Waste Gasification and Melting Technology
- Direct Melting System -

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NIPPON STEEL & SUMIKIN ENGINEERING

Steinmüller Babcock Environment
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Contents

Contents

Ownership structure

Steinmüller Babcock Environment
NIPPON STEEL & SUMIKIN ENGINEERING GROUP

NIPPON STEEL & SUMITOMO METAL

Turnover: 38.3 billion €
Employees: 84,837

100 %

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NIPPON STEEL & SUMIKIN ENGINEERING

Turnover: 2.5 billion €
Employees: 4,954

100 %

Steinmüller Babcock Environment

Turnover: 201.2 million €
Employees: 265

* all information for the financial year 2015

Group structure NSSMC and NSENGI

NSSMC

- Chemicals
- Steelmaking
- Engineering (NSENGI)
- New Materials
- System Solutions

Engineering (NSENGI):

Steel Plant and Machinery

Marine Engineering/ Construction

Environmental Solutions

Energy/ Pipeline

Building Construction/ Steel Struct.

Technical/ Business Develop.

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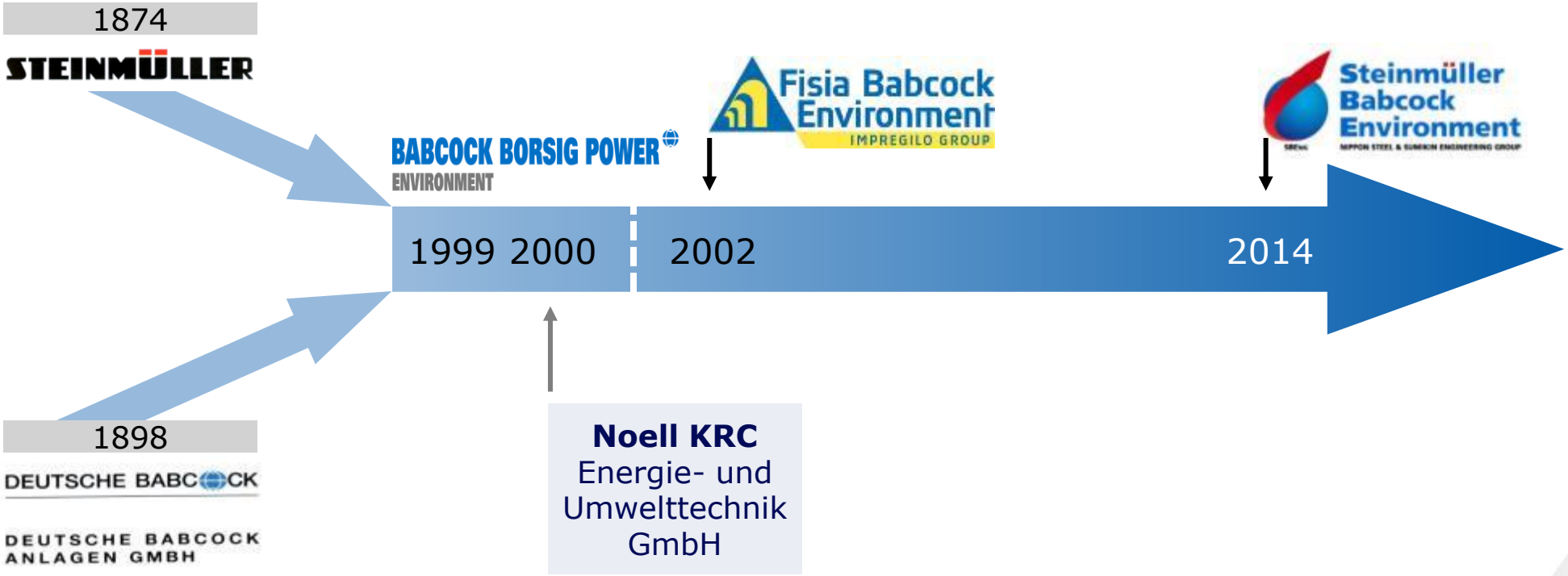
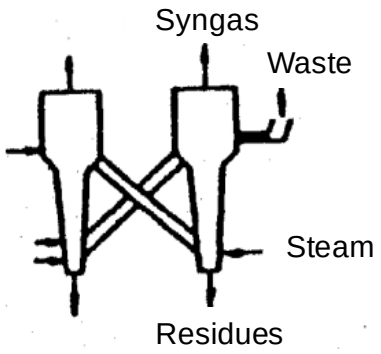
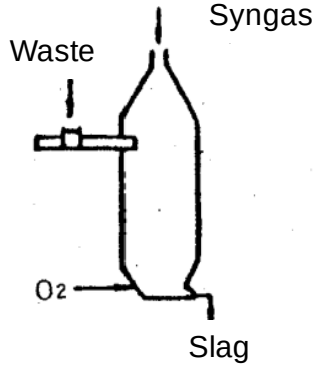
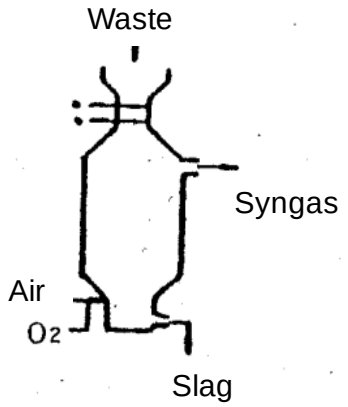
Roots of the company



