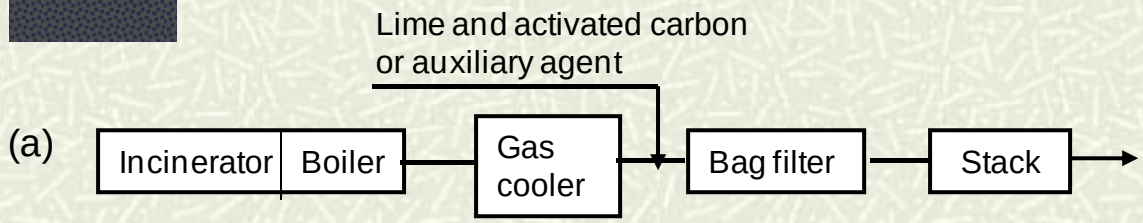




Based on a detailed investigation conducted for 7 facilities

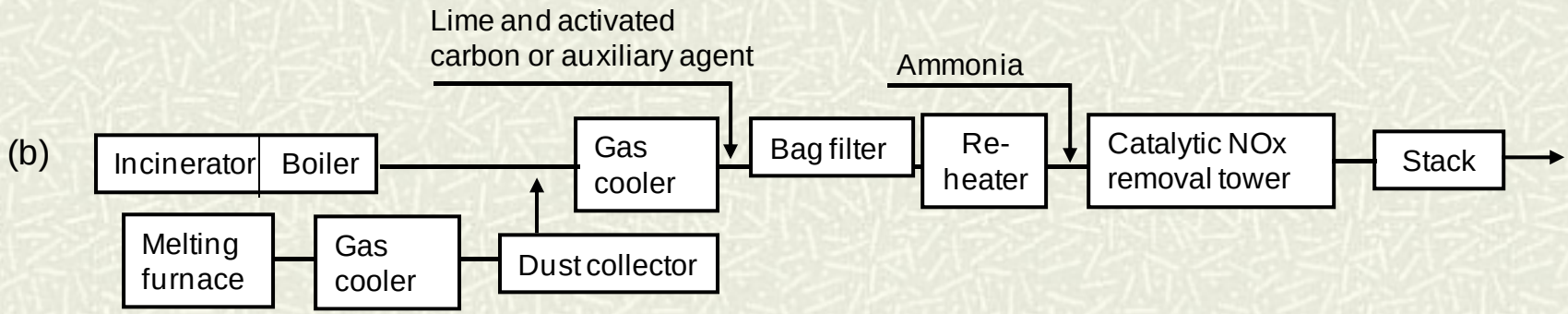
Exhaust gas treatment technology

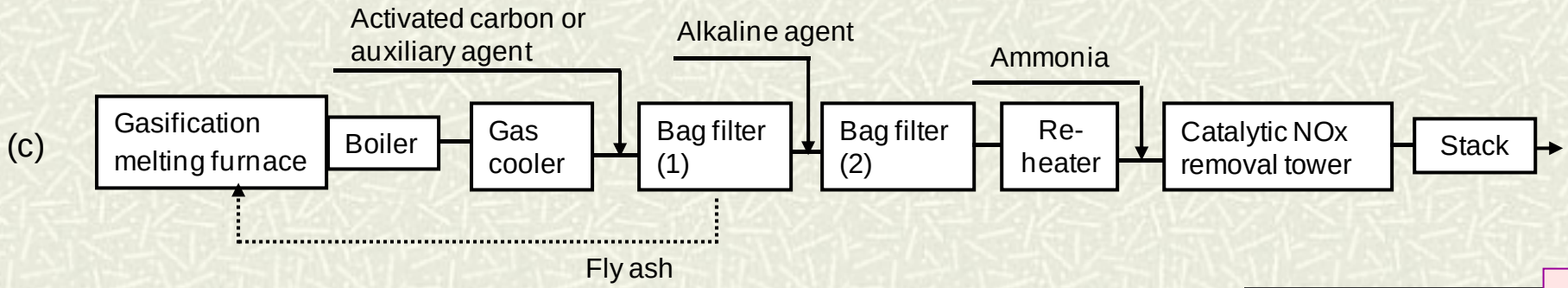
Typical recent exhaust gas treatment systems



