

Incineration of Alpha-Contaminated Wastes by Oxygen-Enriched Combustion

150

가 1) , 2)
, 3) 가가 .
1/7
가 .

Abstract

An application of oxygen-enriched combustion on incineration of alpha-bearing wastes has been reviewed. The oxygen-enriched incineration (OEI) would bring a) a higher combustion temperature, b) less off-gas production, and c) higher concentration of air pollution gases, compared with a conventional air combustion. The OEI could reduce an off-gas production up to 1/7 compared to air combustion, which would bring a reduction of off-gas treatment facility and a less capital cost. Some problems, such as a hot spot and an increase in production of nitrogen oxides, generated from a use of oxygen, could have been solved by a recycle of flue gas.

1.

1960

(International Atomic Energy Agency; IAEA)

(Radioisotope; RI)

[1,2] ,

가

(10:1)

(100:1)

, , ,)

가

가

(,

가

가

가

2

[3].

가

(KAERI)

/

가

2.

2.1

(Alpha bearing)

(Alpha-contaminated)

,

,

,

(,

)

20

가 4,000 Bq/g

2 kW/m³

[4].

(International Atomic Energy Agency; IAEA)

()

[5].

(TRansUranic; TRU)

가 3.7 kBq/g

가 20

가 92

0.37 GBq/t

(Pu)

Pu

가

가

2가

(Heat and non-heat generating wastes)

[5].

2.2

가

MOX (Mixed Oxide)

가

(Decontamination

and decommissioning; D&D)

가

95%

가

가

400

(200

)

100 /

가 가

[6,7]

Table 1

KAERI

800

KAERI

Table 1.

				Lime Stone	Neoprene,PE, PVC,	/ ,	

1991	7	0	319	46	5	94	471
1992	6	0	238	71	5	87	407
1993	6	0	191	60	5	89	351
1994	48	4	137	44	3	82	318
1995	32	0	274	47	5	71	429
1996	78	13	231	39	10	140	511
(kg)	250	250	25	250	85	85	
가	No	No	No	No	Yes	Yes	
(%)					100%	: 35% : 10% : 55%	
가 (,%)					32 17 51		

3.

2가

U, Pu
[3,8]. /
/ ,
50 kg/h
U, Pu
Pu가 20 kg/h 가 [8]. 가
/ , KAERI / 가
KAERI 350 / 가
가 60% 가
/ 500 / 가 . 0.5 kg/m³ 가 [7],
가 200 가 5 (,

50 kg/h가) 가 가 [9]

4.

4.1

/ 가

[6]
가

1
가

4.2.

‘87 가 , ‘91 KAERI
[10],

-
-
-
-
-
-

가

가

/

가

4.3

가

(酸素富化 焼却技術; Oxygen Enriched Incineration; OEI) ,

21%

100%

가

가 가

(alpha tight)가

가

Table 2

1/4

가 가

Table 2.

				2				(m=2.0)	
	m=1.5	m=2.0	m=2.5	m=2.0	m=2.5	m=1.5	m=2.0	70%	50%
(Nm ³ /kg- ,STP)	12.06	15.86	21.86	29.83	36.53	3.05	3.83	5.18	6.97
CO ₂ (%)	9.92	7.55	6.54	7.35	7.80	39.29	31.24	23.12	17.17
H ₂ O (%)	9.98	7.88	7.28	8.84	9.62	34.070.	27.09	20.04	14.88
N ₂ (%)	73.53	74.54	75.03	74.71	74.55	16	0.13	26.10	45.12
O ₂ (%)	6.51	9.90	11.14	9.03	7.98	25.78	41.00	30.34	22.53
SO ₂ (ppm)	29	22	16	12	10	115	91	68	50
HCl (ppm)	1727	1313	953	570	570	6838	5436	4023	2987
NO _{max} (ppm)	619	169	123	690	690	18	20	249	282

) m : = () / ()
 NO_{max} : 1/3

4.4

(NOx)

가

가

가

가

가 가

가

가

[11].

가

70%

가

1,100

Fig. 1

가

Fig. 2

[11].

1/10

가

가

가

가

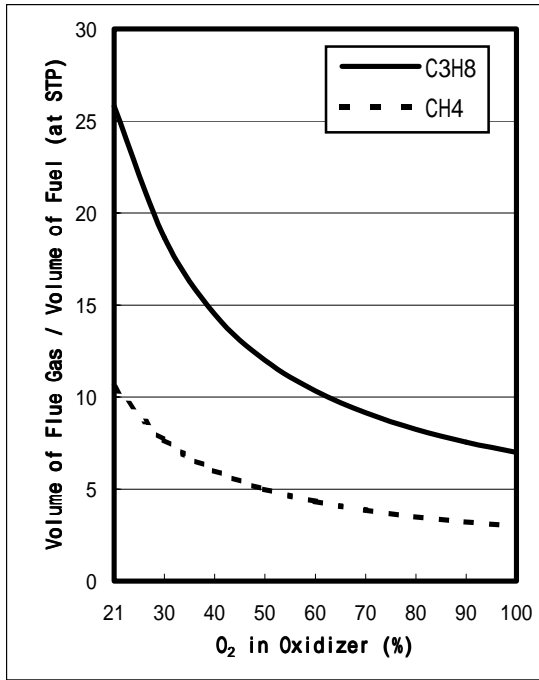


Fig. 1.