’70 - ’80
- Development of Gasification Technologies -

Energy recovery from Waste via Gasification has been a great interest

1) National Project or development as a Japanese original technology
2) Modification of foreign technologies

Name	Tsukishima (Pyrox)	Showa-denkou (Purox)	Nippon Steel (DMS)
Type	Dual Fluidized Bed Gasifier	Shaft-furnace Type License from Union Carbide	Shaft-furnace Type
Overview			
Reference	1979 Funabashi-City (450 t/d)	1981 Chichibu-City(150 t/d)	1979 Kamaishi-City (100 t/d) 1980 Ibaraki-City (450 t/d)

’80 - ’90
- Development of Gasification Technologies -

✓ Ash was specified as a specially-controlled municipal waste
Optimum treatments for ash were required.
Melting is one of the optimum methods for ash treatment.

- it is not allowed to recycle bottom ash as a road construction material directly
- Aging requires a long term to stabilize toxic components
Due to its small land in Japan, it is difficult to find the space for aging.

✓ Reduction and detoxification of bottom ash and fly ash are required in Japan.

1) Ash Smelting systems using electricity or fuel were developed
2) A lot of ash smelting technologies are employed
(Arc type, Plasma type, Fuel type etc.)

’90
- Gasification and Melting Technologies become popular-

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✓ Dioxins problems
Establishment of Dioxins guidelines (1.0 => 0.1 ng-TEQ/m^3_N)

✓ Recycling of waste (Especially metal and slag (not bottom ash)

✓ Triggers
- Mitsui’s Gasification technology introduction (Recycle 21) from Siemens
- Replacement of Nippon Steel DMS in Ibaraki-City (1993)

1) Shaft-furnace type : 2 companies (Nippon Steel DMS)
2) Kiln type : 2 companies +2 groups
3) Fluidized bed type : 8 companies + 1 group

Total 12 companies + 3 groups

Requirement for Gasification

1) Low emissions (especially **Dioxins and other components**)

2) Material and energy recovery from waste
   Energy recovery is not a first priority
   Due to its severe regulation on bottom ash, it is not allowed to recycle as a road construction material directly.

3) Reduction and minimisation of final landfill amount
   Treating various kinds of waste together
   Due to its small land, reduction of final landfill is a first priority

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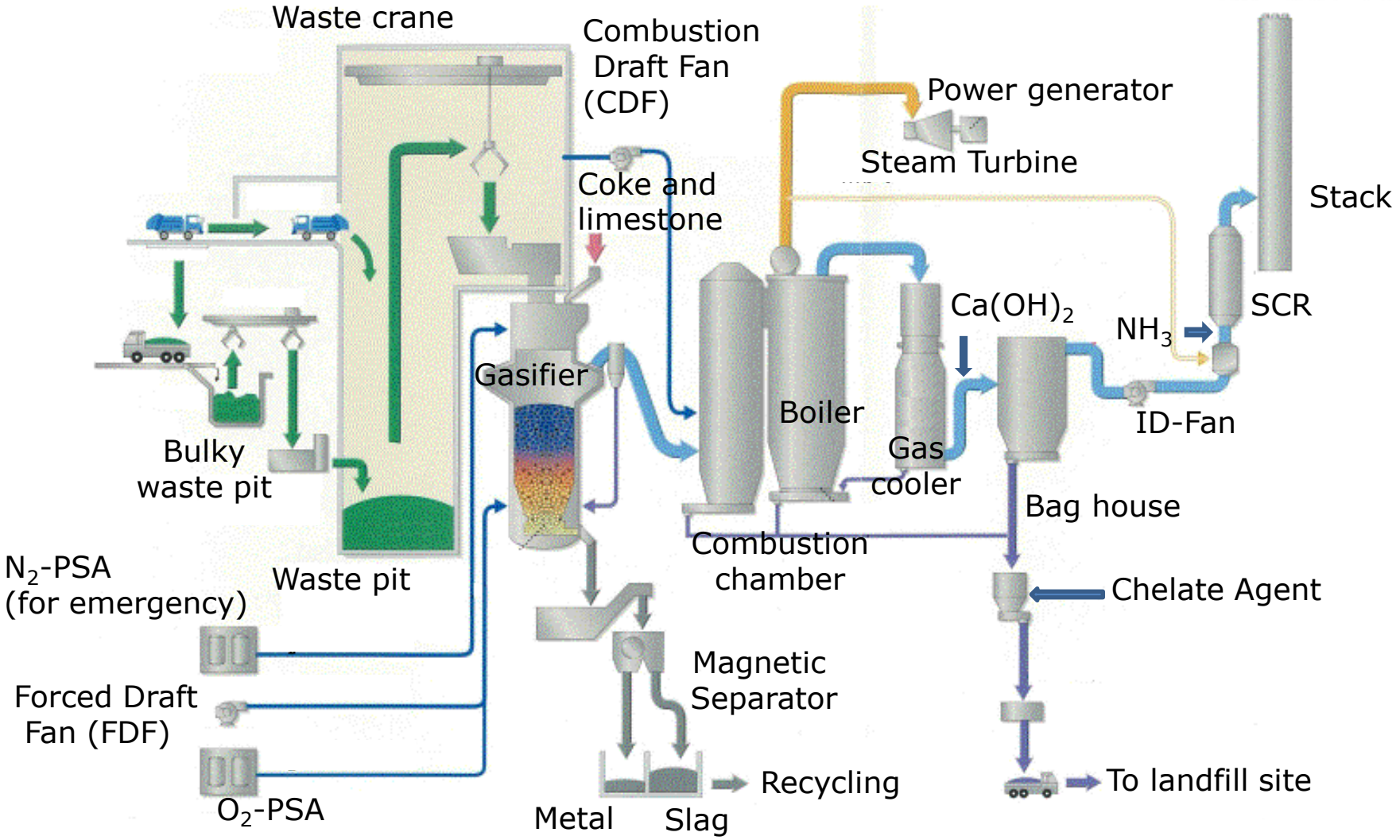
4) Cost reduction (including final landfill gate fee)

