

1.

< >

IMF 가

가

가 2001 2

9 , P/H IDF 4

2 15 2 가 13.8 %

36 2001 31 , 5

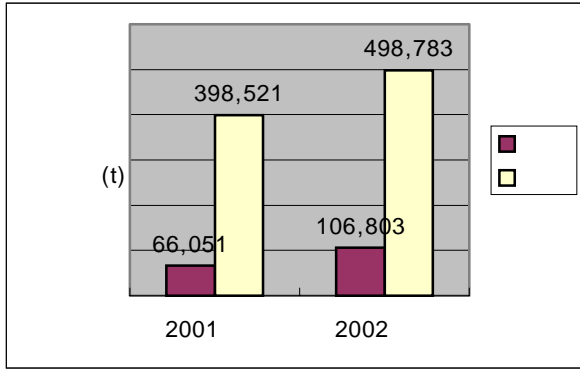
가 가

1.

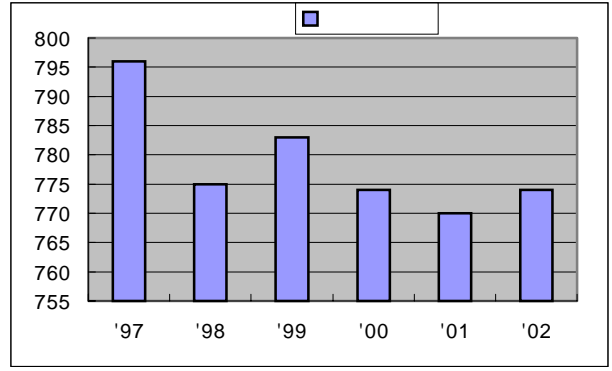
		/ ,	(%)
2001		398,521	2.46
		66,051	5.55
2002		498,783	3.15
		106,803	14.6

) Pet coke ,

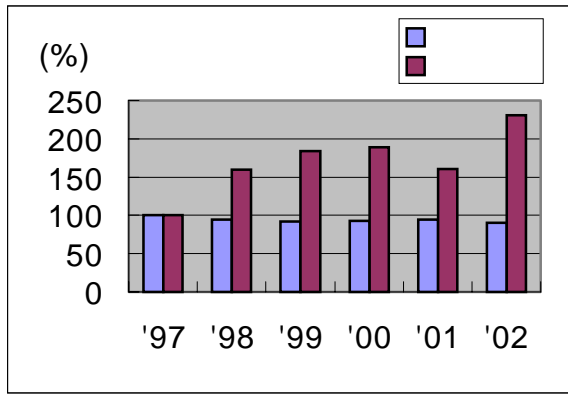
가 2 5



1.

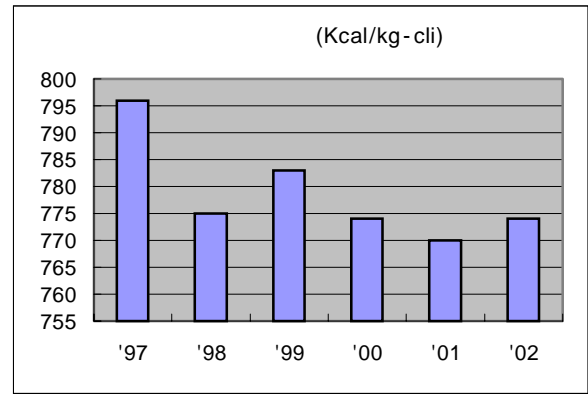


2.



a) 97

3.



b)

2. 2 5

2.1

2

가

- 2

(by - pass)

