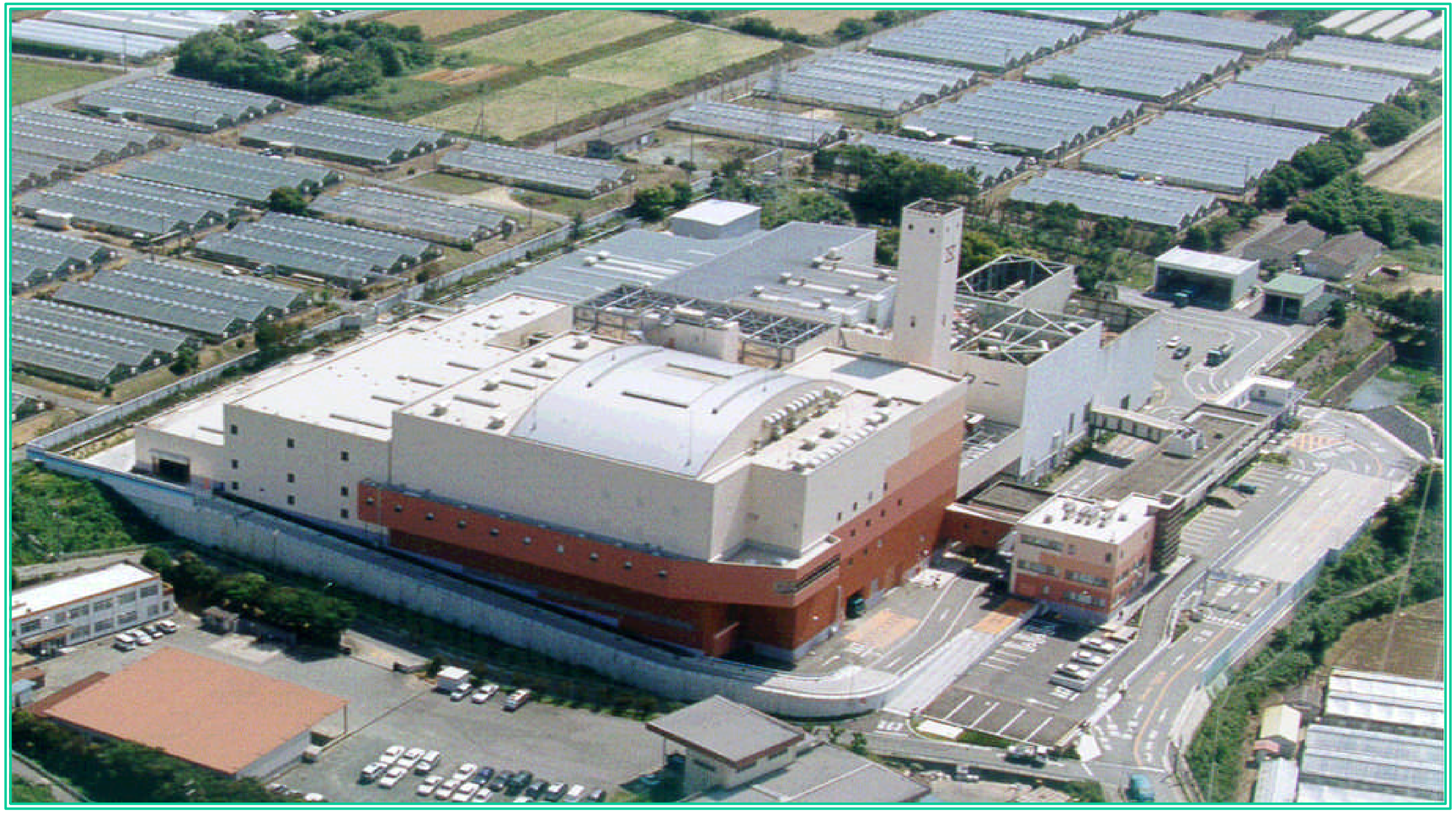
Mitsui Recycling ▪ ▪

Pyrolysis Gasification & Melting Process



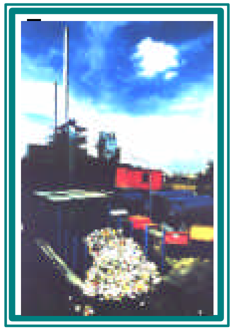
MES 三井造船株式会社

▪T oyohashi R21 Plant ▪

Development History of R21

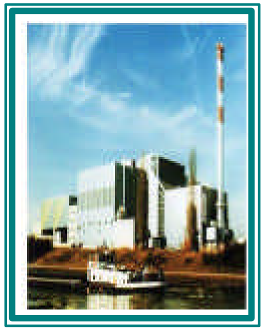
Mitsui Recycling 21

1984



Siemens

1994-1998



1998/8 Gas leakage trouble at Fürth

Investigation proved no change required to design of Yame Seibu Plant

Ulm Plant
2 00kg/h

Fürth Plant
4 80t/d

Mitsui

License Granted in 1991

1994 - 2000

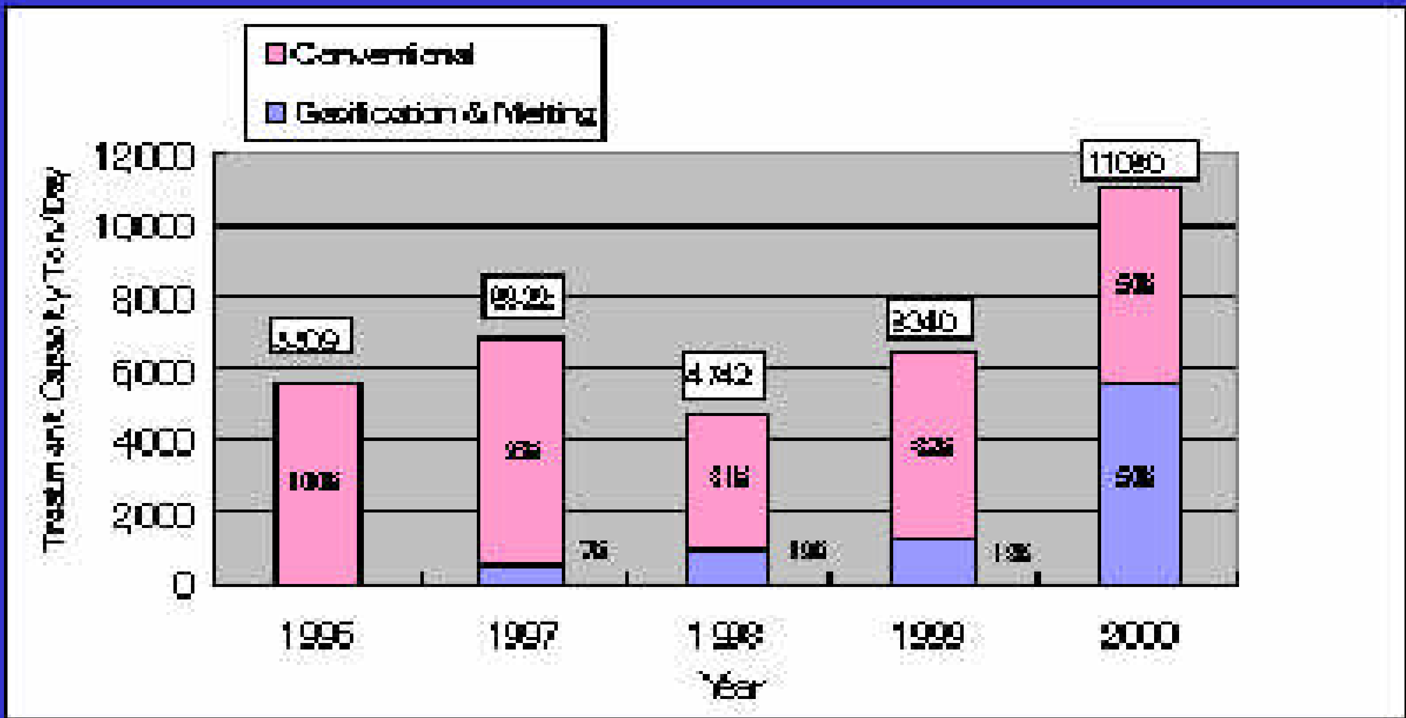
Delivered on March 2000

Yokohama Plant and Chiba Plant 24t/d

Yame Seibu Plant
2 20t/d

Trend of Japanese Incinerator Market

- Order Record of MSW Incinerator in Japan -



Construction Record of R21

For: Yame Seibu Regional Administrative Association
110 ton/day 2 trains
Start Const. 1997
Completed March 2000

For: Toyohashi City
200 ton/day 2 trains
Start Const. 1998
Completed March 2002

For: Ebetsu City
70 ton/day 2 trains
Start Const. 2000
Completed Nov. 2002

For: Koga City and One City, Four Towns' Waste Disposal Cooperative
130 ton/day 2 trains
Start Const. 2000
Completed March 2003

Owner: Nishi Iburi Regional Union
Operator: Nishi Iburi Kankyo Co. Ltd
105 ton/day 2 trains
Start Const. 2001
Completed March 2003