Contents

Process Flow



Gasifier Advantages

➢ **Waste Flexibility**
No Pretreatment (Max. 800 mm)
Co-gasification


Sewage sludge


Bottom ash

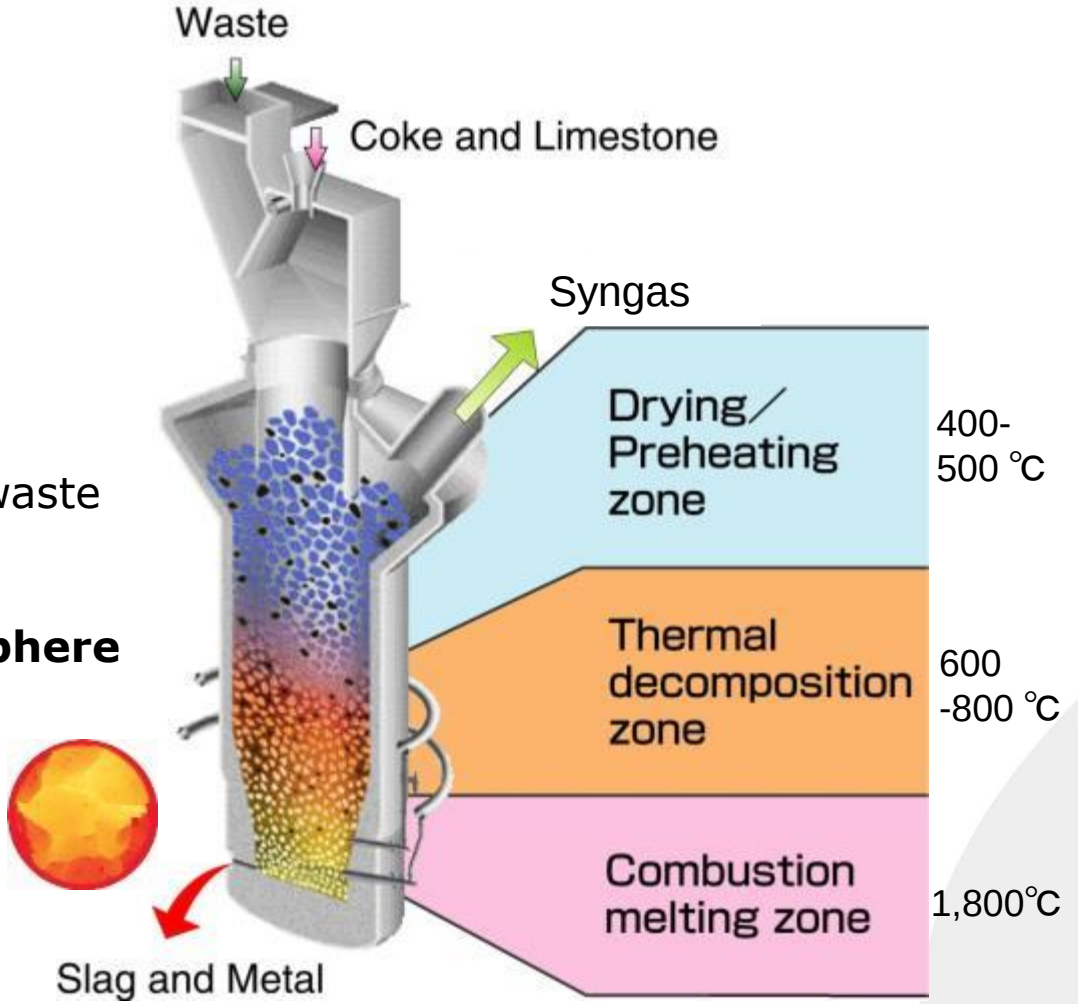

Landfill Waste


Clinical Waste

➢ **High LHV of Syngas**
Continuous syngas measuring
Stable combustion
Approx. 5.9 MJ/m^3_N based on 9.1 MJ/kg-waste
refer to N.Tanigaki et. al. Waste Management

➢ **High Temperature & Reducing Atmosphere**
Produced by coke burning heat
Toxic heavy metals are volatilized and distributed to fly ash.
Few toxic heavy metals remain in slag and metal.