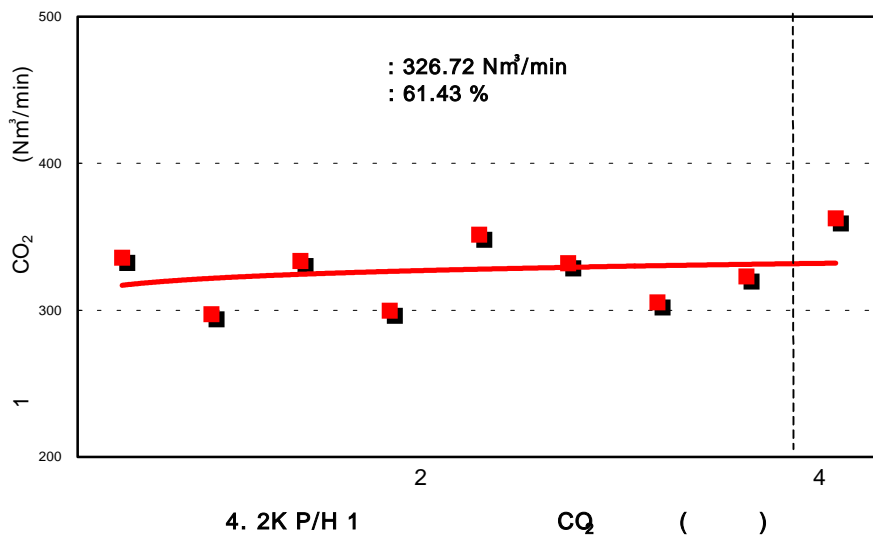
가

· 2001

가

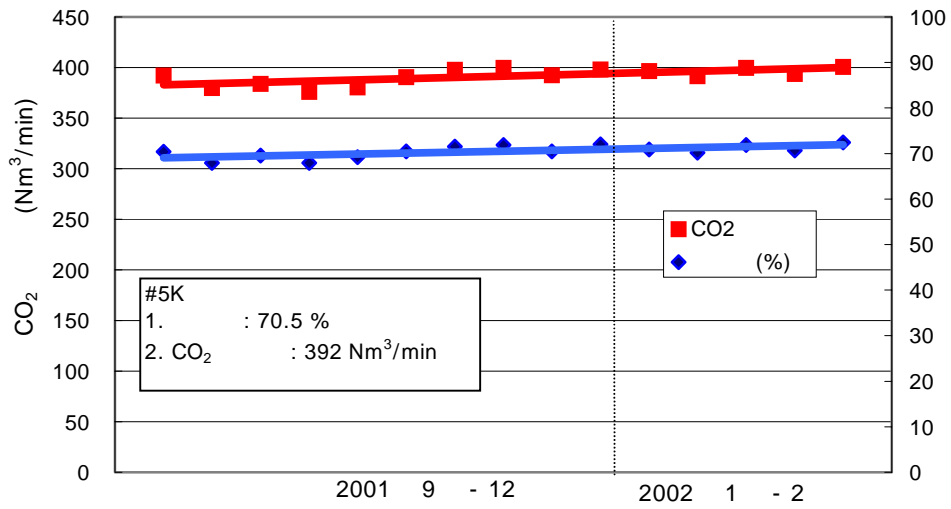
2.

		2	5
	(T/D)	3,200	3,000
	NSP	MFC	PREPOL - AS
	Stage	4	5
	Dimen. (m x mL)	4.9 x 75	4.0 x 60
	Slope (%)	3.65	3.5
	Rev. (rph)	172	210
COOLER	Type	GRATE	GRATE INLET ; IKN KIDS
	Stage	3	2
BURNER		NFK	Rotafam
(%)	Main	80	42
	Precal	20	58



5 (spec. vol. load)가 3.27(tpd/m³) 82~84%
1 ~7 (1.61~2.59)

가 가
(water gun) 가
70.5%



5. 5K P/H 1 , CO₂ ()

2 5

2.2

2 5
(K₂O)가

3 (sulfur)
K, Na, Sulfur, Cl

(sulfates), (spurrites), (carbonates)

3. : %

		SO ₃	K ₂ O	Na ₂ O	Cl
2		9.75	4.94	0.16	0.33
		16.41	6.18	0.17	1.34
5	1 Cyc.	14.45	6.59	0.25	3.29

SO₃ 가 (.7) . 2 , 5 1

SO₃가 가

가 ASR(alkali sulfur molar ratio) (1.2)