High efficiency dust removal

Low temperature (150-200°C)





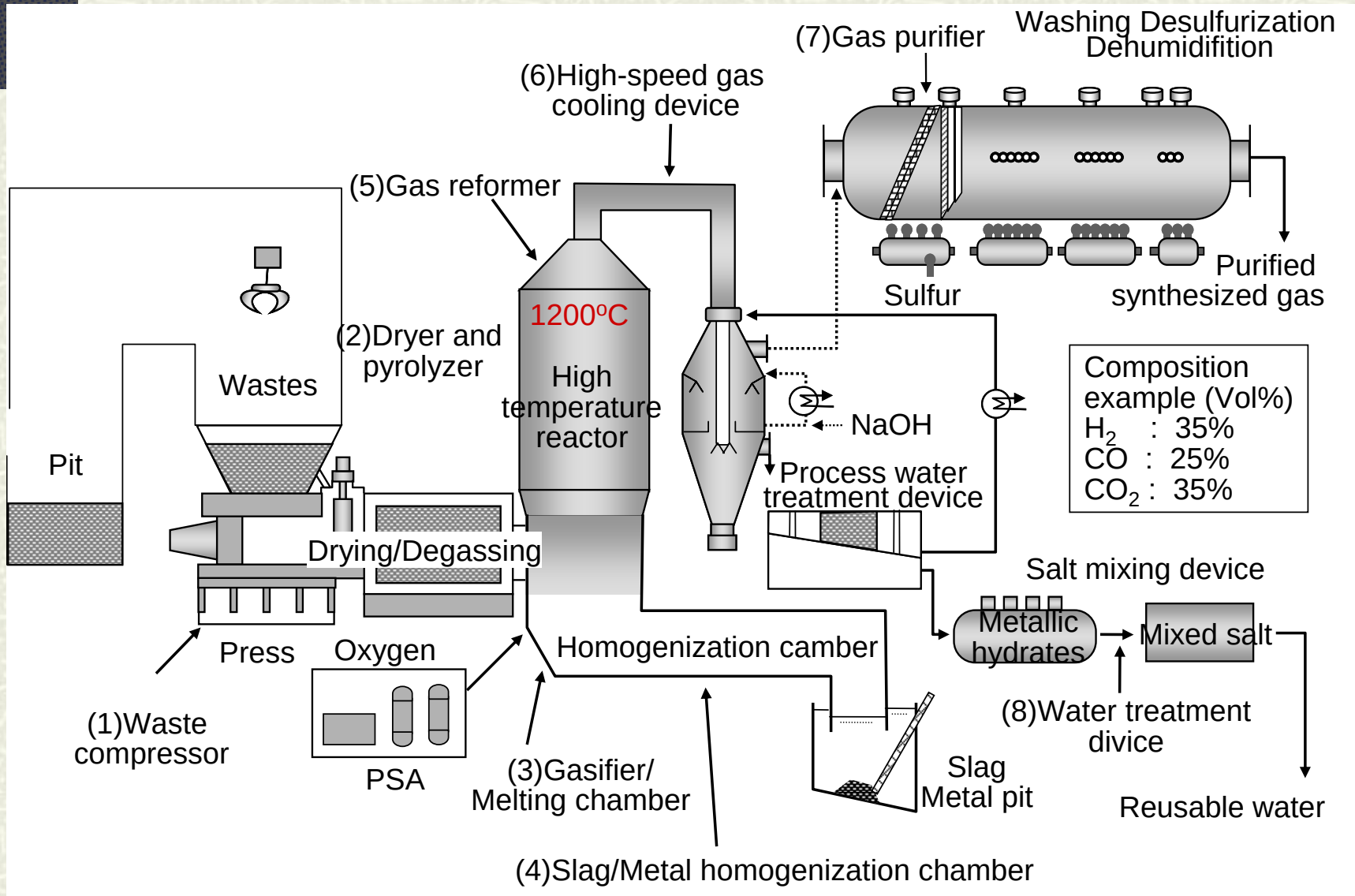
Gasification and gas reforming technology

- Gasification/melting system succeeds in the utilization of potential energy of MSW. However, chemical species such as C and H are not utilized as materials.