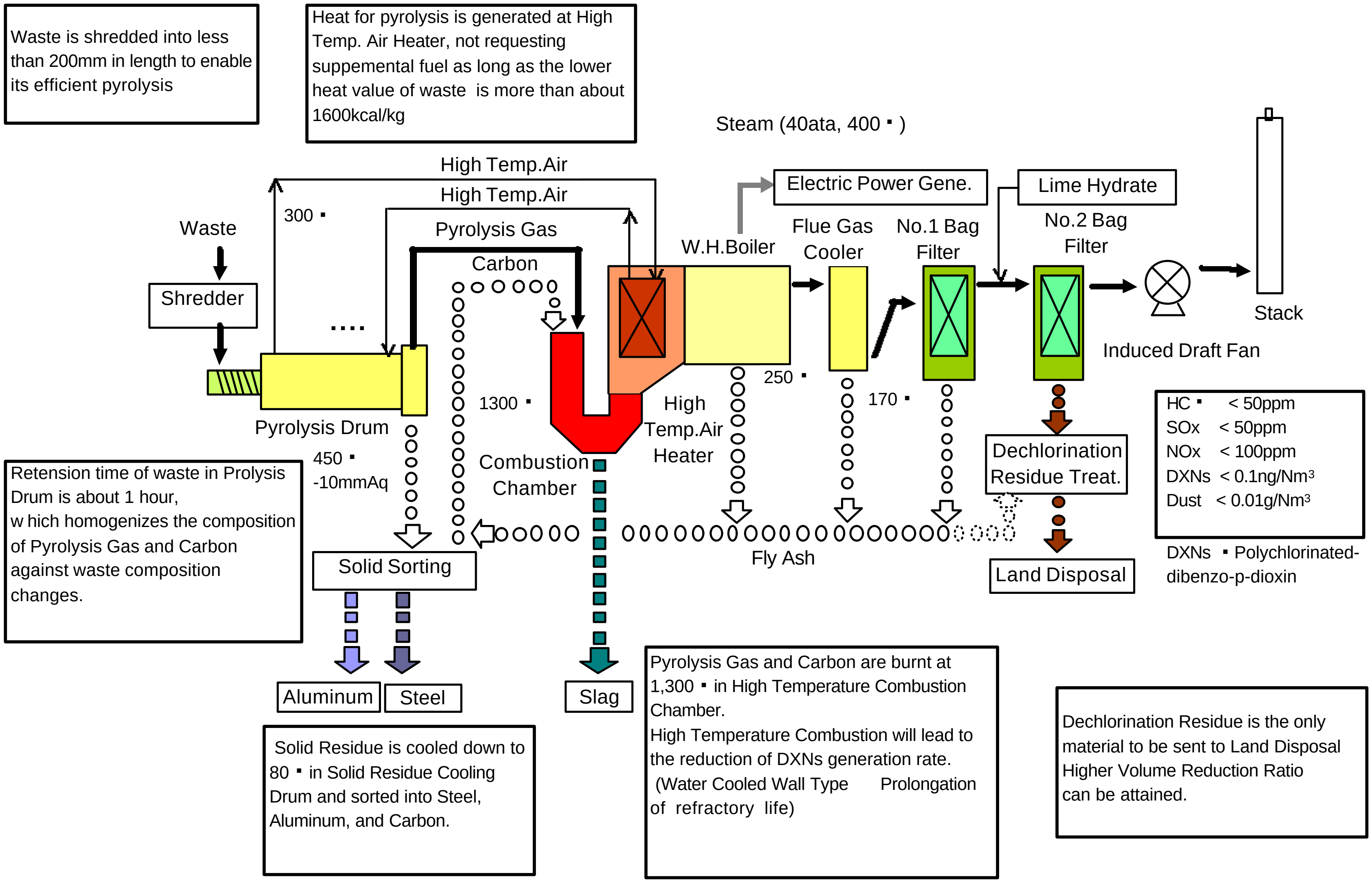
For: Kyohoku Regional Administrative Association
80 ton/day 2 trains
Start Const. 2001
Completed March 2003

R21 Projects Status as of May 20, 2003

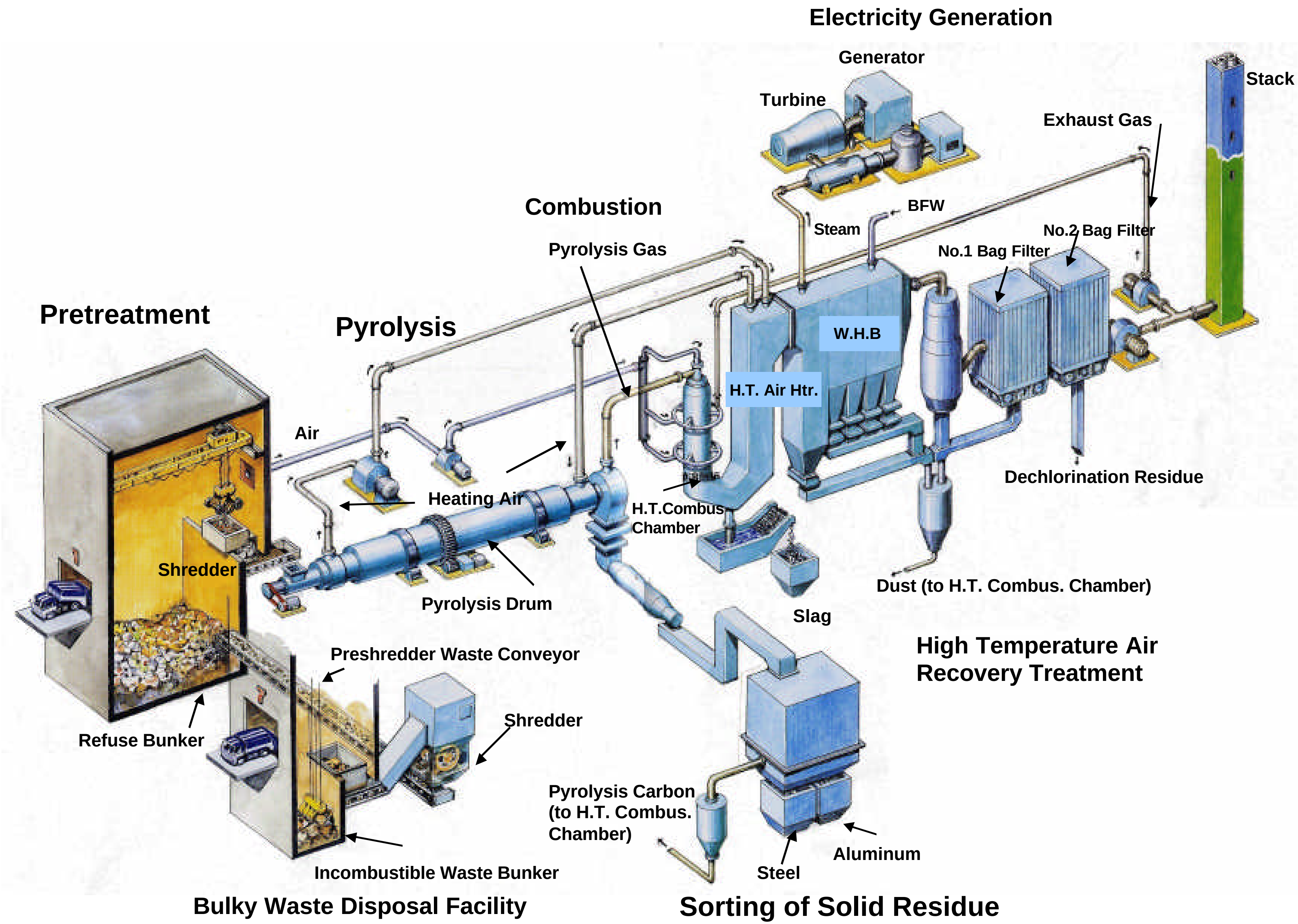
Facility	Yame Seibu R21	Toyohashi R21	Ebetsu R21	Koga Seibu R21	Nishiiburi R21	Kyouhoku R21
Current Status as of May 20, 2003	Yame R21 has been under commertial operation for more than 3 years without any critical troubles. Yame R21 is the first pyrolysis gasfication and melting facility in Japan which was turnovered in March, 2000.	Toyohashi R21 has been commertially operated steadily for more than 1 year, which was turnovered in March 2002.	Ebetsu R21 was turnovered in November, 2002 and has been under steady commertial operation.	Koga Seibu R21 was turnovered at the end of March, 2003 after the performance guarantee operation successfully completed at the end of January 2003.	Nishiiburi R21 was turnovered at the end of March, 2003 after the performance guarantee operation successfully completed on March 8, 2003.	Kyouhoku R21 was turnovered on March 15, 2003 after the performance guaranty operation at the end of January 2003.
Contract Date	July 7,1997	September 27,1998	September 26, 2000	November 4, 2000	January 15, 2001	March 26, 2001
Turnover Date	March 31, 2000	March 15, 2002	November 30, 2002	March 31, 2003	March 31, 2003	March 15, 2003
Plant Capacity						
R21	110t/d x 2Trains (220t/d Total)	200t/d x 2Trains (400t/d Total)	70t/d x 2Trains (140t/d Total)	130t/d x 2Trains (260t/d Total)	105t/d x 2Trains (210t/d Total)	80t/d x 2Trains (160t/d Total)
Bulky Waste Treatment	50t/d (5 hour operation per day)	70t/d (5 hour operation per day)	35t/d (5 hour operation per day)	Not installed	57t/d (6 hour operation per day)	Not installed
Waste LHV for Plant Design						
High (kcal/kg)	2400	3000	3200	2580	3100	2750
Middle (kcal/kg)	1600	2300	2400	1580	2300	1900
Low (kg/kg)	1000	1200	1500	960	1500	1100
Flue Gas Cleaning Method	Dry Type Gas Cleaning Method (Dust Removal Bag Filter + Dechlorination Bag Filter)	Dry Type Gas Cleaning Method (Dust Removal Bag Filter + Dechlorination Bag Filter + Catalytic Reactor)	Dry Type Gas Cleaning Method (Dust Removal Bag Filter + Dechlorination Bag Filter + Catalytic Reactor)	Dry Type Gas Cleaning Method (Dust Removal Bag Filter + Dechlorination Bag Filter)	Dry Type Gas Cleaning Method (Dust Removal Bag Filter + Dechlorination Bag Filter)	Dry Type Gas Cleaning Method (Dust Removal Bag Filter + Dechlorination Bag Filter)
Stack Flue Gas Limitation for Plant Design (*1)						
DXNs (ng-TEQ/Nm3)	<0.1	<0.01	<0.05	<0.05	<0.1	<0.1
HCl (ppm)	<50	<40	<61	<100	<50	<25
SOx (ppm)	<50	<25	<395	<100	<50	<20
NOx (ppm)	<100	<50	<50	<100	<100	<100
CO (ppm)	<10	<30	<30	<30	<30	<30
Dust (g/Nm3)	<0.01	<0.02	<0.01	<0.02	<0.02	<0.02
Generated Steam	40ata, 400degC	40ata, 400degC	30ata, 300degC	40ata, 400degC	30ata, 300degC	30ata, 300degC
Type of Steam Turbine Generator	Extraction Turbine	Extraction Turbine	Extraction Turbine	Extraction Turbine	Condensing Turbine	Condensing Turbine
Electric Power Generated (Rated)	1950kW	8700kw	1980kW	4500kW	1980kW	1500kW