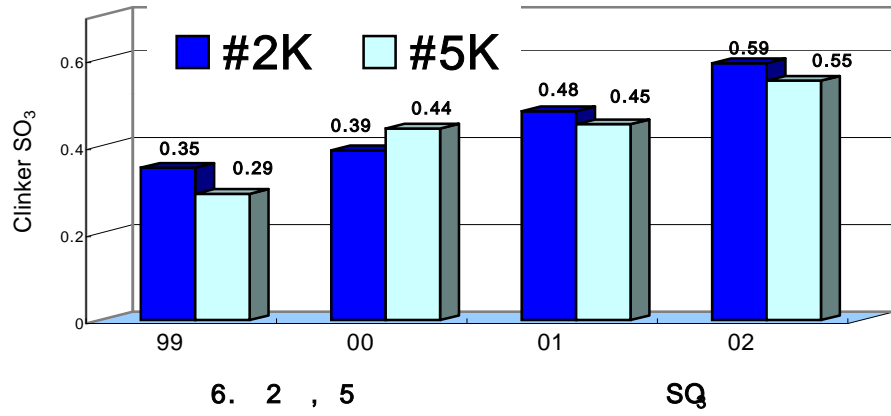
(8,9).

가 SO₃ 가

가 ¹⁾ 가 SO₃

가

가



가 가 가 .
2)

- 1 : /
- 2 : (build - up) 가
- 3 :

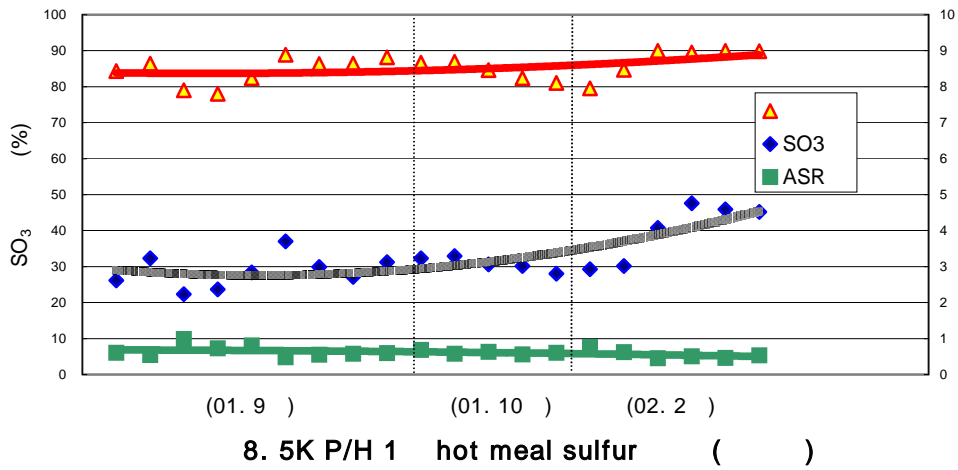
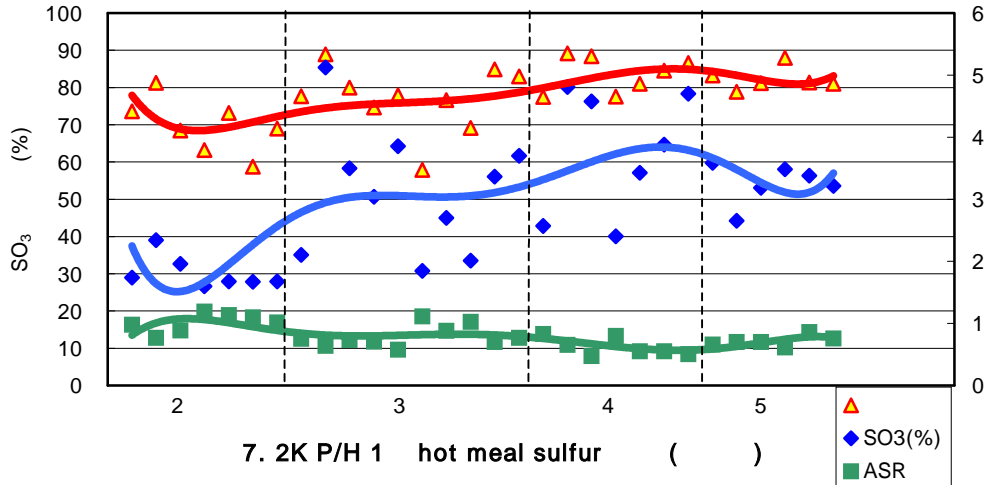
4