가

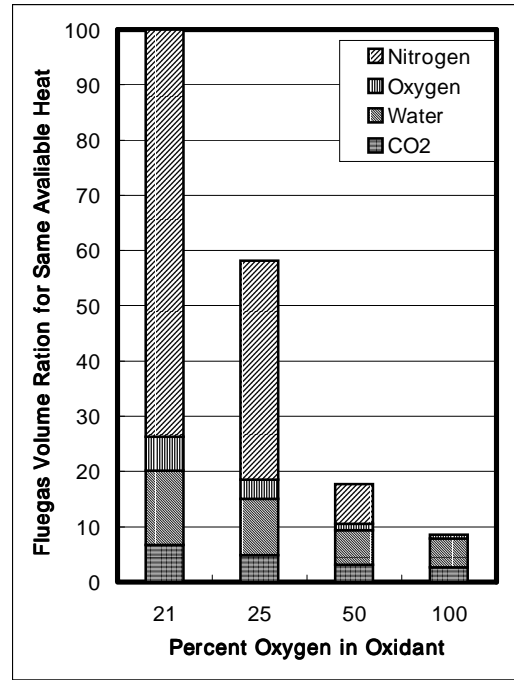


Fig. 2.

가

(: 1100°C, 6%)

19%

(Fig. 3).

가

71%,
가 1/3,

10%,
2/3

가

(CO₂) , CO₂ 가

[11].

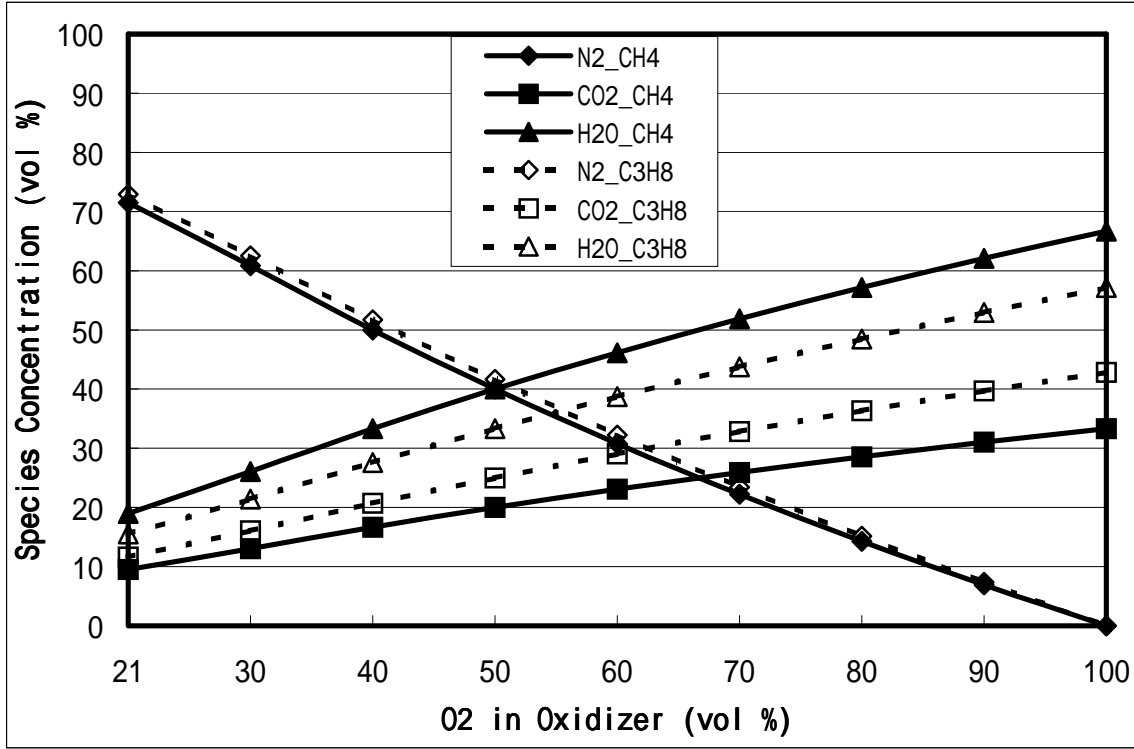


Fig. 3. 가

4.5

가 가 “
 (hot spot) ” 가 ,
 가 가
 . HCl 가 가 .
 (gas momentum)
 가 , 가

4.5.1

1900°C , 2800°C 가

가

가

4.5.2

가

가

가

가

4.6

가 50%

가

1

2

가

Table 3

가

- : 10 kg/h

- :