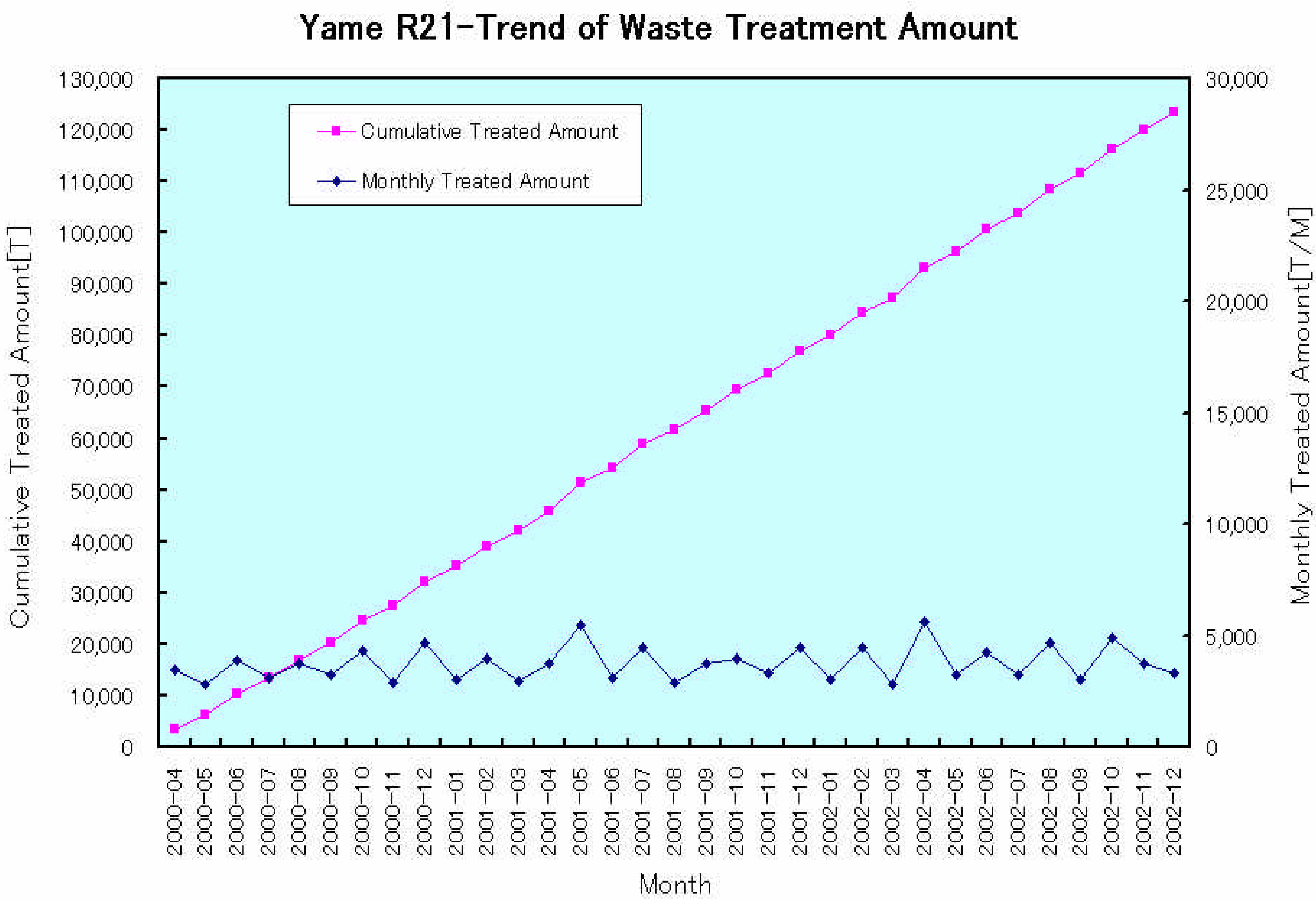
(*1) Base on Dry Gas 12%O2

Toyohashi R21 Process Flow



Process Flow of Pyrolysis Gasificaton & Melting Facility





Yame R21-Trend of Waste Treatment Amount
Cumulative Treated Amount
Monthly Treated Amount
Cumulative Treated Amount[T]
Monthly Treated Amount[T/M]
Month
130,000
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
30,000
25,000
20,000
15,000
10,000
5,000
0
2000-04
2000-05
2000-06
2000-07
2000-08
2000-09
2000-10
2000-11
2000-12
2001-01
2001-02
2001-03
2001-04
2001-05
2001-06
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2001-11
2001-12
2002-01
2002-02
2002-03
2002-04
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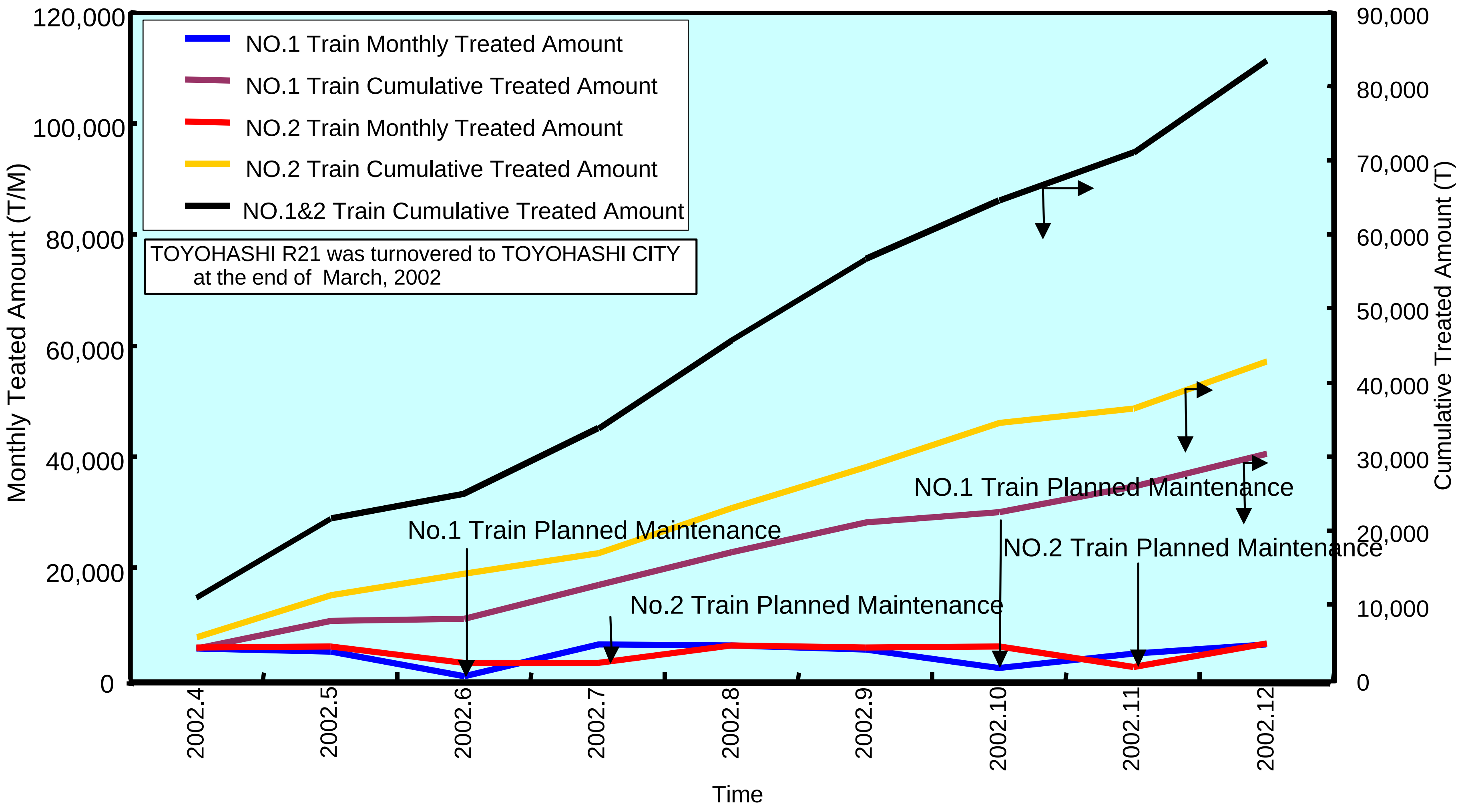
2002-08
2002-09
2002-10
2002-11
2002-12

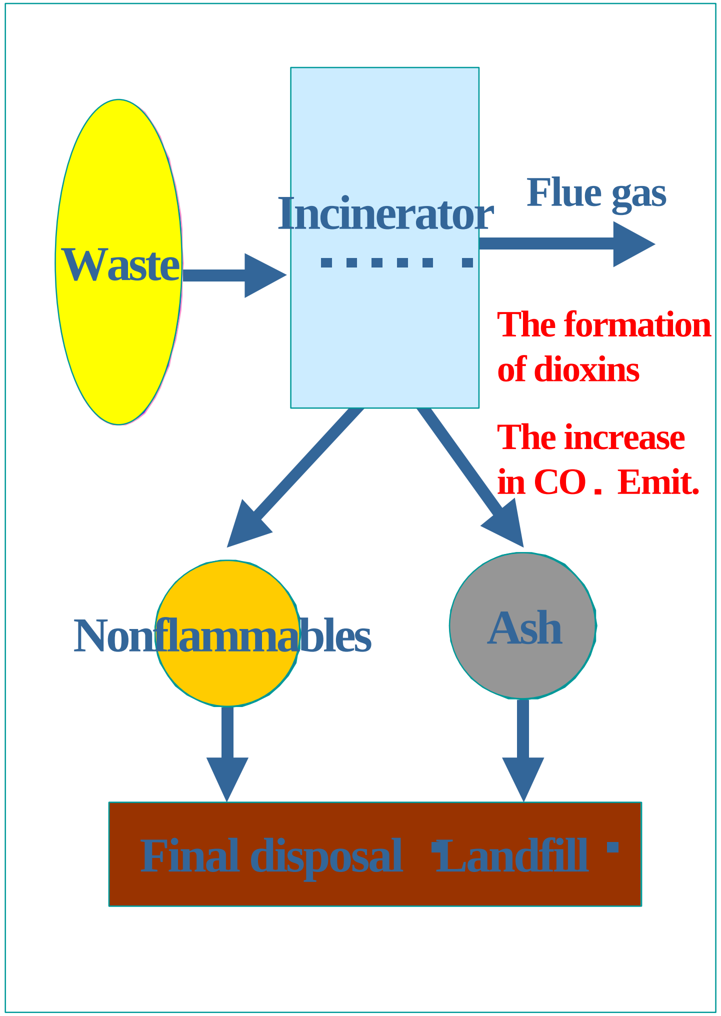
TOYOHASHI R21 Trend Data on Treated Amount of Waste