- : 16~18 g - SO₃/kg - cli,
- : 4 g - SO₃ /kg - cli(loss - free basis) ³⁾
- (Holcim) 가 , 4~5 SP ²⁾

		(%)	(%)
(SO ₃)		0.5	1.25
	Coal	< 1.5	> 3
	Coke	< 2	> 4
	Fuel oil	< 2.5	> 5

● loss - free basis

가
가 (2.72, 2.39)
0.27, 0.80 1 SO₃가



4. 1 (hot meal) sulfur 가 가

*Ig - loss free

	2	5
	Sulfur (%)	Sulfur (%)
1	2.99	3.19
1	2.72	2.39
1 가	- 0.27	- 0.80
(%)	78	86
가 가	- 0.060	- 0.113
(Kg/)	19,520	12,954
(Kg/)	17,739	9,705
가 가 (Kg/)	- 1,781	- 3,249

● 1 Hot meal sulfur ASR(alkali sulfur molar ratio)
(2K=1.0, 5K=0.7)

● 가 sulfur 가 = hot meal 가 × (1 - / 100)

2.3

AlK₂SO₄, Ca₂K₂(SO₄), 2C₂S · CaSO₄, CaO, C₂S

1 가

2 5

1 가 CO>0.1%, O₂<1.5~2% 가

O₂>2%, CO< 0.05%

가 가

가 가

가 90, 200μm

가 2

가

5. sulfur

		가	
		2	5
O ₂ 가		L	I
		P	G
		P	G
		P	G
/		L	
Kiln speed		P	G
		P	G

L ; limited, I ; little, G; good, P; poor

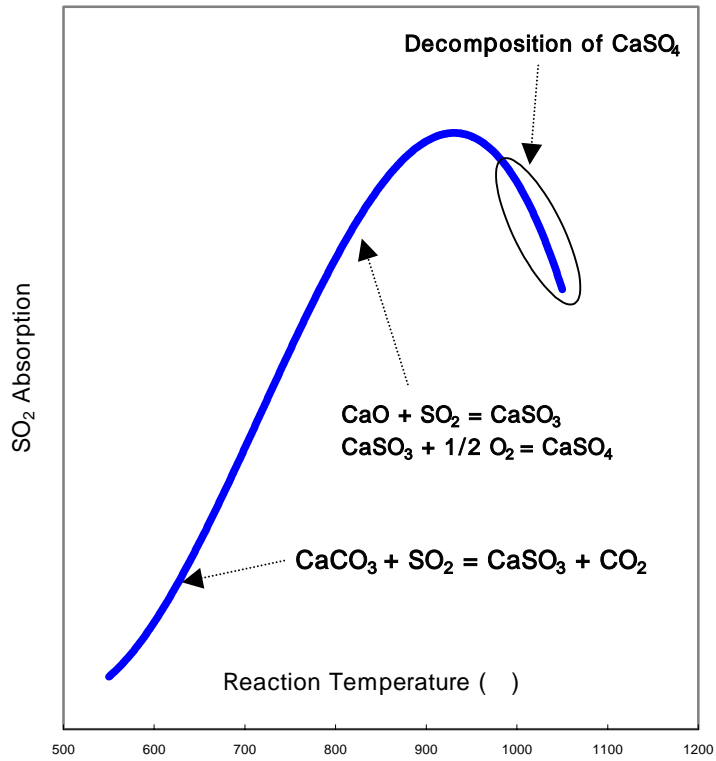
2 ASR(alkali sulfur molar ratio)

가 ()

