

가

가

**Characteristics of Off-gas Production in Plasma Melting  
of Non-combustible Waste by using Nitrogen Gas**

, , ,

150

가

가

가

가

NO

가

. NO

가

NO

NO가

NO

100ppm

Thermal mechanism

NO

**Abstract**

In order to analyze the characteristics of off-gas generated from melting process of non-combustible waste in a plasma torch melter using nitrogen gas as a carrier gas, off-gas concentration was measured. Considerable amounts of No and particulate were found in the off-gas, but no sulfur oxide or carbon oxide was detected. NO gas concentration in the off-gas was measured controlling the off-gas flow rate from the melter in order to investigate NO gas productive mechanism inside the melter. The results showed that air inleakage rate into the melter had an important role in the production of No gas. NO concentration could be reduced to less than 100ppm by sealing tightly the space between the torch body and the furnace wall of torch guide hole. It is necessary to design the waste feeding system of a commercial plasma torch melter to minimize NO gas production due to thermal mechanism of hot nitrogen gas with oxygen.

가 가 가 가 가

가 가 가 (inert slag)

[1].

가 가 가 가

NOx 가 가

가 가 가 가

[2].

가 가 가 가

가 가

2.

2.1

가 7 가 1 [3].

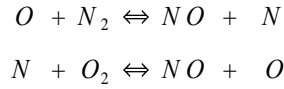
1.

Dinitrogen monoxide (nitrous oxide)	N <sub>2</sub> O	linear	colourless gas (bp -88.5 °C)
Nitrogen monoxide (nitric oxide)	NO	N-O	colourless paramagnetic gas (bp -151.8 °C)
Dinitrogen trioxide	N <sub>2</sub> O <sub>3</sub>	planar	blue solid; dissociates reversibly in gas phase to NO and NO <sub>2</sub>
Nitrogen dioxide	NO <sub>2</sub>	planar	brown paramagnetic gas; dimerizes reversibly to N <sub>2</sub> O <sub>4</sub>
Dinitrogen tetroxide	N <sub>2</sub> O <sub>4</sub>	planar	colourless liquid (mp -11.2 °C) dissociates reversibly in gas phase to NO <sub>2</sub>
Dinitrogen pentoxide	N <sub>2</sub> O <sub>5</sub>	planar	colourless ionic solid; sublimes at 32.4 °C to unstable molecular gas
Nitrogen trioxide	NO <sub>3</sub>	planar	unstable paramagnetic radical

3가 가 , thermal Zeldovich ,

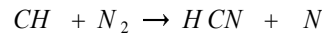
Fenimore prompt , N<sub>2</sub>O-intermediate [4].  
 Thermal  
 Fenimore , N<sub>2</sub>O-intermediate

Zeldovich NO<sub>x</sub> ,

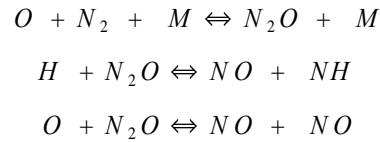


Zeldovich 1800K , 가

Fenimore 가 가  
 (amine) (cyan)  
 NO Fenimore 가  
 (CH radical)



N<sub>2</sub>O-intermediate



N<sub>2</sub>O-intermediate NO<sub>x</sub> 가  
 가 가 100 가  
 2000 , 가 가  
 NO 가 Zeldovich  
 NO 가 가  
 , 2 [5].

2. NO가

$N_2 + O_2 \rightleftharpoons 2NO$	T (K)	$K_p$
$K_p = \frac{(P_{NO})^2}{(P_{N_2})^2(P_{O_2})^2}$	300	$10^{-30}$
	1000	$7.5 \times 10^{-9}$
	1200	$2.8 \times 10^{-7}$
	1500	$1.1 \times 10^{-5}$
	2000	$4.0 \times 10^{-4}$
	2500	$3.5 \times 10^{-3}$

2 가 NO 가 가 , 가  
 NO 가 가 NO<sub>2</sub> .  
 NO 가 가 NO .

2.2

가 가

3 [6].

3.

	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	CaO	MgO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	MnO	TiO <sub>2</sub>
(w %)	55.22	23.22	5.25	7.72	1.26	0.97	2.69	0.03	0.7	0.28

가

(Bottom Ash)

(Fly Ash)

4

[7].

4.