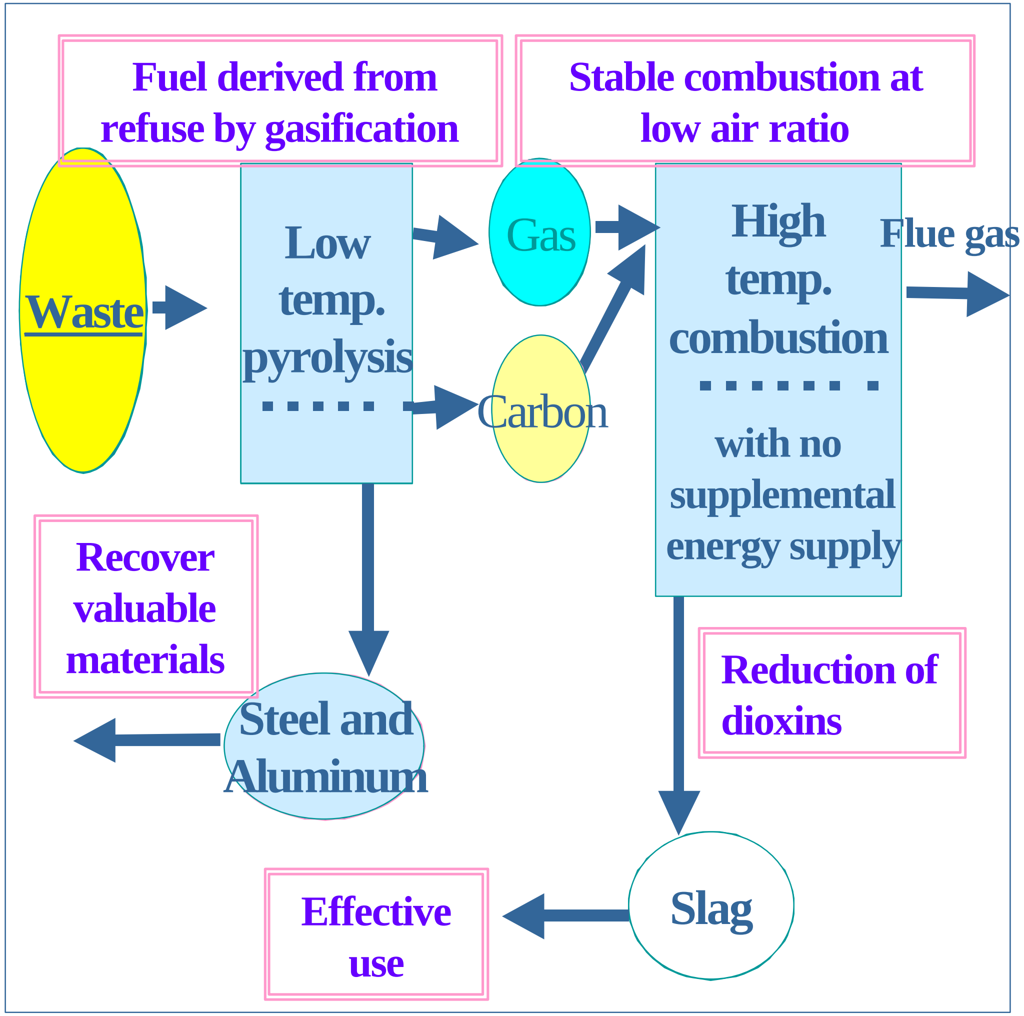
▪ ▪Next generation of the waste treatment facilities Pyrolysis Gasification & Melting Process ▪ ▪

Mitsui Recycling 21

Conventional Incinerator

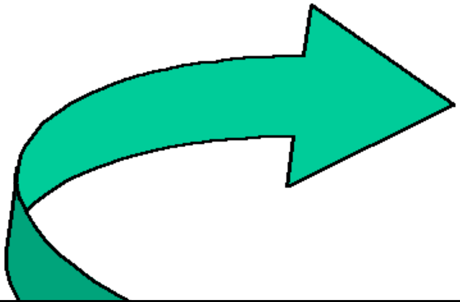


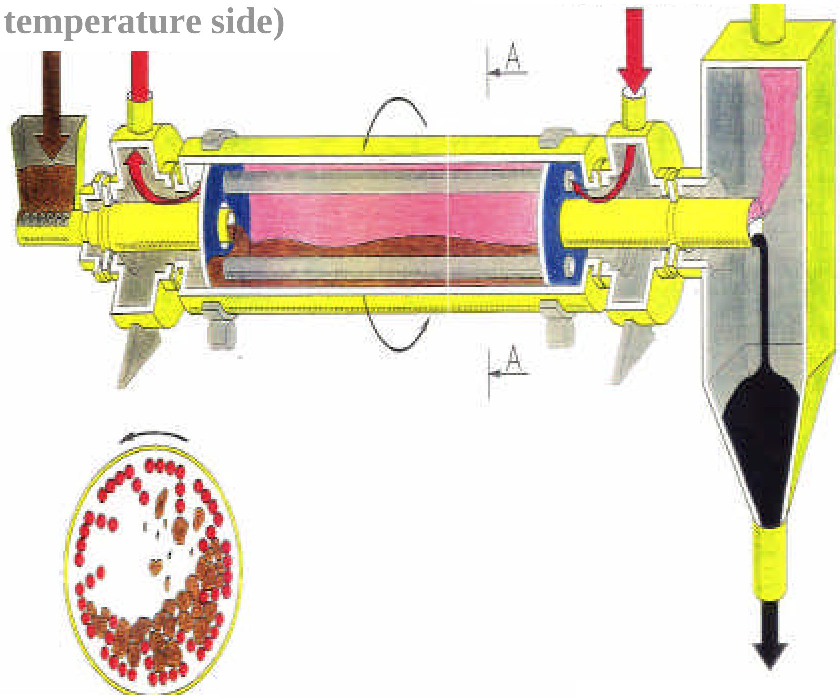
Gasification melting furnace



Specific Components of R21: Pyrolysis Drum

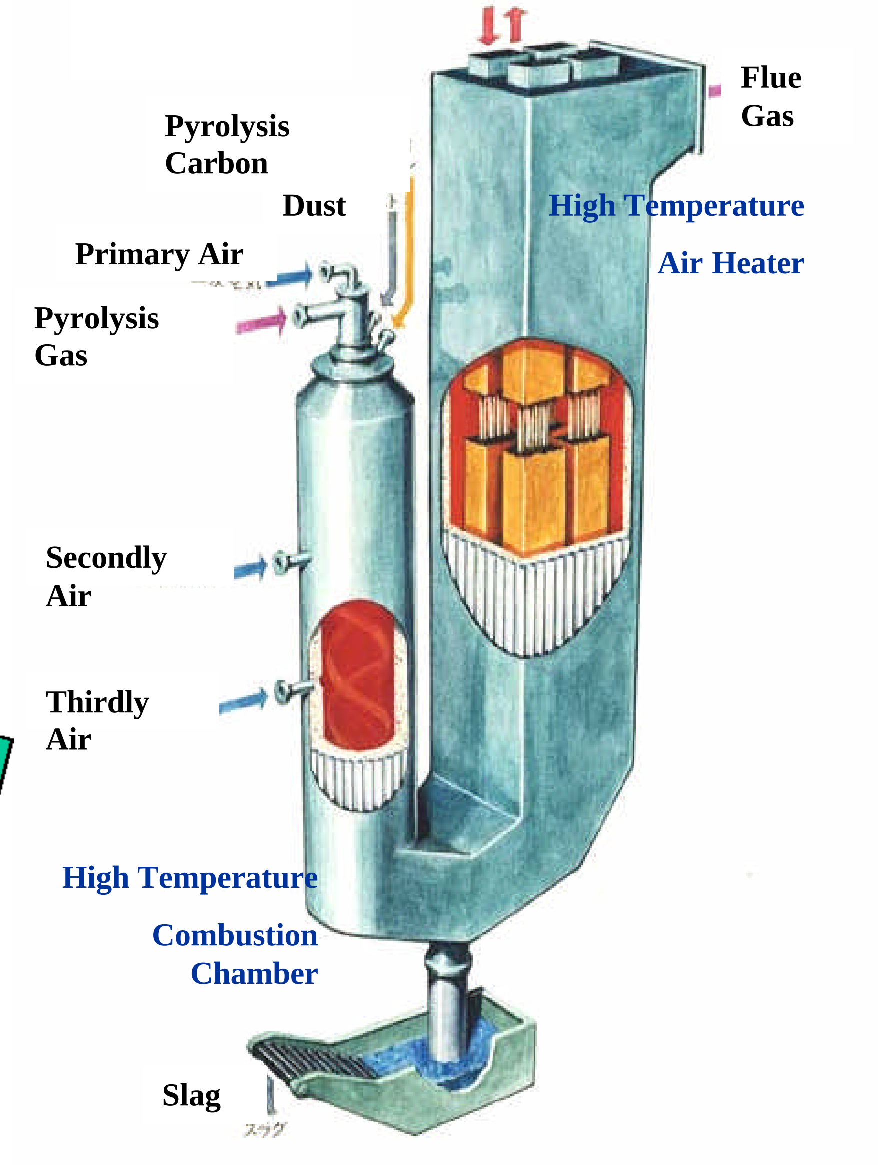
waste





Pyrolysis Drum

Specific Components of R21: Furness and Air Heater



Operation Results of Yame Seibu Clean Center

- <u>Emission level:Guarantee vs Actual</u>

Items	Regulatory Standard	Guaranteed Value	Actual 2002 Average
Hcl	430 ppm	50 ppm	ND
SO x	500 ppm	50 ppm	ND
NO x	250 ppm	100 ppm	47 ppm
CO	100 ppm	10 ppm	0~1 ppm
Dust	0.04 g/m3N	0.01 g/m3N	ND
DXNs	1 ng-TEQ/m3N	0.1 ng-TEQ/m3N	0.007 ng-TEQ/m3N

TOYOHASHI R21 Flue Gas Emission Data

NO.1 Train

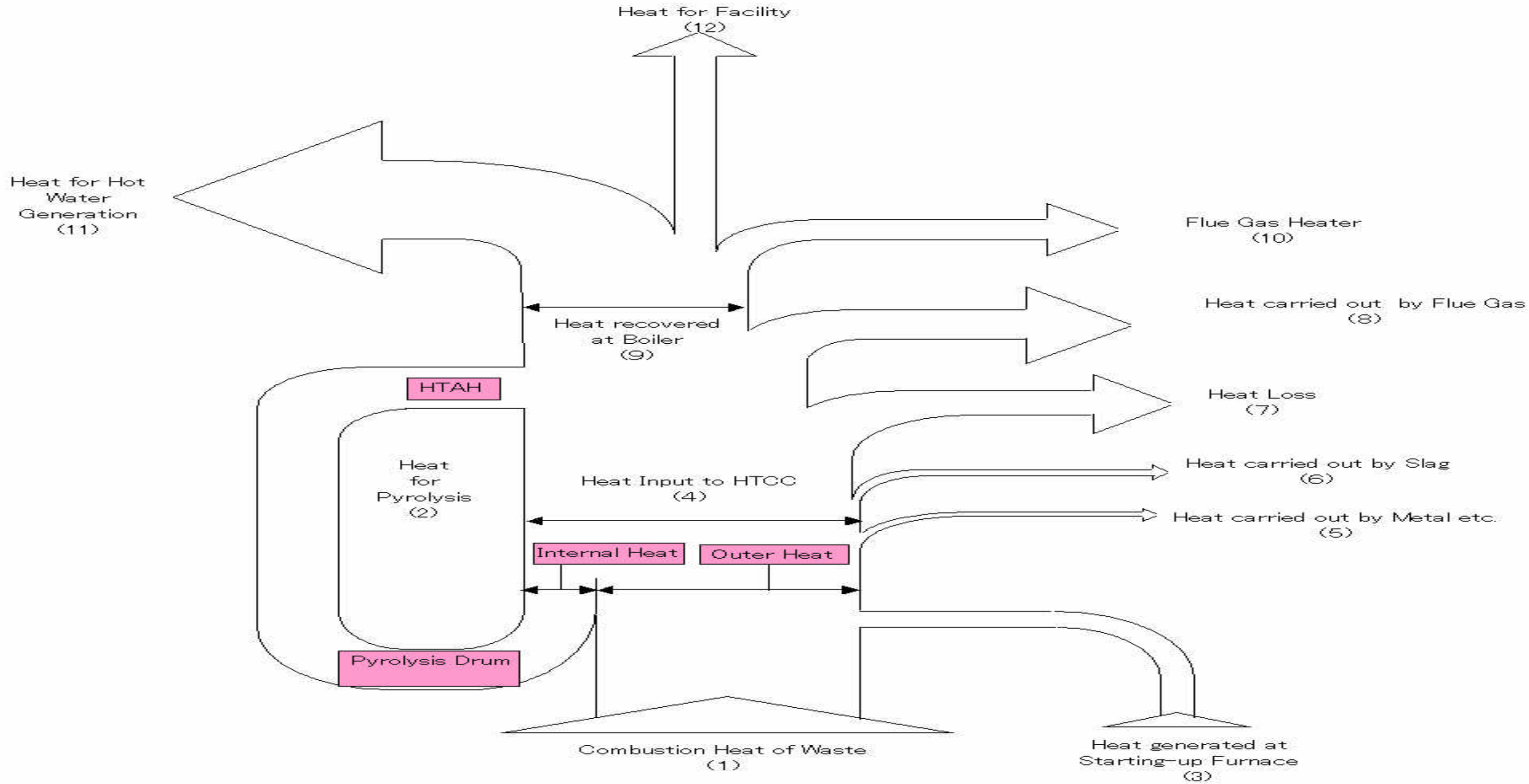
	Unit	Design Limit	Actual Data (*1)				
			Apr. 22	May 22	May 23	Aug. 19	Oct.8
Dust	g/Nm3	<0.02	<0.001	<0.001	<0.001	<0.001	<0.001
SOx	ppm	<25	5.9	7.6	10	3.6	2.9
HCl	mg/Nm3	<65 (*2)	34	50	22	39	34
NOx	ppm	<50	24	32	27	20	14
DXNs	ng-TEQ/Nm3	<0.01	–	0.0046	0.0018	–	–