가

(kiln inlet) CaO가

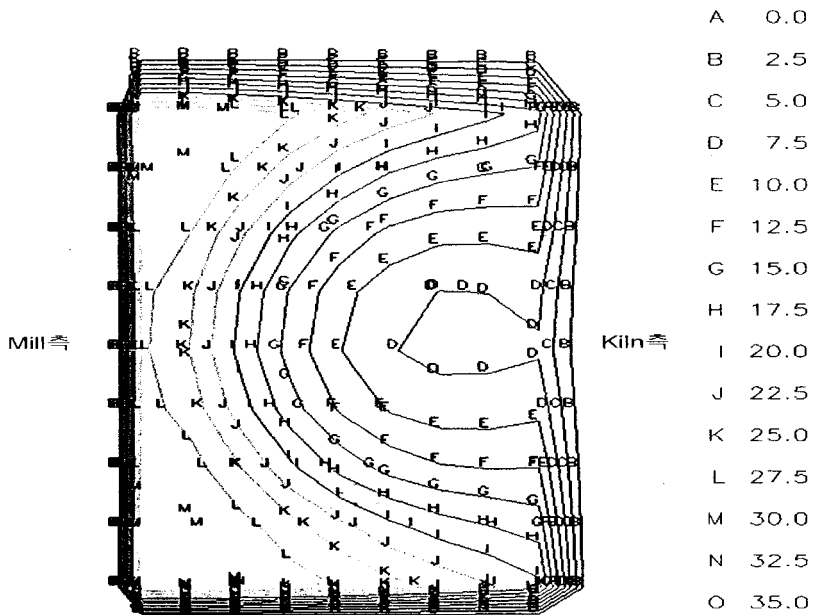
가 ³⁾



9. SO_2 absorption by CaO resp. CaCO_3

2.4 5

P/H 가 CFD 가 ,
 가 . 2
 3 가 가
 가 . 2
 가 - , CO_2 가 .



Orifice center(현재 형태)

10. 가

가 30 m/s, 7.5 m/s
 27.5 m/s 1.3 m/s
 가 “0” P/H ()
 , 가 가 가
 가 가 5,282 N·m (6). 2
 3,234 N·m 가 7.5 m/s 가
 2.3 m/s가 가
 22.8 m/s, 1,686 N·m 가
 9.8 m/s (15,233 N·m)
 가 가

6. , 가 ,

		(Kg/s)	27.5
		(N·m)	3,234
		(N·m/m ²)	15,233
	Main	(t/h)	6.8
	Precal		8.8
		(Am ³ /min)	35.2
		(Nm ³ /min)	43.4
		(m/s)	34.9
		(N·m)	1,490
		(N·m/m ²)	88,690
가		(N·m ³ /min)	1,065
		(Am ³ /min)	4,808
		(Kg/s)	26
		(N·m)	5,282
		(m/s)	20.3
		(Am ³ /min)	5,398
		(N·m ³ /min)	1,065
		(Kg/s)	26
		(N·m)	6,657
		(N·m/m ²)	1,686
		(m/s)	22.8

3.

P/H

가

-1

-2

- ASR()

3.1 2

(chute)