: w %

	(Bottom Ash)	(Fly Ash)
Ca	13.3	29.2
SiO <sub>2</sub>	28.1	23.8
Al <sub>2</sub> O <sub>3</sub>	7.2	3.1
MgO	2.2	2.1
FeO	3.0	0.9
Na	2.5	6.1
K	1.2	5.2
C	33.1	2.9
Cl	1.9	30.0
S	0.49	3.3
Zn	2.13	0.94
Cu	0.09	0.07
Cd	0.001	0.02
Pb	0.08	0.20
Cr	0.07	0.02

3

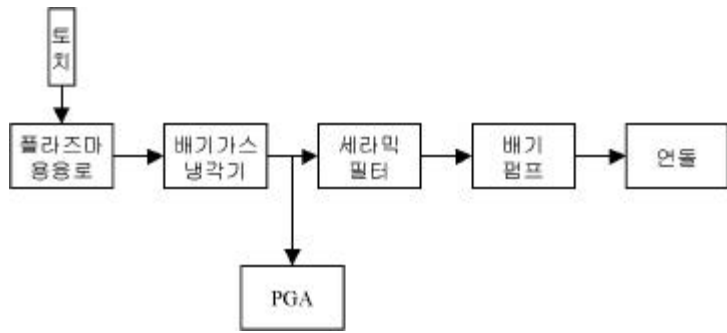
Ca, Na, K, Cl, S, Cd, Cd, Pb

가

, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, FeO, C, Zn, Cr

2.3

가 , 가 , 가 , 가  
 , 1 가 가 가 가  
 , 가 가 가 가  
 , NH<sub>3</sub>, NO<sub>x</sub>  
 (PGA; Portable Gas Analyzer)  
 가 , 가 , SO<sub>x</sub>,  
 NO<sub>x</sub>, C<sub>x</sub>H<sub>y</sub> PGA  
 가  
 Eurotron GreenLine Mk2 Combustion Gas Analyzer  
 2 GreenLine Mk2 25% O<sub>2</sub>,  
 4000ppm CO, 2000ppm NO, 2000ppm SO<sub>2</sub>, 5% C<sub>x</sub>H<sub>y</sub>  
 batch (batch )



1.

GreenLine Mk-2 가 가 , ,  
 LED screen(control consol), water trap, line filter,  
 , 가 cells(O<sub>2</sub>, CO, SO<sub>2</sub>, NO, NO<sub>2</sub>, C<sub>x</sub>H<sub>y</sub>), 가  
 2 (Pt100,Tc), Draught /Pressure Transducer  
 Callidus PT 150C Plasma Arc Torch , 가