NO.2 Train

	Unit	Design Limit	Actual Data (*1)				
			Apr. 24	May 20	May 23	Aug. 20	Oct. 9
Dust	g/Nm3	<0.02	<0.001	<0.001	<0.001	<0.001	<0.001
SOx	ppm	<25	10	4.9	7.5	1.7	4.2
HCl	mg/Nm3	<65 (*2)	43	24	33	37	41
NOx	ppm	<50	30	33	32	12	34
DXNs	ng-TEQ/Nm3	<0.01	–	0.0013	0.0039	–	–

Remark 1 : Based on 12%O2 Dry Gas
Remark 2 : Corresponding to 40 ppm

R21 Heat Balance (Example)



Item			Waste kcal/h	Waste %
Heat Input	Combustion Heat of Waste	(1)	10,000,000	100.0
	Internal Heat Input through Pyrolysis Drum	(2)	(1,688,000)	
	Generated Heat at Start-up Furnace	(3)	0	0.0
	Heat Input Total	(4)	10,000,000	100.0
Heat Output	Heat carried out by Metal etc.	(5)	27,300	0.3
	Heat carried out by Slag	(6)	116,300	1.2
	Heat Loss	(7)	754,500	7.5
	Heat carried out by Flue Gas	(8)	1,698,500	17.0
	Internal Heat Output though HTAH	(2)	(1,688,000)	
	Recovered Heat at Boiler	(9)	7,403,400	74.0
	(Breakdown) Flue Gas Heater	(10)	183,000	1.8
	Hot Water Generation	(11)	7,070,400	70.7
	Heat for Facility	(12)	150,000	1.5
	Heat Output Total		10,000,000	100.0

(Remark) Combustion Heat of Waste ⇒ 100%

Operation Results of Yame Seibu Clean Center

Utility Cost

Fiscal Year	2000	2001	2002
Fuel	830 Yen/ton	1060 Yen/ton	1000 Yen/ton
Electric	990 Yen/ton	890 Yen/ton	700 Yen/ton
Chemicals	1540 Yen/ton	870 Yen/ton	1090 Yen/ton
Water	30 Yen/ton	30 Yen/ton	30 Yen/ton
Total	3400 Yen/ton	2800 Yen/ton	2800 Yen/ton

Recycle of Materials in Marketable Quality

Recovery of valuable resources

Non-oxidized steel, non-molten aluminum : Reuse

Yame C.C. Metals: Confirm the recovery of high quality steel and aluminum, sold out at the market price

Slag : Reuse as a asphalt composite material

Yame C.C. Slag : Meeting the requirements of the Environmental Notice No.46 for elusion test as the soil fit for agricultural use

NIPPON HODOO Co., Ltd. receives the slag as the asphalt composite material at the market price.

Recovered Iron

Recovered Aluminum

slag

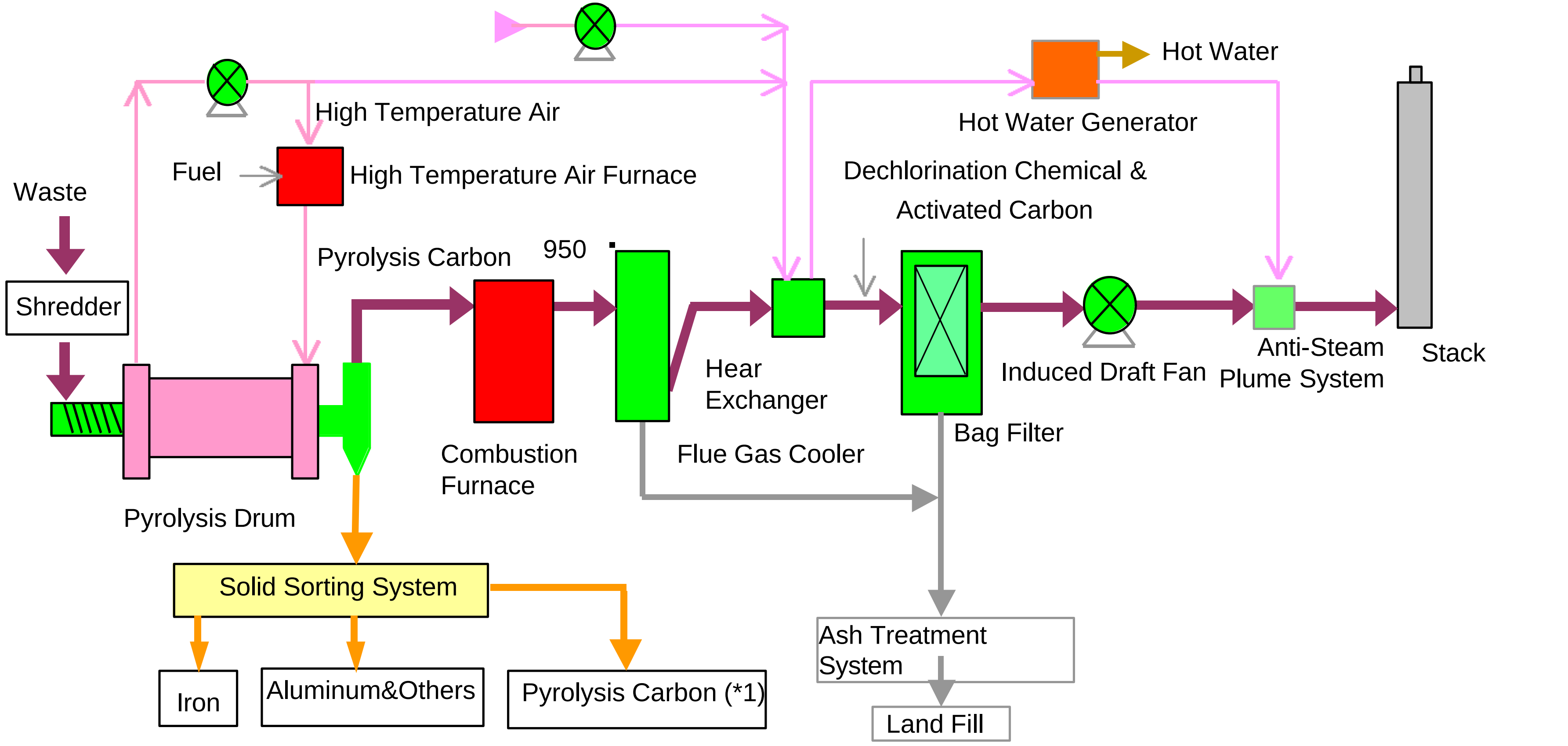
Reuse of slag

Comparison between conventionals and new process

	unit	Gasification & Ash-melting	Conventionals	Conventionals ▪ Ash-melting
initial cost	▪ ▪ ▪	120 ▪ 150	100	150
running cost	▪ ▪ ▪	120 ▪ 150	100	150
maintenance cost	▪ ▪ ▪	120 ▪ 150	100	150
number of operator		100	100	150
plant area	▪ ▪ ▪	120 ▪ 150	100	150
recycle material		Fe, Al, slag	___	slag
volume reduction ratio	▪ ▪ ▪	1/100 ▪ 1/150	1/10 ▪ 1/30	1/50 ▪ 1/00 ▪
dumping material		salt, part of ash *1	salt, ash, unburnables	salt, part of ash, unburnables
content of flue gas				
Nox	ppm	▪ 100 ▪ 150	▪ 100 ▪ 150	▪ 100 ▪ 150
Sox	ppm	▪ ▪ 30 ▪ ▪ 50	▪ ▪ 30 ▪ ▪ 50	▪ ▪ 30 ▪ ▪ 50
Hc ▪	ppm	▪ ▪ 50 ▪ 100	▪ ▪ 50 ▪ 100	▪ ▪ 50 ▪ 100
Dust	g/Nm^3	▪ ▪ 0.1	▪ ▪ 0.1	▪ ▪ 0.1
Co	ppm	▪ ▪ 10	▪ ▪ 50	▪ ▪ 50
Dxn				
gas side	$ng\text{-}TEQ/Nm^3$	▪ 0.1	▪ 0.1	▪ 0.1
solid side	ng-TEQ/g	0.1 ▪ 0.5	1 ▪ 5 ▪	▪ ▪ 1 ▪ 2 ▪
total discharge rate	ì g-TEQ/t-waste	1 ▪ 5	10 ▪ 50	10 ▪ 30

*1 MES is developing new technology that salt and part of ash are not necessary to be dumped.