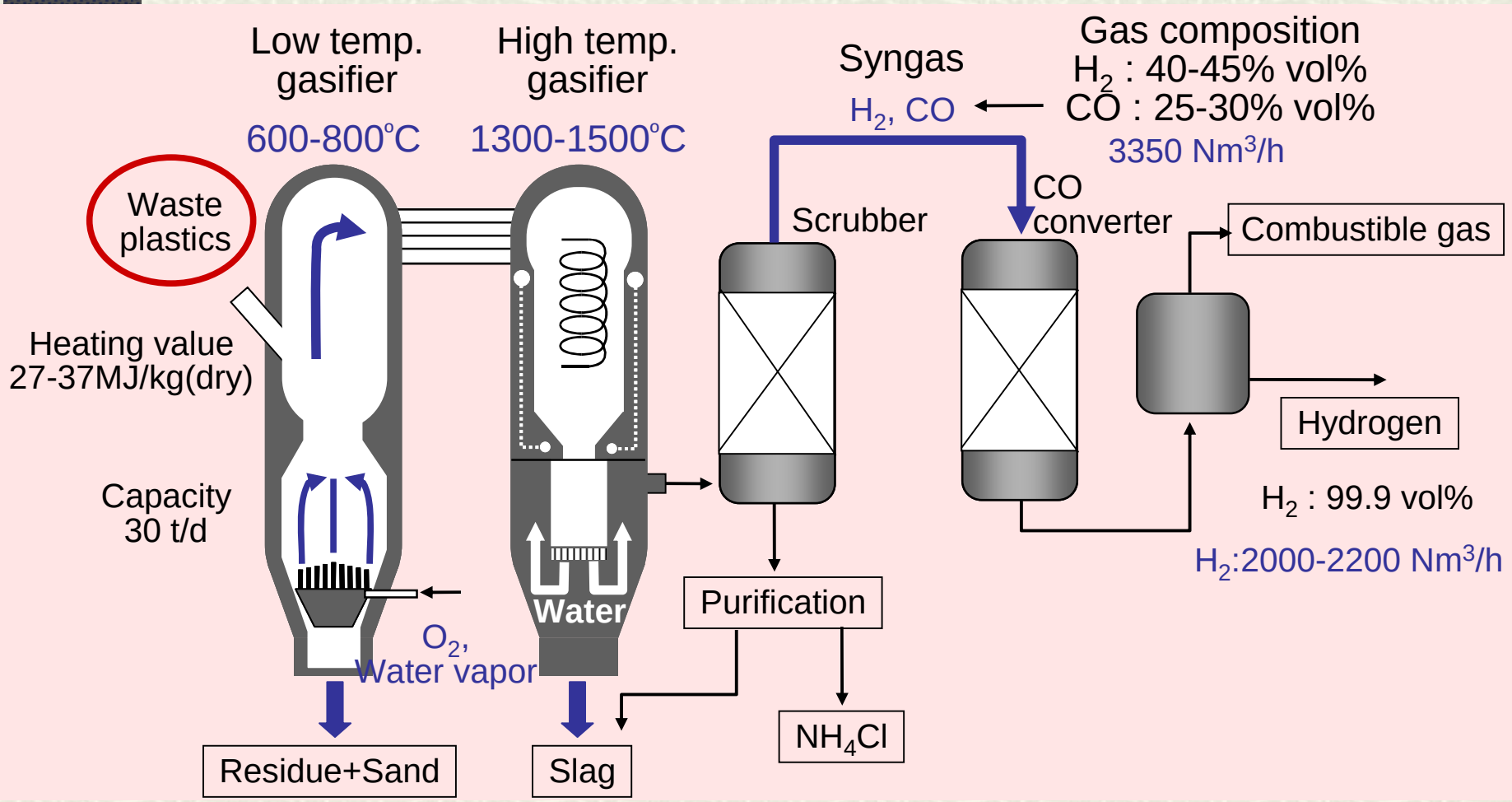
- Gas reforming process converts pyrolysis gas to H_2, CO, CO_2 and CH_4 etc.. Especially, H_2 can be utilized in a fuel cell.