➢ **Low Environmental Impact**
Low HCl and SO_2 concentration



Contents

Key Advantages for Deploying

(1) Flexibility
- Waste flexibility

(2) Environmental Friendly
- Lower Emissions
- Contribution to “Circular Society”

(3) Sustainability
- High Power Generation
- Material and Energy Recovery from Waste

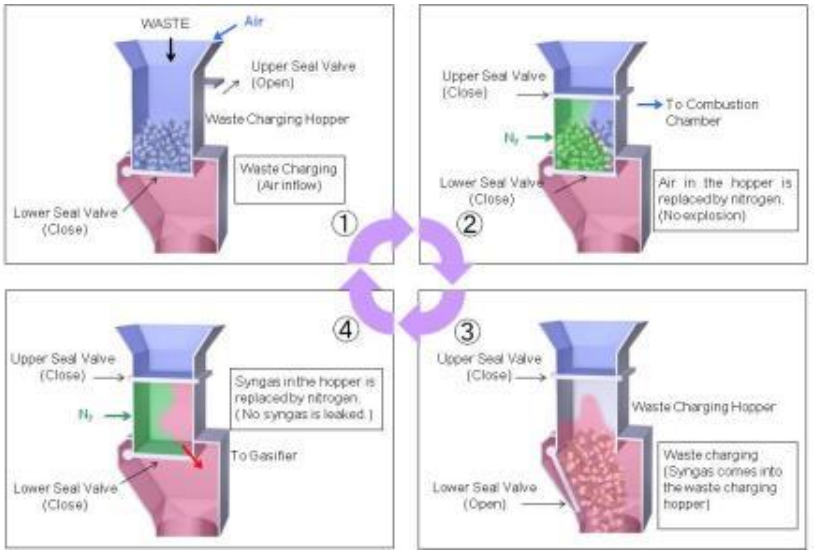
(4) Reliability
- Technology is well-proven
- Company
- Technology supplier or Turn-key supply?

Waste Flexibility

(1)Waste Flexibility

This system has high waste flexibility and requires no pre-treatment.

- ✓ High temperature gasification (>1,800 C)
- ✓ Double damper system (max. 800 mm)
- ✓ No pre-treatment



(2) Waste to be processed

Mainly MSW or RDF

In addition, we process other waste with higher gate fee (co-gasification).

The **"Co-gasification"** can improve the feasibility of the plant.

Sewage sludge

Bottom ash

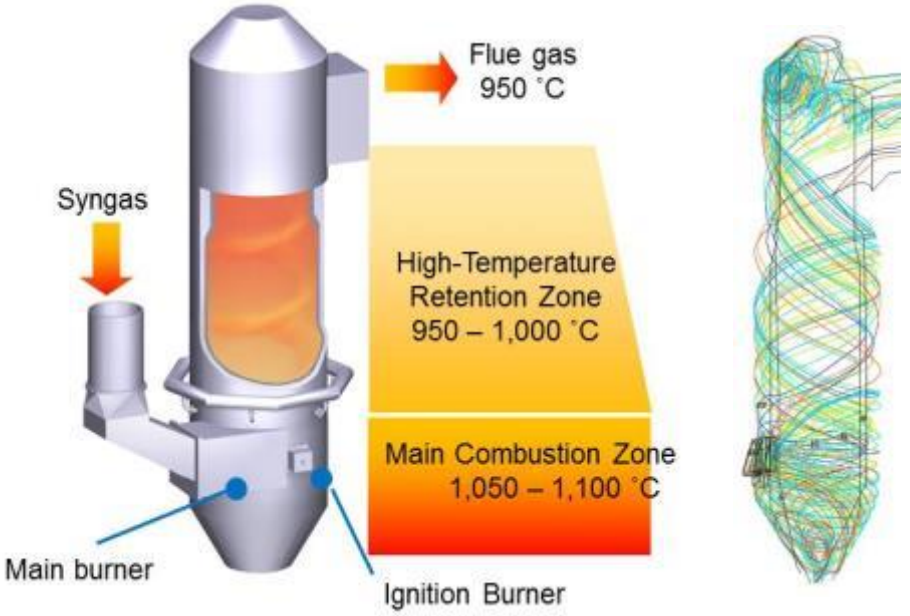
Landfill Waste

Clinical Waste

Environmental Friendly

(1)Low Emissions

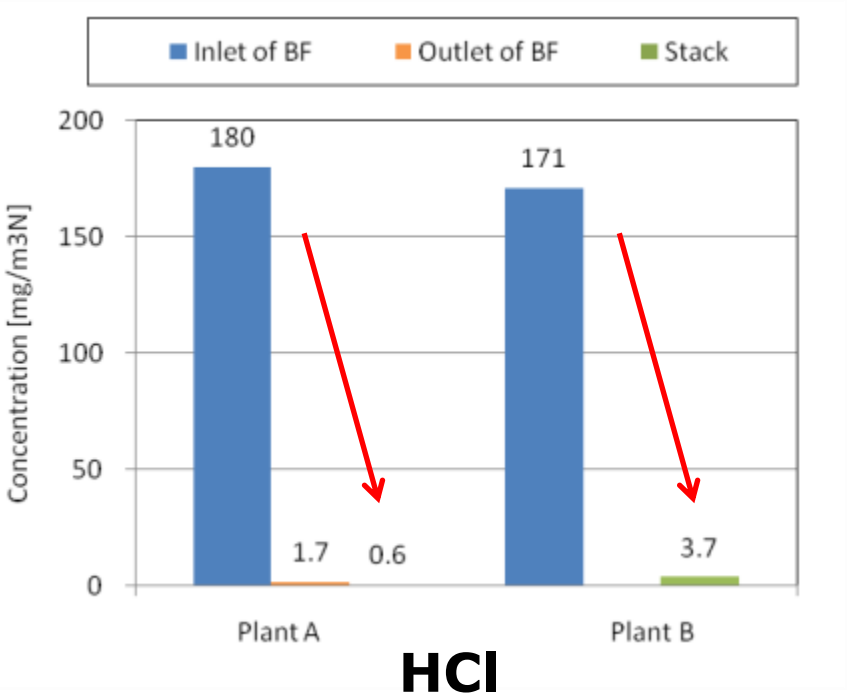
- ✓ Syngas combustion (homogeneous combustion) for low NOx and PCDD/DFs emissions
- ✓ 3Ts (Time, Temperature, turbulence)
- ✓ Lower emissions such as PCDD/DFs, HCl and SO_2 have positive impact for achieving permissions.