▪ ▪ ▪S Carbonizing Process Flow
Suitable for Low LHV Waste (Food Waste)



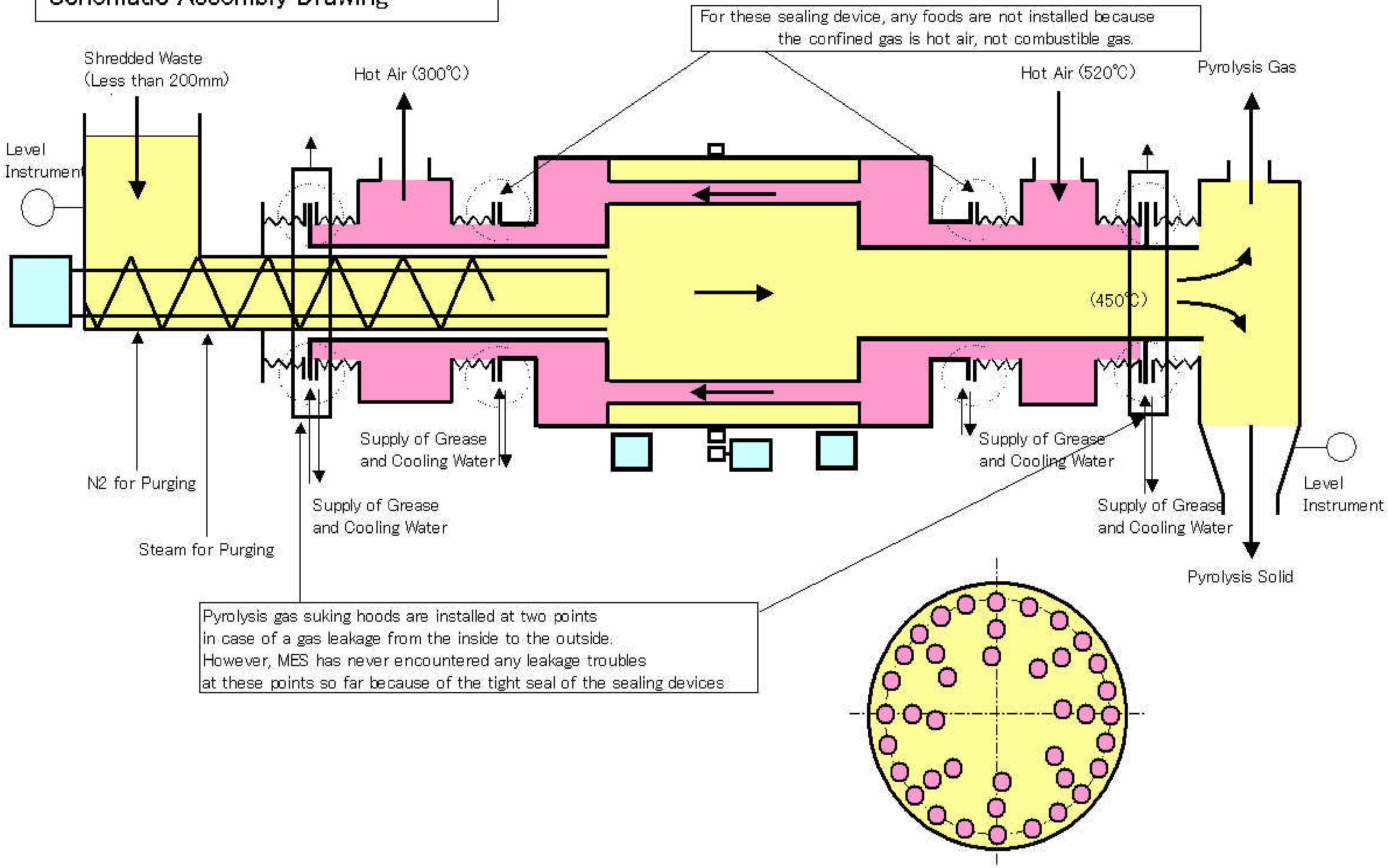
(*1) Potential Users

▪Cement Manufacturer

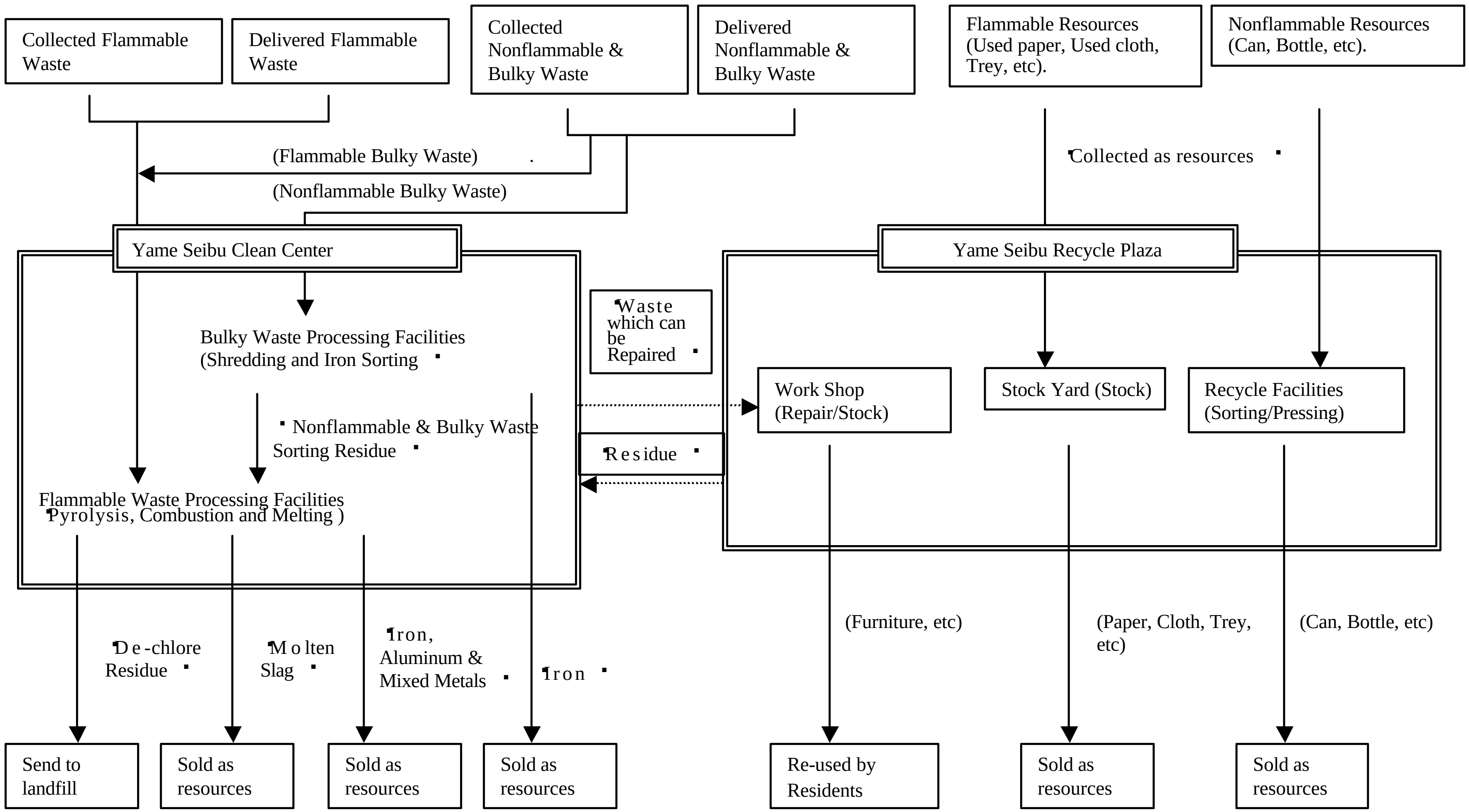
▪ ▪ ▪ ▪ Electric Furnase Steel Maker

▪ ▪ ▪ ▪ Fertilizer Manufacturer

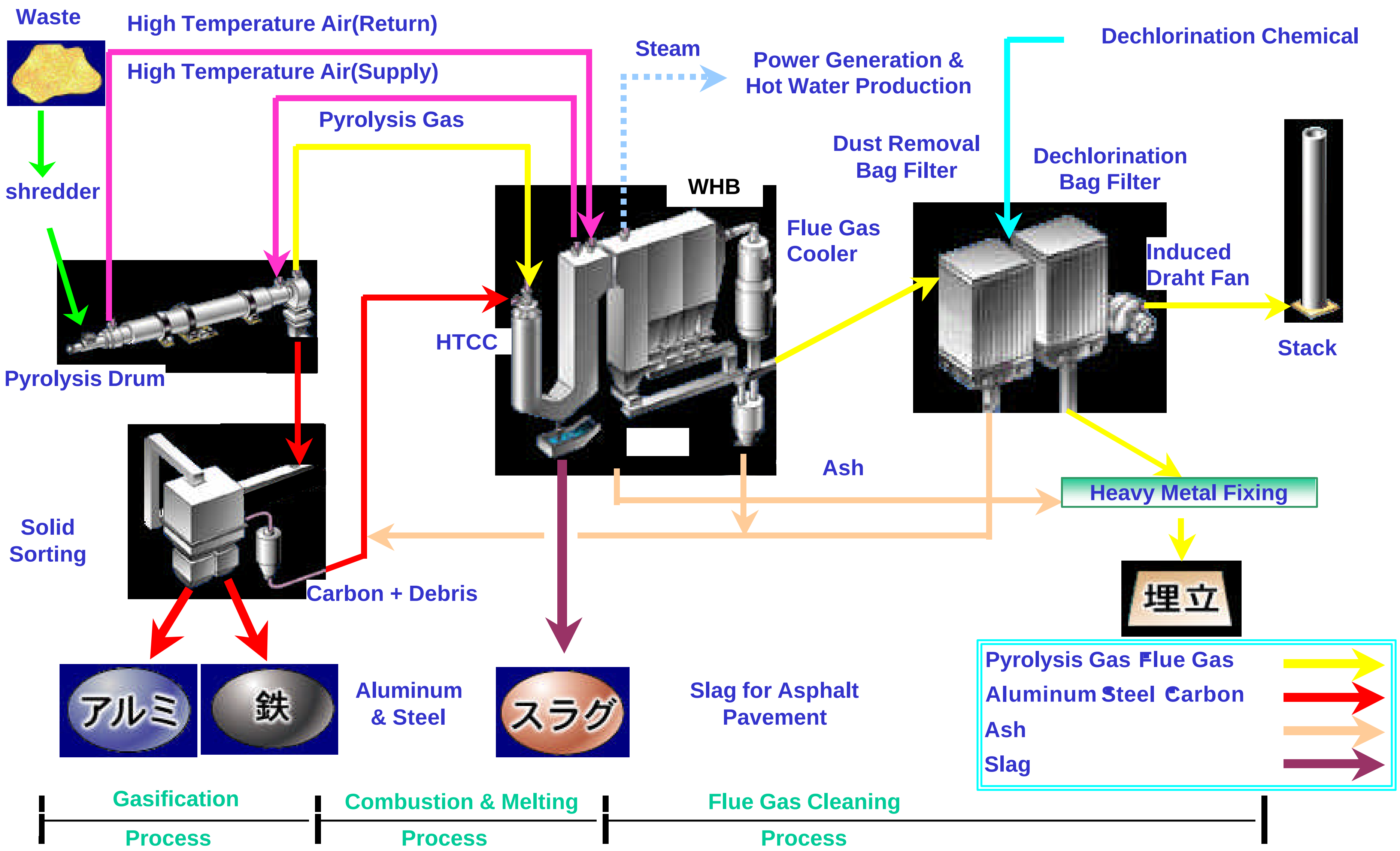
Pyrolysis Drum
Schematic Assembly Drawing