5

2

3

2

가

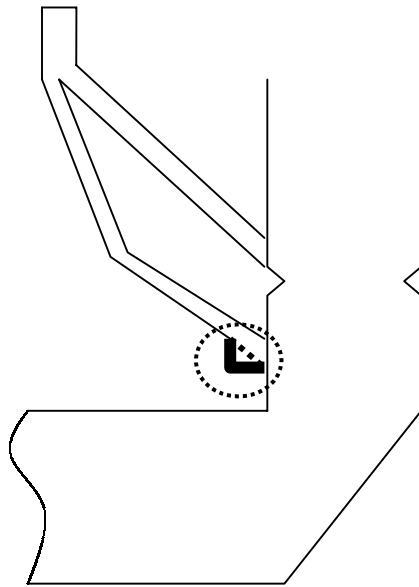
2

가

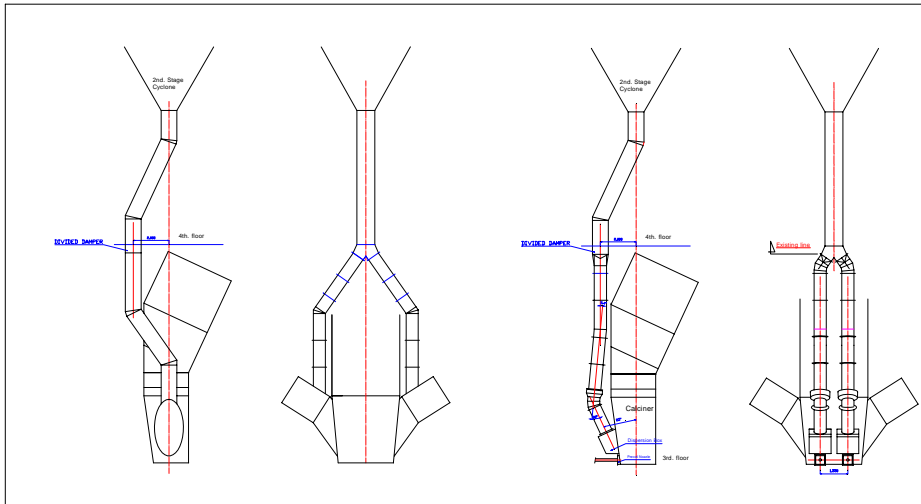
(.11, 12),

가

ASR



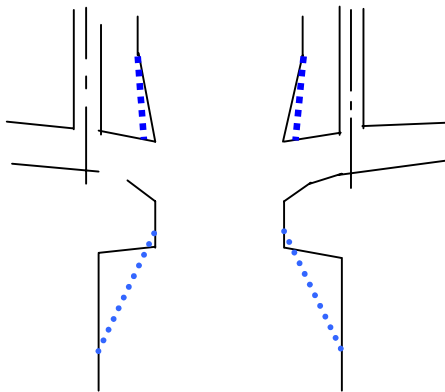
11. 2K



12.2 Chute /

3.2

가



3.3

1997	P	15~17%	1	20	가
(swirler)		가		가	
		30	2001 1		
		가	12% 1		
		40	8%(Burner)	1	2002 2
			가		CO 가
0.6%		14~16m가			8~9m

(ash coating, ring)

가 6% 가

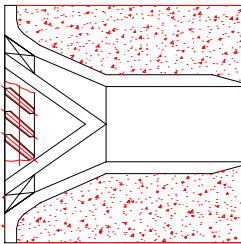
SO₃ 가 1 SO₃ 8 ASR

가

3.4 (Precaliner nozzle)

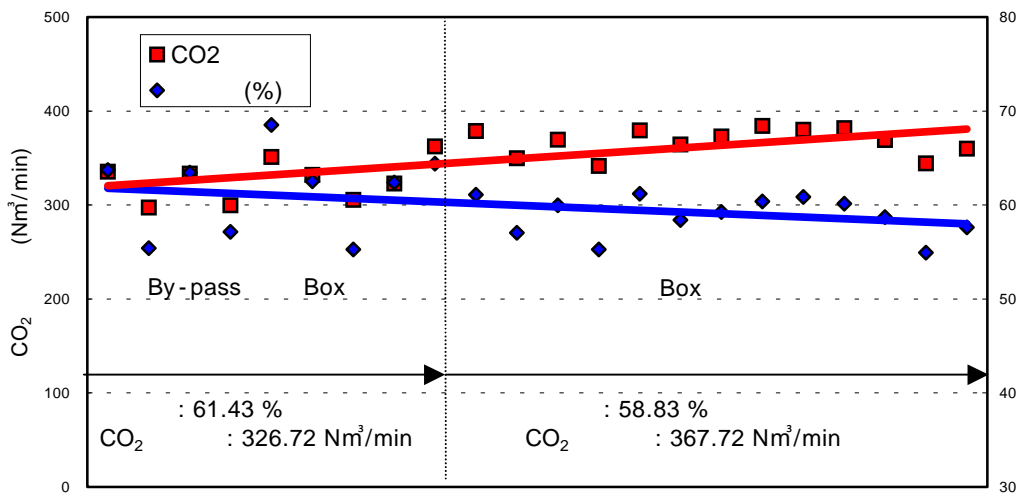
3

가



4.