(2) Energy and Material Recovery from Waste

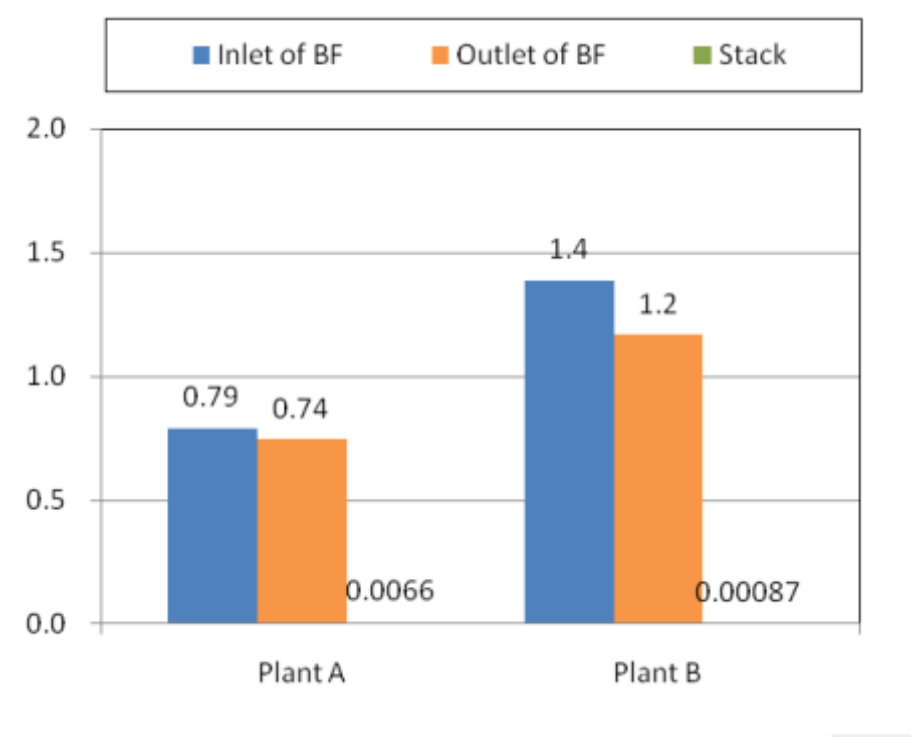
- Recycling material from waste without further post- treatment
- Minimizing non-recyclables and landfill amount
- Contributing to **"Circular Economy"**

Environmental Friendly
- HCl and PCDD/DFs Emissions -



HCl

- due to Desulfurization by limestone injection to the gasifier, HCl and SO_2 concentration from gasifier is very low.



PCDD/DFs

✓ PCDD/DFs were not removed at BF due to no activated carbon injection.

✓ PCDD/DFs concentration at stacks are significantly low.

Source: Tanigaki, N. et. al 2013. ***Waste Management* & Research**, Nov.

Sustainability
- Power Generation -

- **Horizontal Boiler**
- η : >**28%**
  (11 MJ/kg, 10t/h x 2 lines)

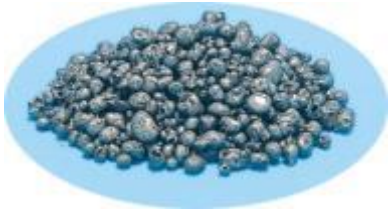
- Dust Removal:
  Rapping system
  Shower Cleaning
  Soot Blower for Economizer
  Lower maintenance problems

- Well-organized boiler structure via SBENG's know-how.

- Combustion chamber is also the part of the boiler

Sustainability
- Material Recovery from Waste -

Discharging Molten Materials
(mixture of slag and metal)



metal

slag

Materials of Iron industries

Counterweight for construction machine

		Slag (DMS)	Natural Sand (example)	Japanese Standard limited value
Pb (lead)	mg/kg	5~20	1~15	<150
Arsenic	mg/kg	<0.5	~2	<150
Cd	mg/kg	<0.1	<0.1	<150
T-Hg	mg/kg	<0.05	<0.05	<15
Chromium	mg/kg	<1	<1	<250
Selenium	mg/kg	<0.2	<0.2	<150
Fluorine	mg/kg	50~200	<400	<4,000
Boron	mg/kg	100~250	<400	<4,000