- Hydrogen energy attracts a great concern because it can be applied to fuel cell and may produce a new energy system in a future society.

Thermoselect system™ (JFE Engineering)



Two-stage fluidized bed type gasification and gas reforming process（EUP™: Ebara-Ube Process）



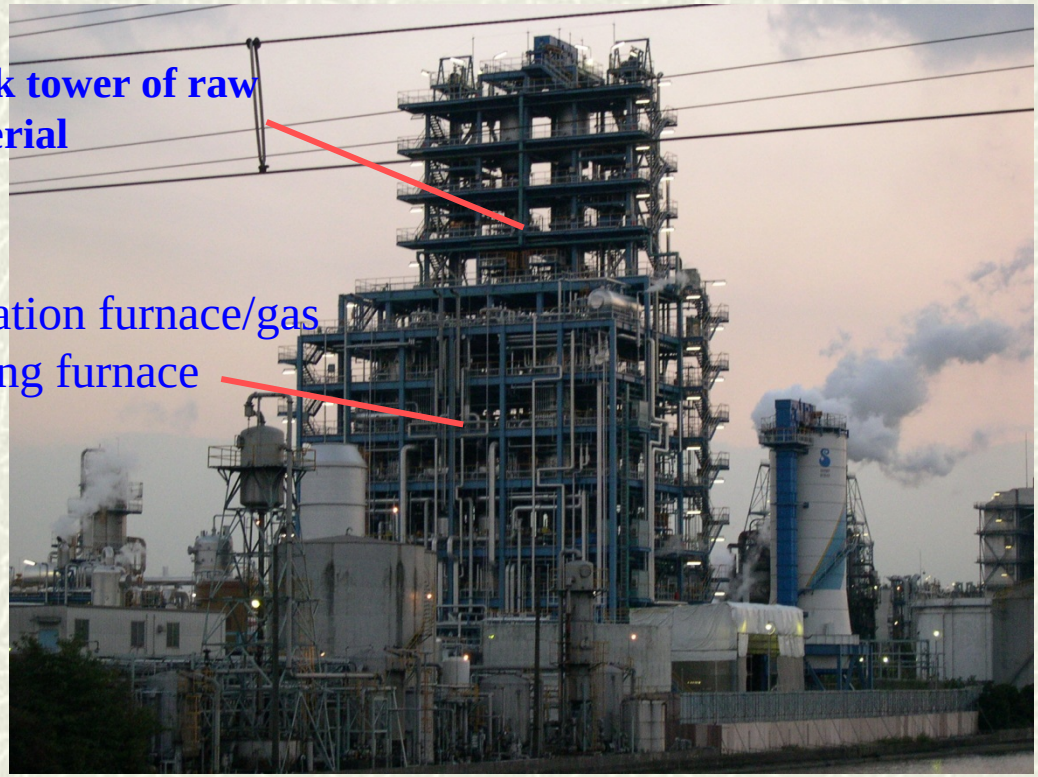
Gasification/gas reforming plant installed in a plant of Showa Denko K.K.

- Type : EUP
- Operated from April, 2003
- Raw material : Waste plastics
- Amount treated : 195 t/d