4.1



13. 2K P/H 1 ,CO₂ ()

2

(61.43 %) 2.6 %

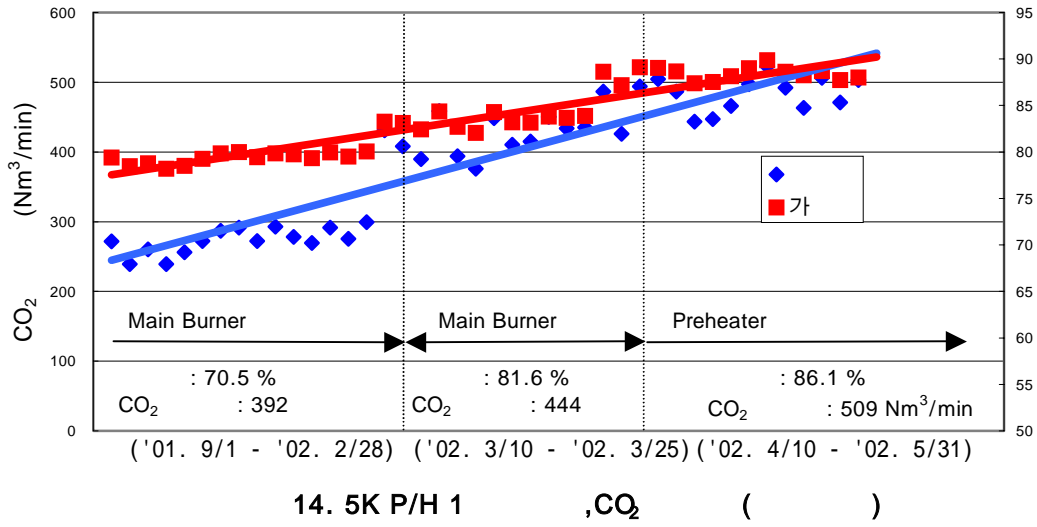
가

가 (CO₂)

CO₂

41 Nm³/min 가 가 . 5

가 11.1 %, 4.5 % 가 CO₂
 52 Nm³/min, 65 Nm³/min 가 가 .