- : 6 - 8 vol%

-

-

-

-

-

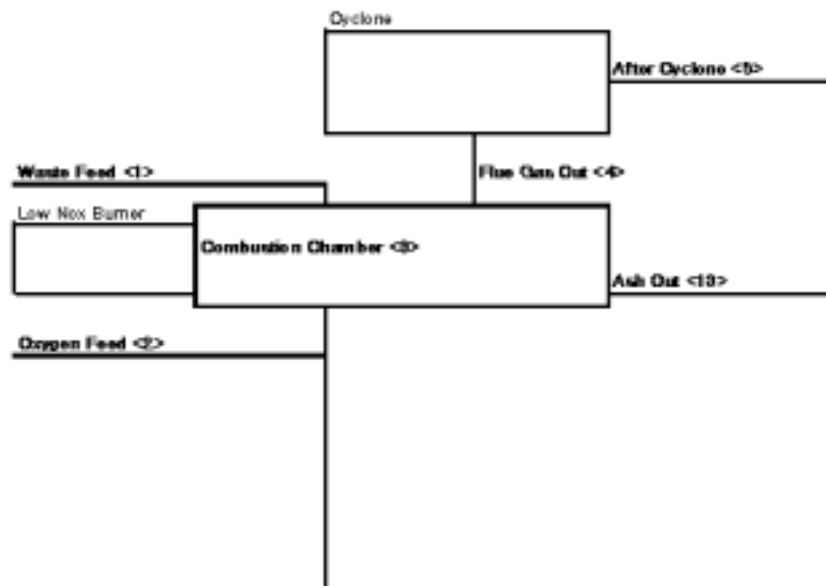
가

70%, 50%

6 - 8 vol%

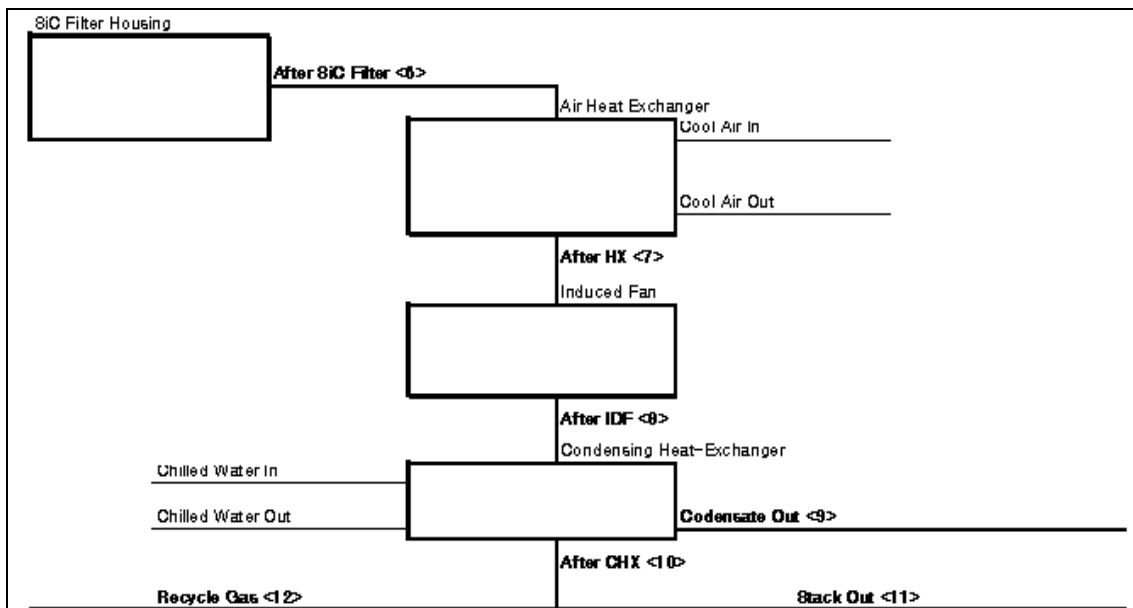
Table 3. Heat and Material Balance for Oxygen-Enriched Incinerator