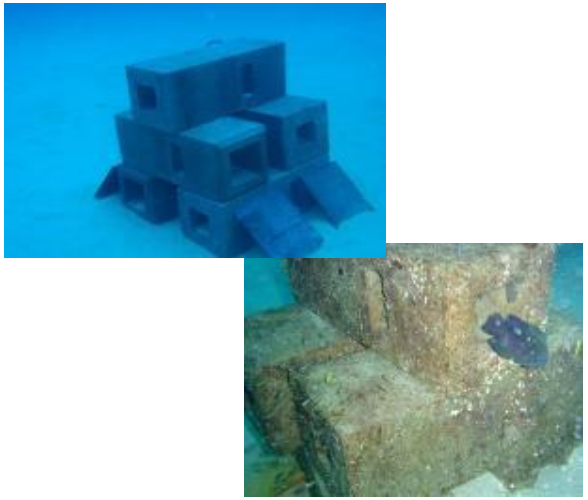
Acid leaching test (JIS K0058-2)

Sustainability
- Slag (Eco-sand) Recycling -

Produced Slag is 100% recycled and is sold as “Eco-Sand”, not only for secondary materials but also marine block or soil.

Concrete block

Slag (Eco-Sand)



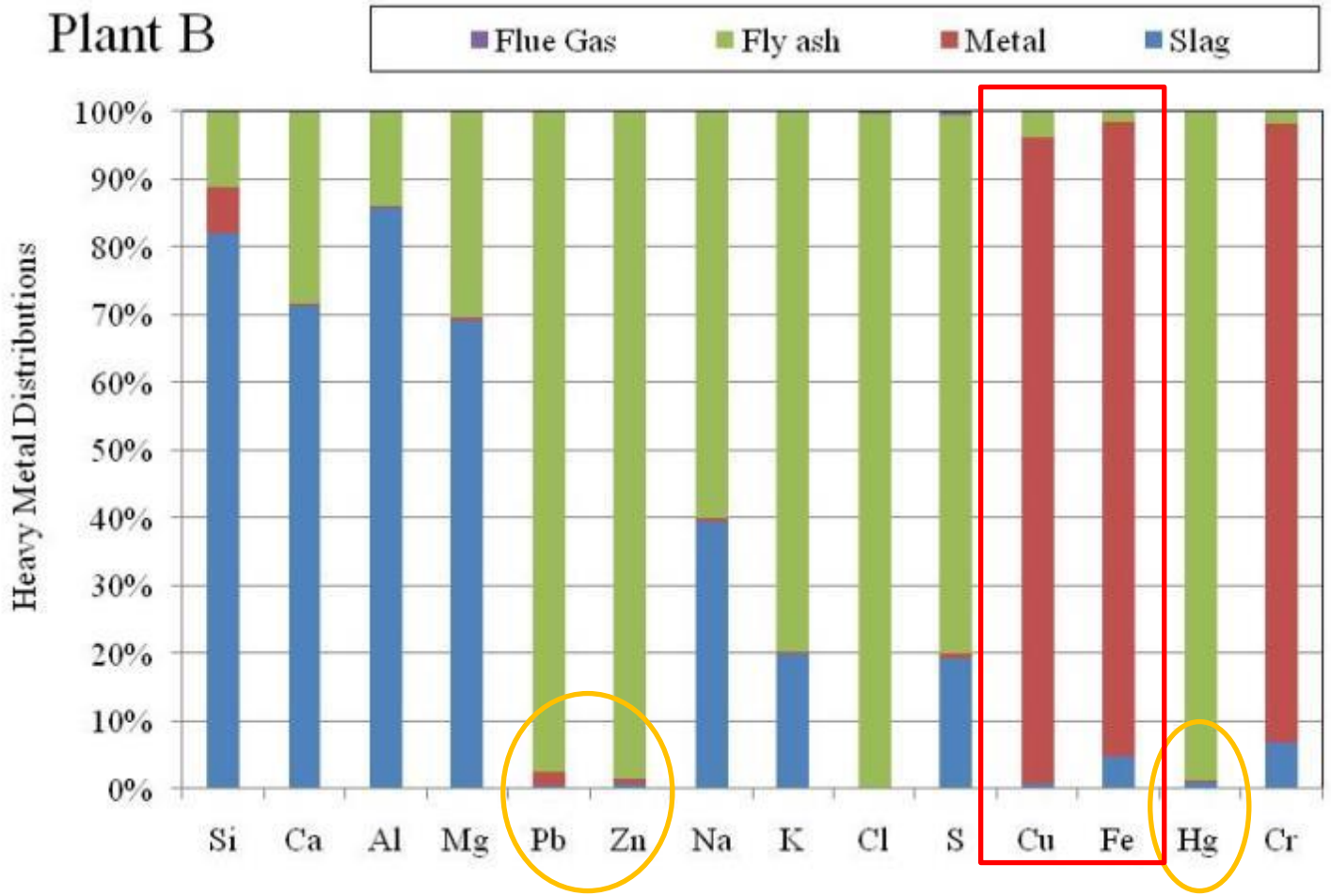
Marine Block

Interlocking block

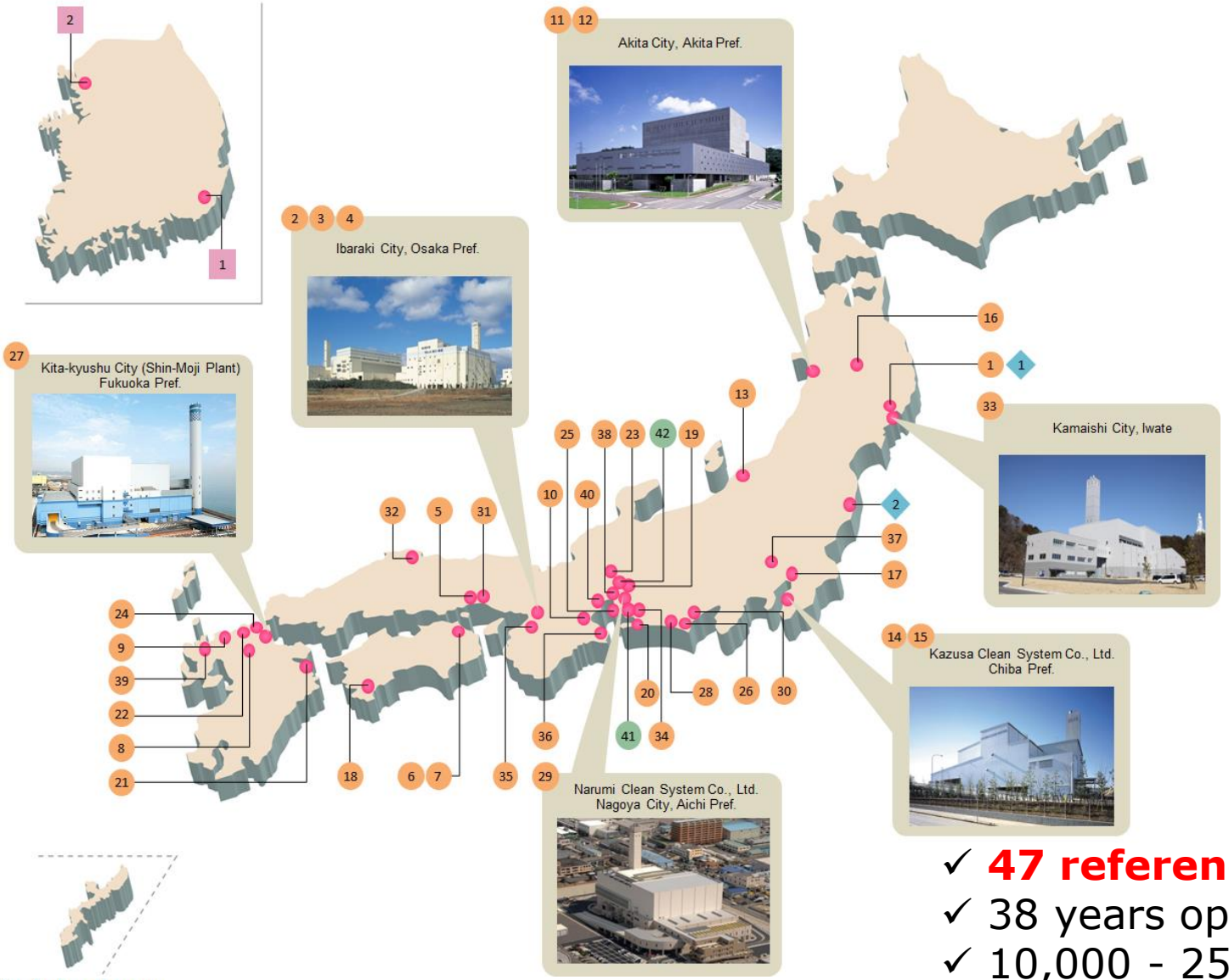
Asphalt paving

Soil

Sustainability
- Heavy Metal Distribution (Recycling) -



Reliability
- Commercial References -



- ✓ **47 references**
- ✓ 38 years operation
- ✓ 10,000 - 250,000 t/a

Reliability
- Measures for Scaling-up of Gasifier -

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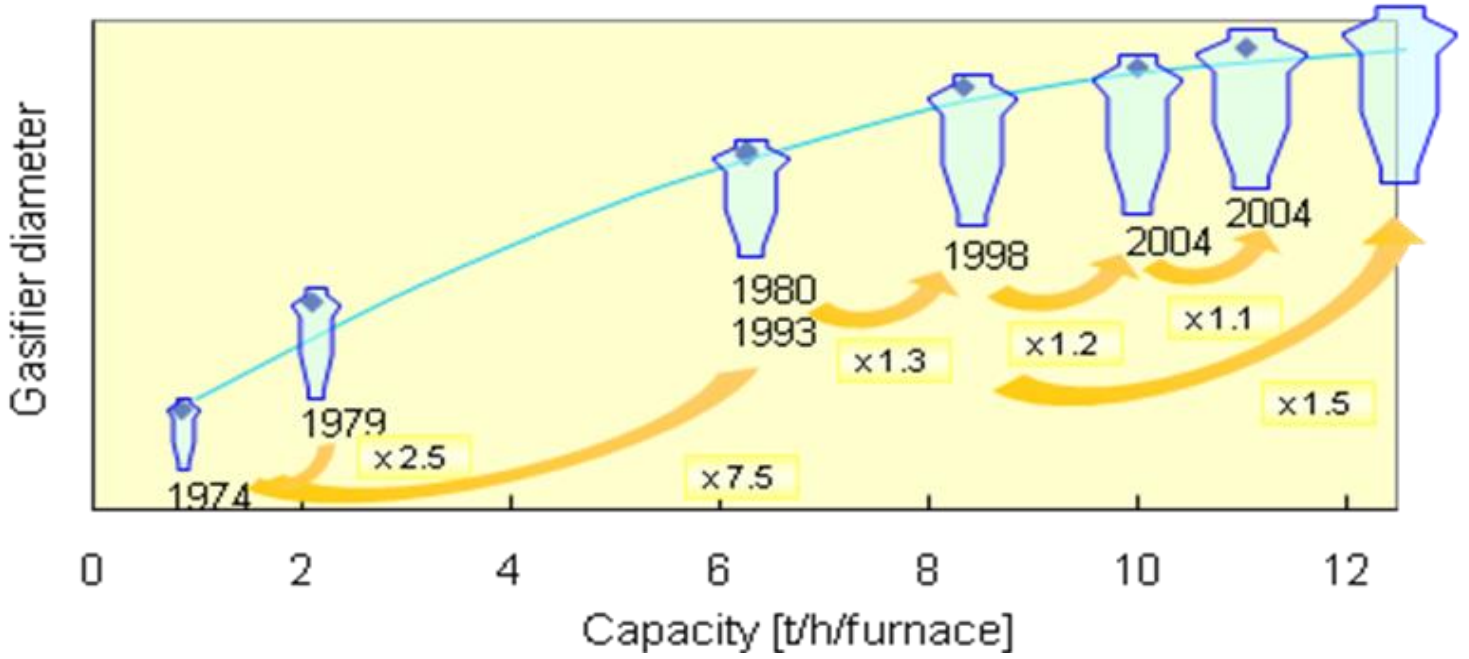
Scale-up of gasification technology is one of the technical issues.
- Gasification reaction in the gasifier.
- optimization of waste charging and combustion conditions.

Our gasification (Direct Melting System) gradually expands its capacity, during 37 years and leach the capacity of 14 t/h per line.



Shin-Moji Plant, Japan

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Location / Purchaser
Kitakyushu City, Japan

Fuel
Municipal solid waste
Incombustibles

Capacity
3 x 10 t/h
9 100 - 12 000 kJ/kg
Largest gasification Plant in operation

Year of Start Up
2007

NSENGI Scope of Supply
Full Turn key
Operation & Maintenance

Saitama Plant, Japan