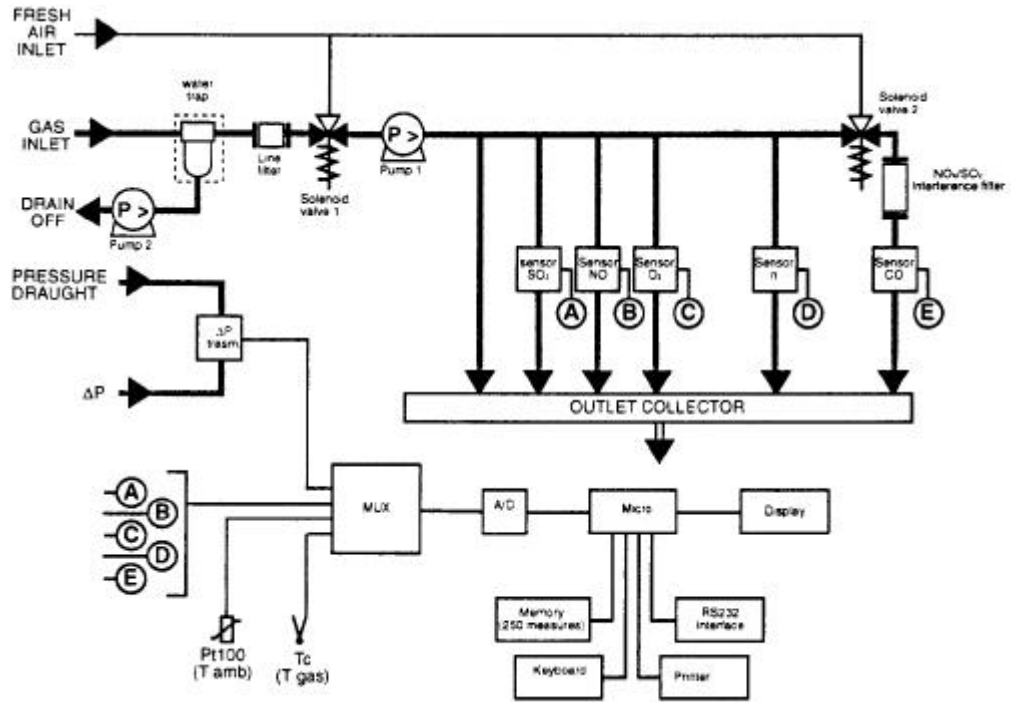
2.4

가

가

가

가



## 2. GreenLine Mk2 가

가

가

가

가

가  
가

가  
2.4m³/h

가  
10m³/h

가  
2.4m³/h

6.6m³/h

가

가

가

가

가

가

10m³/h

2.4m³/h

가

가

가

가

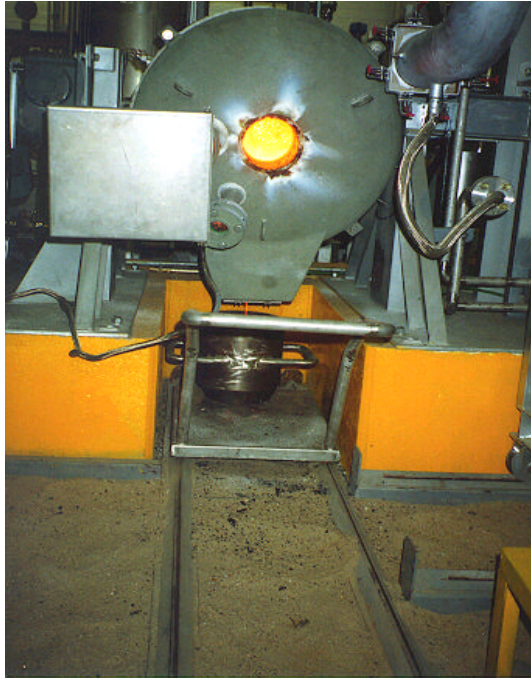
NO 가 가

가

가

가

NO 가

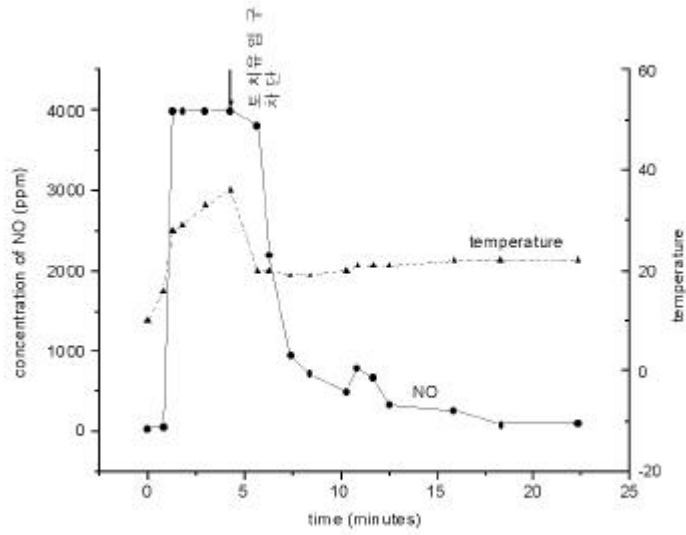


3.

3.

NO 가  
 NO 가  
 가 , 가 가  
 가 가  
 가 가  
 NO 가  
 NO 가  
 , , 4 가 4 가  
 가 4 가 NO 가  
 가 NO 가 가  
 , 가 가  
 , NO가  
 4 NO가 가  
 가 가  
 , 가 가

가 NO가 가 , NO 가



4. 가 NO 가

NO 가 1800K Zeldovich

가

가 purge 가

가 NO 가

가 Ca 가

0.58g  
80 /min  
35.2g  
25  
PGA  
14.7mg/ (=ppm)  
0.37%

1.58  
30  
9.3kg

가

가

4.

가 가 가



NO 가 가 .  
 NO 가 가  
 가 , 가  
 , NO 가 feeding 가  
 가 purge ,  
 가 .

5.

- [1] "Plasma Environmental Technologies," Bright Engineers, <http://brightengr.com/>.
- [2] , " (I) ," TM. 96NJ17.M1999.7 (1999).
- [3] Especial Gas Inc., " Chart of Nitrogen Oxides," [http://www.c-f-c.com/charts/nitrogen\\_oxi.htm](http://www.c-f-c.com/charts/nitrogen_oxi.htm).
- [4] Troy Pressnall and Aydin Ungan, " Summary of Research Goals : NOx and Soot Formation," Heat and Mass Transfer Research Laboratory, <http://www.engr.iupui.edu/ungan/noxsoot.html>.
- [5] Kenneth Wark and Cecil F. Warner, " Air Pollution : Its Origin and Control," 2ed., Harper & Row, New York (1981).
- [6] , " (I) ," TM.96NJ17.M1998.600, p.244 (1998).
- [7] " , " ( ) (2000).