Waste Treatment System of Yame Seibu Regional Administrative Association



Pyrolysis Gasification & Melting Process



Yame R21 (110t/d x 2trains)

Toyohashi R21 (200t/d x 2trains)

Ebetsu R21 (70t/d x 2trains)

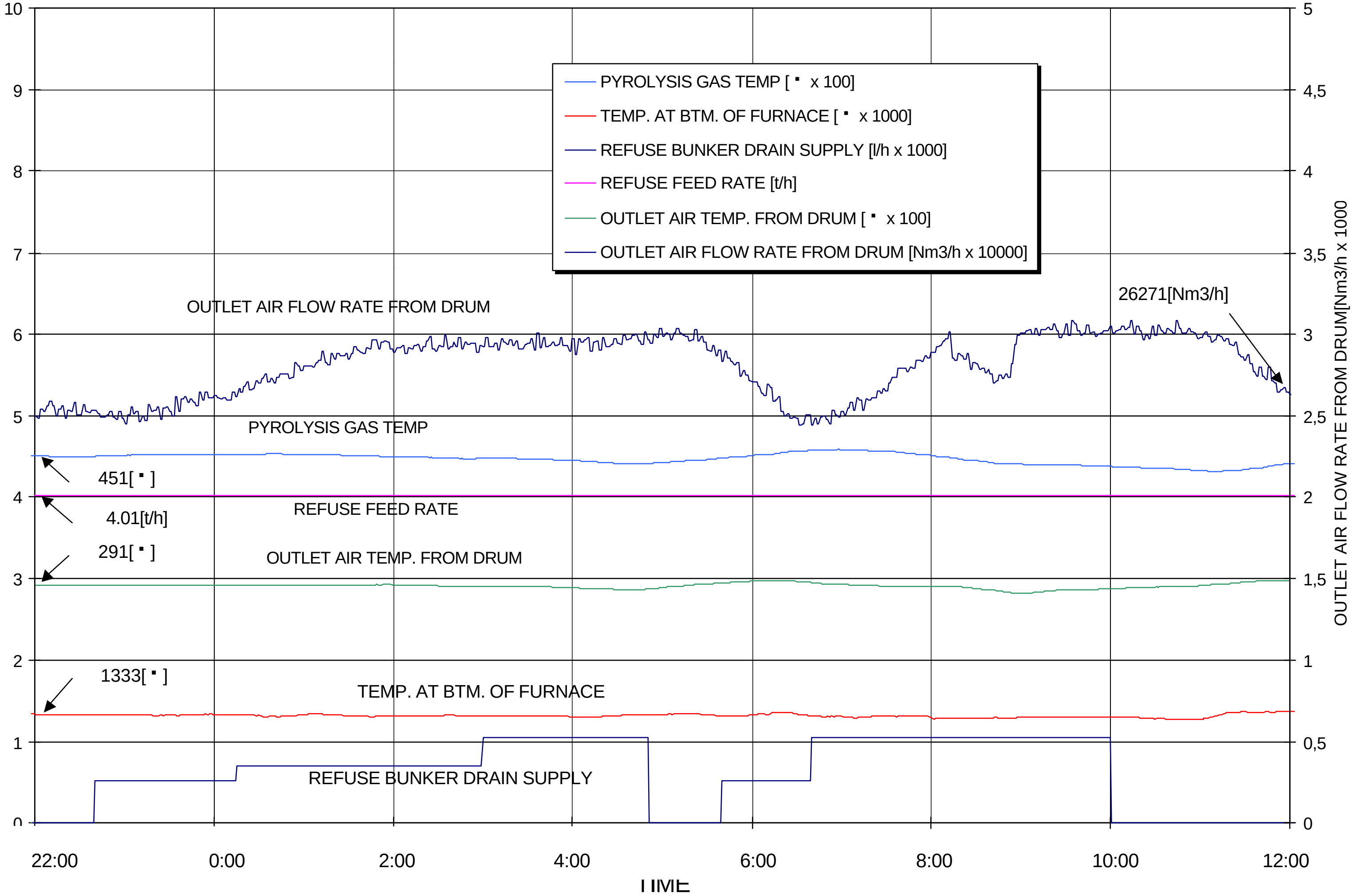
Koga Seibu R21 (130t/d x 2trains)

Nishiiburi R21 (105t/d x 2trains)

Kyouhoku R21 (80t/d x 2trains)

Gasification and Combustion Stability of R21

Excellent stability can be obtained even for the sudden waste composition change (water injection) as shown below.

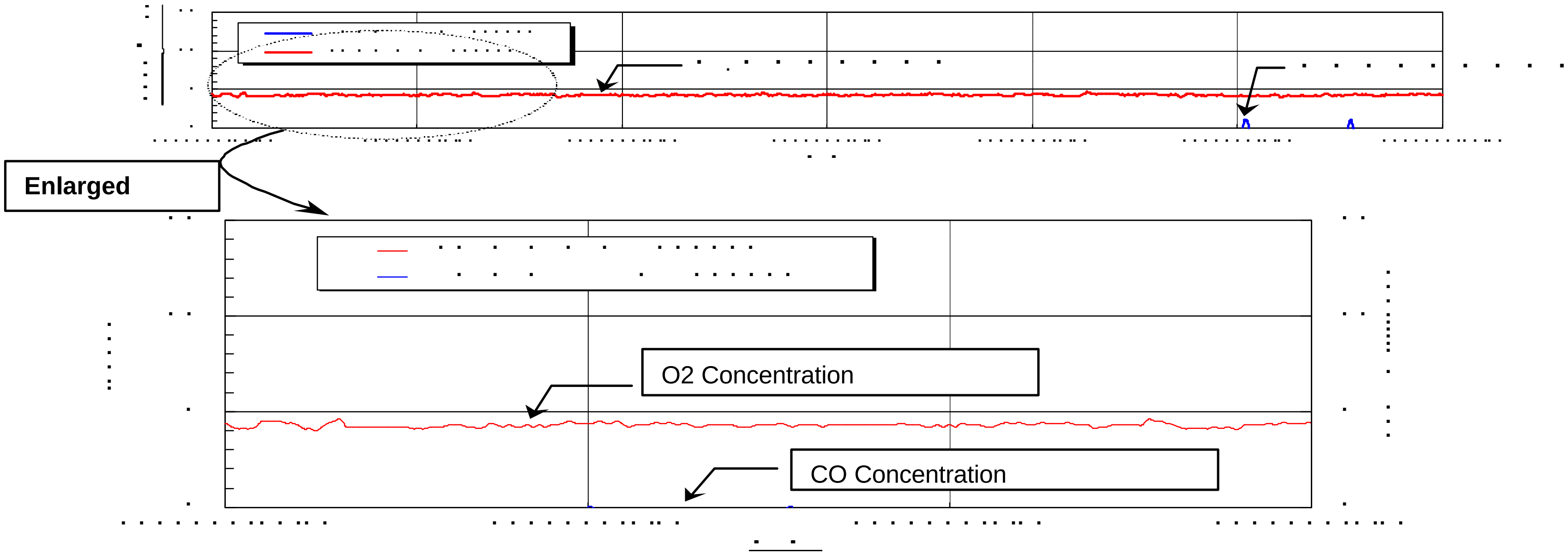


Attachment 2 Mitsui R21 vs. Fluidized Bed Type

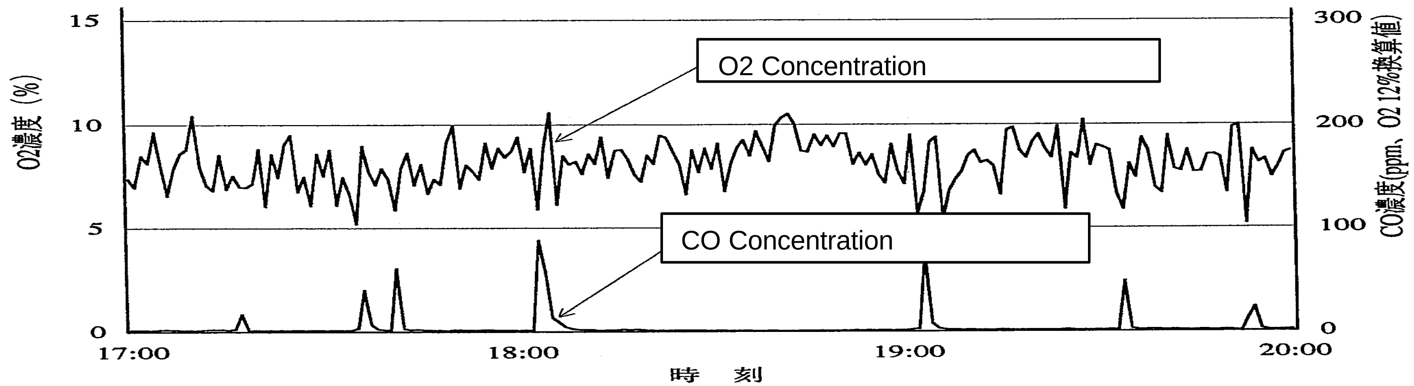
. . . Trend Data on Flue Gas Composition Combustion Stability