  in plan（64,000 t/y）

- Major gas components : H_2, CO,CO_2
  Gas formation amount : 200,000m^3_N/d

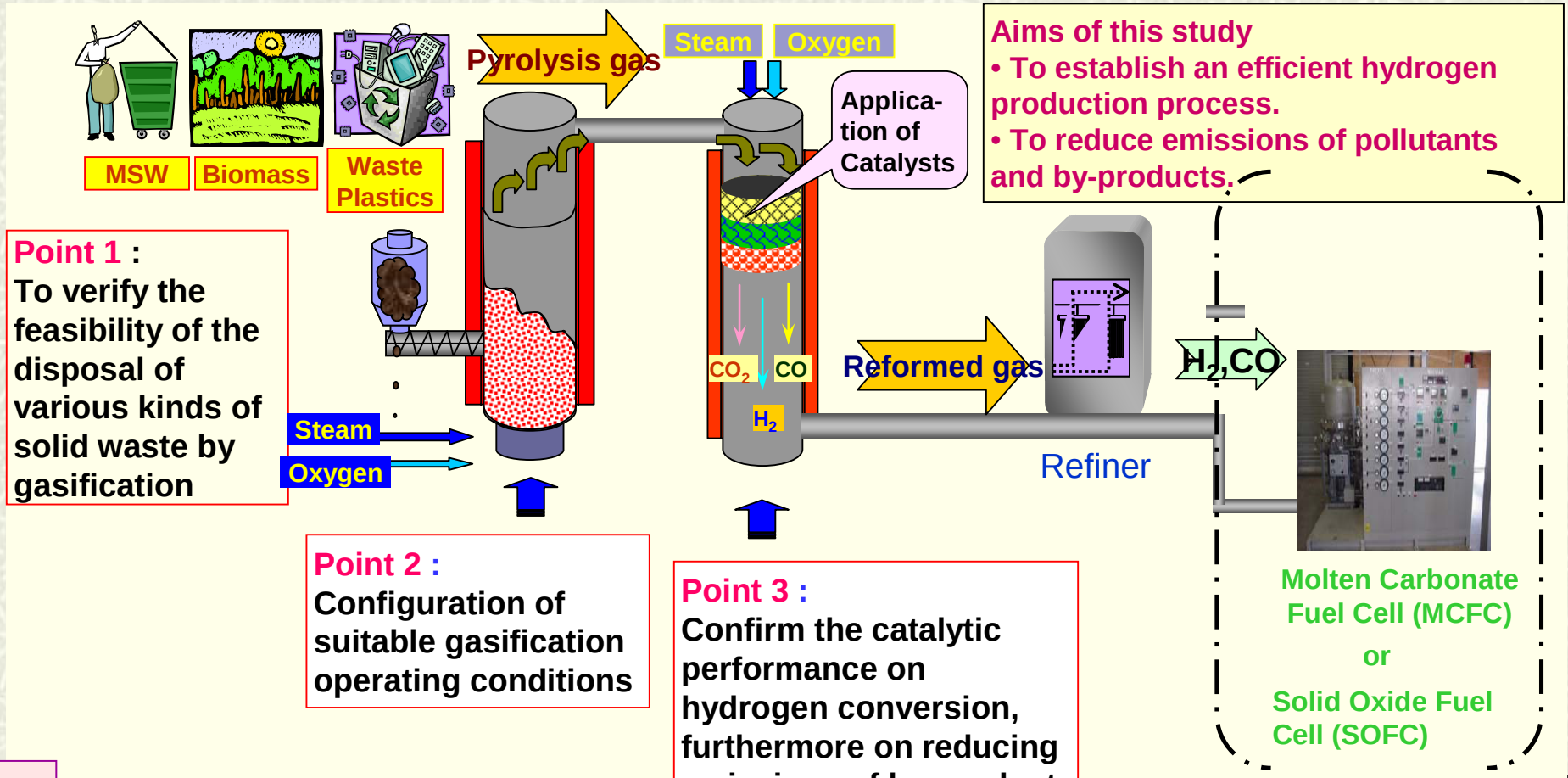
Height : 70 m (!)



Use of gas : H_2 is used as a raw material of ammonia synthesis.
CO_2 is supplied to another manufacturer.