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Location / Purchaser
Saitama City, Japan

Fuel
Municipal solid waste
Bottom ash
Incombustibles
Sewage Sludge

Capacity
2 x 7.9 t/h

Year of Start Up
2015

NSENGI Scope of Supply
Full Turn key
DBO
Operation & Maintenance

Narumi Plant, Japan - Co-gasification -

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Location / Purchaser
Nagoya City, Japan

Fuel
Municipal solid waste
Bottom ash
Incombustibles
Combustibles

Capacity
2 x 11 t/h
6 500 kJ/kg

Year of Start Up
2009

NSENGI Scope of Supply
Full Turn key
BTO
Operation & Maintenance

✓ Bottom ash direct recycling is not allowed
✓ The municipality has no landfill site
⇒ ***Need solutions. Co-Gasification and recycling***
⇒ ***87% reduction of final landfill amount***

Kita-Nagoya Plant, Japan

Location / Purchaser
Kita-Nagoya City, Japan

Fuel
Municipal solid waste

Capacity
2 x 14 t/h
Largest Waste gasification

Year of Start Up
-
(awarded at 11th Dec. 2015)

NSENGI Scope of Supply
Full Turn key
BTO
Operation & Maintenance

Yangsan, South Korea

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SBENG
NIPPON STEEL & SUMIKIN ENGINEERING GROUP

Location / Purchaser
Yangsan City, South Korea

Fuel
Municipal solid waste

Capacity
2 x 4.2 t/h
12 000 kJ/kg
20% moisture

Year of Start Up
2007

NSENGI Scope of Supply
Basic Engineering
Gasifier, Slag discharger
Combustion chamber
Operation training

Reliability
- Operation Support -

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(1) PlantPAD

- ✓ Monitored operating condition remotely
- ✓ Inspection data is recorded
- ✓ Checking operating data
  - ITV
  - Historical trend data
  - On-time operating condition
- ✓ easier maintenance management

(2) Predictive Operating

- ✓ Many operating records can predict the operating conditions.
- ✓ Several parameters are picked up for predictive operation.

These supporting system lead easier "O&M" of gasification technology

Summary

- ✓ SBENG as NSENGI Group has a capability to provide various solutions for clients. (gasification, incineration and others)
- ✓ SBENG can provide EPC Turn-key Solution to the clients for Incineration and Gasification with reliable references.
- ✓ The Direct Melting System (DMS) can achieve both the energy and material recovery from waste without any pre- and post treatment.
- ✓ Driving factors of waste gasification for deployment are
  (1) Flexibility of waste
  (2) Environmental Friendly
  (3) Sustainability (Energy and Material recovery)
  (4) Reliability (Commercial Reference, O&M, EPC capability)
- ✓ Especially, our waste flexibility have great possibility to contribute to "Circular Economy" and to improve feasibility of the project.

WE MAKE THE WORLD A CLEANER PLACE

Let´s work it out together.

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