Mitsui R21

DCS DATA From 00/01/17 23:00 to 00/01/18 11:00



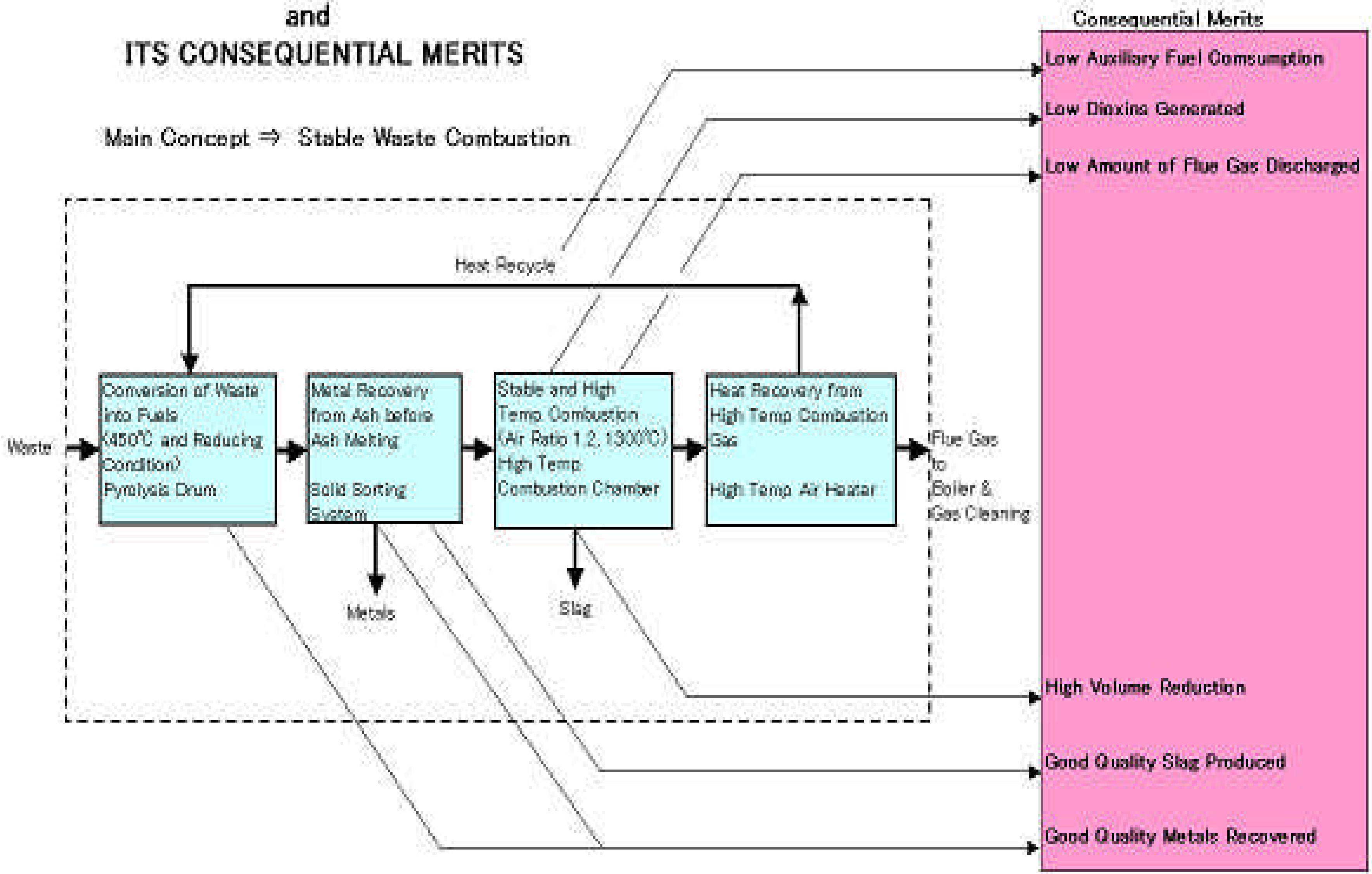
Fluidized Bed Type



CO、O_2濃度の経時変化（H10年11月27日）

CONCEPT OF R21 TECHNOLOGY and ITS CONSEQUENTIAL MERITS

Main Concept ⇒ Stable Waste Combustion



Advantage of Mitsui R21 Process

- No auxiliary fuel input for ash melting

  Self-combustion and melting point can be set around LHV1600~1700 kcal/kg.
  Auxiliary fuel consumption per year can be minimized.

- Low emission of Dioxins

  0.01 ng-TEQ/Nm3 can be attained.

- High volume reduction ratio

  1/100 ~ 1/200
  Life of land fill site can be greatly prolonged.

- Recovery of good quality steel and aluminum

  Because of 450℃ Pyrolysis temperature and Reducing Condition in Pyrolysis Drum, recovered metals are having a good quality, not melted, nor oxidized.

- Stable and good quality slag produced

  Metals are removed from Pyrolysis residue in Solid Sorting System before melting.
  Good quality slag without any metals contained can be produced.

- Efficient heat recovery

  Combustion air ratio can be reduced to 1.2, enabling the flue gas volume and heat loss into the atmosphere to be minimized.

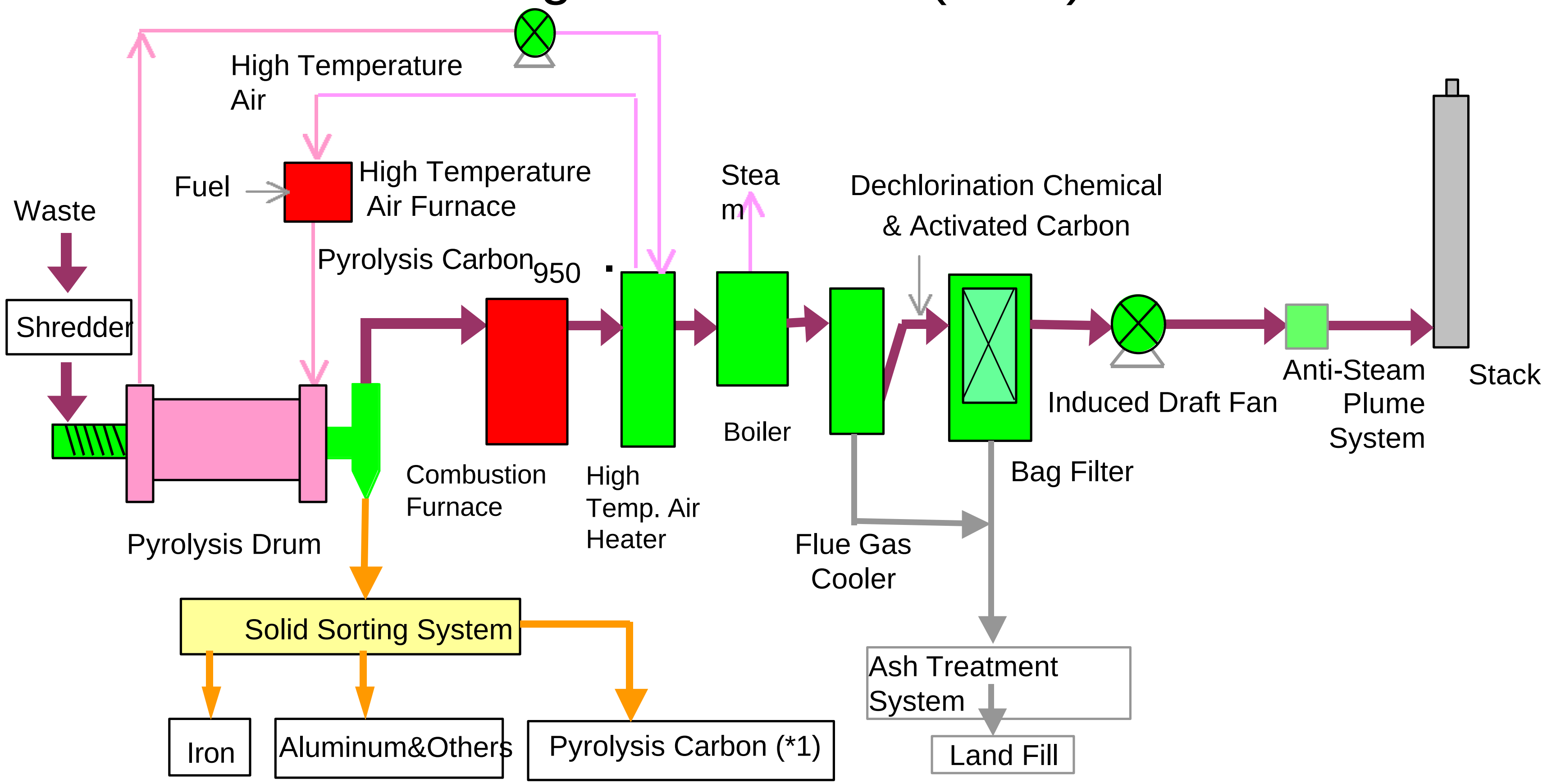
Comparison of new process

	unit	Kiln type	Fludized Bed	Shaft
initial cost	[-]	100	100	150
running cost	[-]	100	120	150
number of operator	[-]	100	120	150
plant area	[-]	100	100	120
recycle material		Fe, Al, slag	Fe, Al, slag	mixed metal
volume reduction ratio	[-]	1/100..1/150	1/100..1/150	1/50..1/100
dumping material	—	—	—	slag
content of flue gas				
Nox	ppm	<100..150	<100..150	<100..150
Sox	ppm	< ▪ 30.. ▪ 50	< ▪ 30.. ▪ 50	< ▪ 30.. ▪ 50
Hc ▪	ppm	< ▪ 50..100	< ▪ 50..100	< ▪ 50..100
Dust	g/Nm^3	▪ < 0.1	< 0.1	< 0.1
Co	ppm	< ▪ 10	< ▪ 30	< ▪ 30
Dxn				
gas side	$ng\text{-}TEQ/Nm^3$	▪ < 0.1	▪ < 0.1	< 0.1
solid side	ng-TEQ/g	▪ < 0.1	▪ < 1 ▪	▪ < 1 ▪
total discharge rate	ì g-TEQ/t-waste	▪ < 1..2 ▪	▪ < 5 ▪	▪ < 5 ▪
auxilially fuel		no	required	cokes
operation technique		easier	harder	more harder

Comparison of conventional process

	unit	Fludized Bul	Stoker
initial cost	▪ ▪ ▪	100	100
running cost	▪ ▪ ▪	100	100
maintenance cost	▪ ▪ ▪	100	120
number of operator	▪ ▪ ▪	even	even
plant area		100	100
recycle material	▪ ▪ ▪	unburnables	___
volume reduction rate		1-30	1-10
dumping material		fly ask	bottom & fly ash
content of flue gas			
Nox	ppm	▪ 100 ▪ 150	▪ 100 ▪ 150
Sox	ppm	▪ ▪ 30 ▪ ▪ 50	▪ ▪ 30 ▪ ▪ 50
Hc ▪	ppm	▪ ▪ 50 ▪ 100	▪ ▪ 50 ▪ 100
Dust	g/Nm^3	▪ ▪ 0.1	▪ ▪ 0.1
Co	ppm	▪ ▪ 50	▪ ▪ 50
Dxn			
gas side	$ng\text{-}TEQ/Nm^3$	▪ ▪ 0.1	▪ ▪ 0.1
solid side	ng-TEQ/g	▪ ▪ 1 ▪ 5 ▪	▪ ▪ 1 ▪ 5 ▪
total discharge rate	ì g-TEQ/t-waste	10 ▪ 30	30 ▪ 50
operation technique		easier	harder
start & stop		Daily start & stop is possible	harder
suitable capacity	t/day	▪ 100 ▪ 300	▪ 300

R 2 1 S Carbonizing Process Flow
Suitable for High LHV Waste (ASR)



(*1) Potential Users

▪Cement Manufacturer

▪ ▪ ▪ ▪ Electric Furnace Steel Maker

▪ ▪ ▪ ▪ Fertilizer Manufacturer

Pyrolysis Carbon & Flue Gas	
Iron & Aluminum ▪Pyrolysis Carbon	
Ash	