Development concept of gasification and reforming system

Basic concept of R & D on gasification/reforming technology conducted in National Institute for Environmental Studies Japan



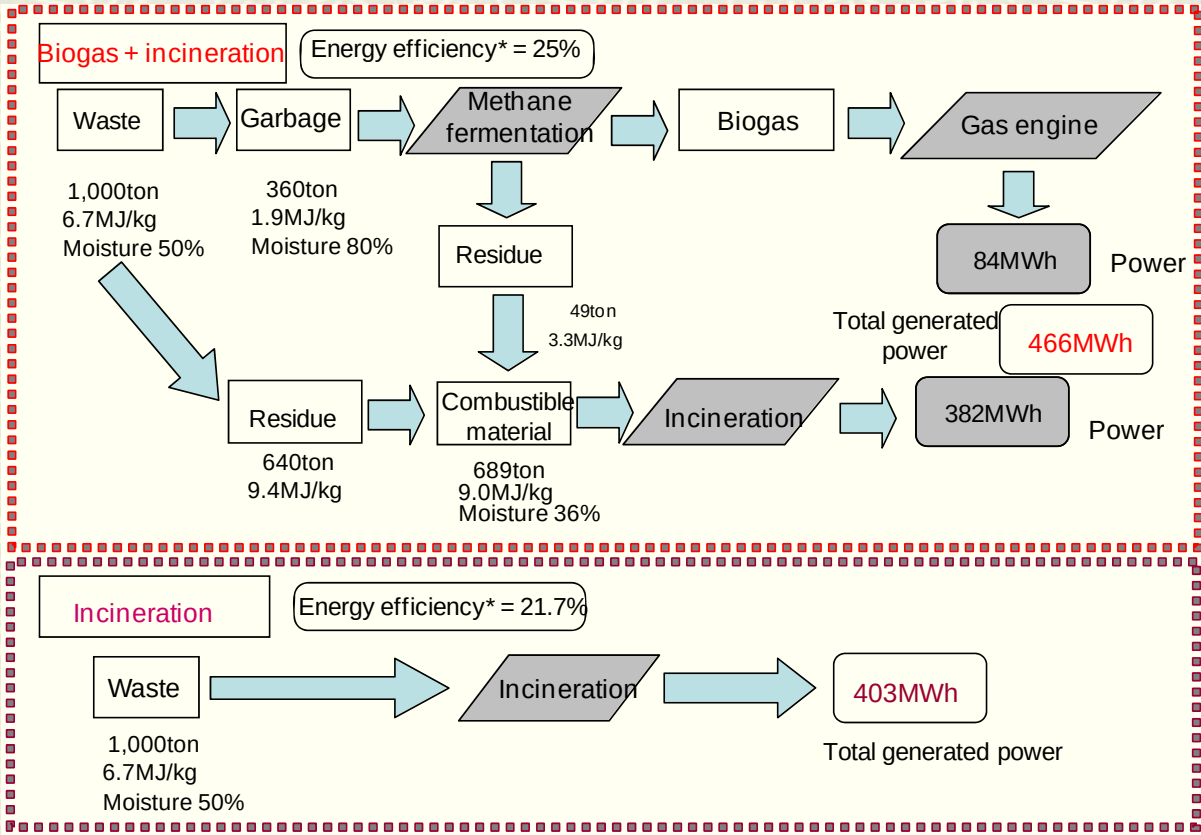
Recent trial in Japan

Example of trial calculation of energy recovery effect by methane fermentation process

What is attracting most attention recently in waste treatment is the use of methane fermentation. It is being studied to produce methane (biogas) by taking advantage of the presence of food waste with a high water content, and to use it directly as an energy source or reform it into hydrogen.

A combination of incineration with methane fermentation technology is expected to be used in future waste treatment.

An increase in generated power is expected based on estimates for the case in which all of the waste produced is incinerated and for the case in which some food waste is used for methane fermentation.



** Energy efficiency = (Generated power x 3,600) / (Heating value of waste)

Conclusions and future direction

- Incineration has been a core technology for MSW treatment in Japan. The performance of rapidly reducing the amount of MSW is reliable.
- However, it needs effective flue gas treatment and further it becomes important to meet the needs of the times, such as recovery of energy and recycling of resources, and to make good use of incineration.
- In this context, gasification and melting furnace system will be a promising way for the disposal of MSW and resource recovery.
- Further, gasification and reforming technology may be an expected technology as a material and energy recovery system from solid wastes including biomass.