Heat and Material Balance of Oxygen Enriched Alpha Waste Incinerator



Heat and Material Balance

Property or Component	Stream Name and Number	1 Waste feed	2 Oxygen feed	3 Combustion chamber	4 Flue gas out	5 After cyclone	6 After SIC filter
Total (kg/h)		10,000	24,285		65,284	65,282	65,273
Flow (AM3/h)		-	20,113		221,514	205,380	205,380
Flow (NM3/h)		-	18,999		44,045	44,045	44,045
Press. (kg/cm ² , Abs.)		-	5,085				
Press. (mmH ₂ O Act.)		-		-20	-40	-70	-170
Temperature (°C)		25	50	1100	1100	1000	1000
Heating value (kcal/kg)		6500	-	-	-	-	-
Carbon (kg/h)		6,425	-	-	-	-	-
Hydrogen (kg/h)		0,795	-	-	-	-	-
Oxygen (kg/h)		1,490	24,285	-	-	-	-
Nitrogen (kg/h)		0,060	-	-	-	-	-
Sulfur (kg/h)		0,005	-	-	-	-	-
Chloride (kg/h)		0,345	-	-	-	-	-
Moisture (kg/h)		0,770	-	-	-	-	-
Ash (kg/h)		0,110	-	-	-	-	-
Particulate (kg/h)		-	-	Ash 10%가 분진	0,011	0,009	0,000
After combustion							
CO ₂ (kg mole/h)		-	-		1,065	1,065	1,065
H ₂ O vapor		-	-		0,740	0,740	0,740
O ₂		-	-		0,137	0,137	0,137
N ₂		-	-		0,004	0,004	0,004
SO ₂		-	-		0,000	0,000	0,000
HCl		-	-		0,019	0,019	0,019
Sub total (kg mole/h)					1,966	1,966	1,966
Vol%							
CO ₂		-	-		(54,174)	(54,174)	(54,174)
H ₂ O		-	-		(37,636)	(37,636)	(37,636)
O ₂		-	-		(6,974)	(6,974)	(6,974)
N ₂		-	-		(0,217)	(0,217)	(0,217)
SO ₂		-	-		(0,016)	(0,016)	(0,016)
HCl		-	-		(0,983)	(0,983)	(0,983)



7 After air heat exchanger	8 After induced draft fan	9 Condensate water out	10 After condensate heat exchanger	11 Stack out gas	12 Recycle gas	13 Ash out	
65,273	65,273	7,925	57,359	26,628	28,525	0,099	Total (kg/h)
108,579	108,579	-	40,443	20,330	20,113	-	Flow (AM3/h)
44,045	44,045	-	34,182	17,183	16,999	-	Flow (NM3/h)
-220	-	-	250	150	100	-	Press (kg/cm2, Abs)
400	400	50	50	50	50	-	Press (mmH2O Act)
-	-	-	-	-	-	-	Temperature °C
-	-	-	-	-	-	-	Heating value (kcal/kg)
-	-	-	-	-	-	-	Carbon (kg/h)
-	-	-	-	-	-	-	Hydrogen (kg/h)
-	-	-	-	-	-	-	Oxygen (kg/h)
-	-	-	-	-	-	-	Nitrogen (kg/h)
-	-	-	-	-	-	-	Sulfur (kg/h)
-	-	-	-	-	-	-	Chloride (kg/h)
-	-	7,925	-	-	-	-	Moisture (kg/h)
-	-	-	-	-	-	0,099	Ash (kg/h)
0,000	0,000	0,000	0,000	0,000	0,000	-	Particulate (kg/h)
1,065	1,065	-	1,065	1,065	1,065	-	After combustion
0,740	0,740	-	0,300	0,300	0,300	-	CO2 (kg mole/h)
0,137	0,137	-	0,137	0,137	0,137	-	H2O vapor
0,004	0,004	-	0,004	0,004	0,004	-	O2
0,000	0,000	-	0,000	0,000	0,000	-	N2
0,019	0,019	-	0,019	0,019	0,019	-	SO2
1,966	1,966	-	1,526	1,526	1,526	-	HCl
-	-	-	-	-	-	-	Sub total (kg mole/h)
(54,174)	(54,174)	-	(69,805)	(69,805)	(69,805)	-	Vol%
(37,636)	(37,636)	-	(19,643)	(19,643)	(19,643)	-	CO2
(6,974)	(6,974)	-	(8,986)	(8,986)	(8,986)	-	H2O
(0,217)	(0,217)	-	(0,279)	(0,279)	(0,279)	-	O2
(0,016)	(0,016)	-	(0,020)	(0,020)	(0,020)	-	N2
(0,983)	(0,983)	-	(1,267)	(1,267)	(1,267)	-	SO2
-	-	-	-	-	-	-	HCl

Table 4

Table 4.

	100% O ₂ , m=1.1	70% O ₂ , m=1.15	50% O ₂ , m=1.2	
(Nm ³ /kg-)	1.72	3.27	4.46	12.06
	0.14	0.27	0.37	1

5.

1) ,

2) , 3) 가 가

가 가

가 ,

1/7 .

가 .

가

가

가 .

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