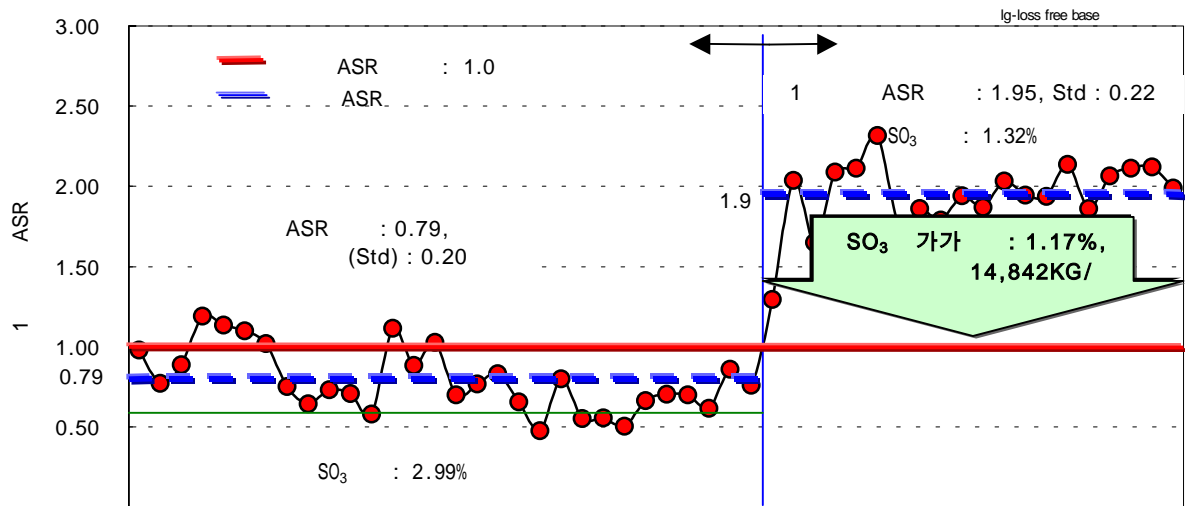


4.2

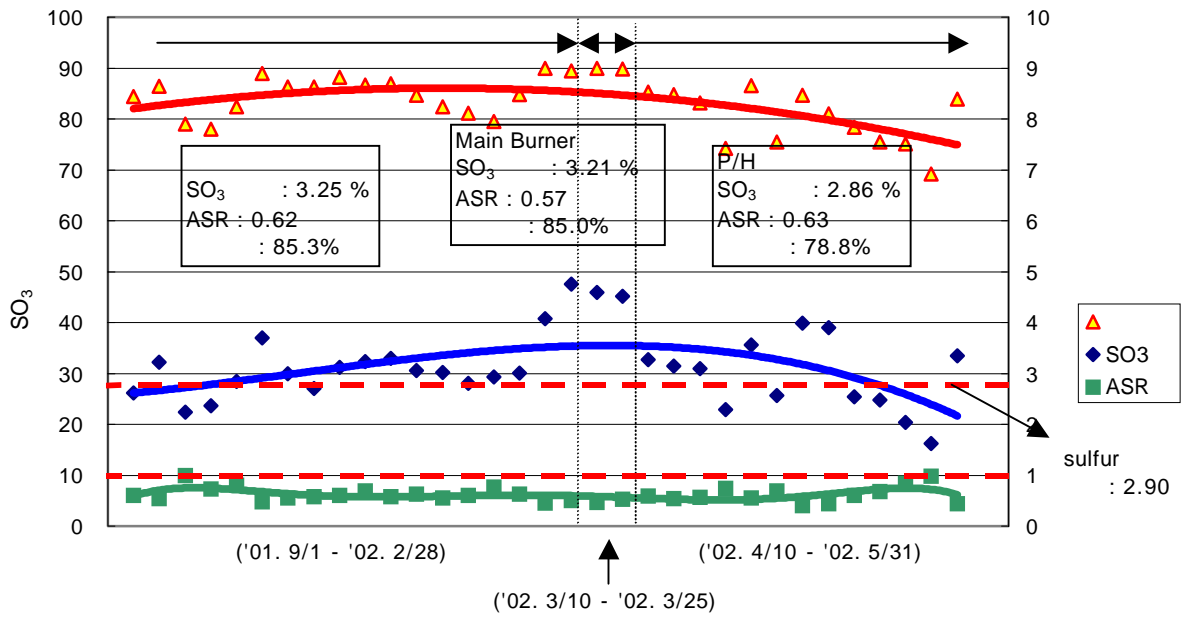
6.

	#2K	#5K	
	Sulfur(%)	Sulfur(%)	
		Burner	P/H
1	1.32	3.25	2.86
1	2.72	2.90	2.90
1 가	1.40	- 0.35	0.04
(%)	52	85	79
가 가 (%)	0.666	- 0.051	0.008
(Kg - SO ₃ /d)	18,555	13,759	17,462
(Kg - SO ₃ /d)	38,195	12,297	17,706
가 가 (Kg - SO ₃ /d)	19,640	- 1,482	244

2 1,781 kg - SO₃/d 가
 19,640 kg - SO₃/d 가
 가 . 5 1,482 kg - SO₃/d 244 kg -
 SO₃/d .



15. 2K 1 hot meal sulfur (



16. 5K P/H 1 hot meal sulfur (

5.

가 sulfur, Cl , 1
 가 SO₃가 1,781 kg - SO₃/d, 1,482 kg - SO₃/d 가
 SO₃가 SO₃ SO₃
 , 2 SO₃ 1 SO₃
 ASR
 1) 2 ,5 2 (chute)
 2) 5
 3) 5
 4) 5
 2 , 5 SO₃ 2 26 %, 5 6 %
 1 SO₃ 1.66 %, 0.39 % ASR 0.63~1.95

	2		5		
(%)	61.43	58.83	70.5	81.6	86
CO ₂ (Nm ³ /min)	327	368	392	444	509
(%)	77.9	52.4	85.3	85.0	78.8
1 hot meal SO ₃ (%)	2.99	1.32	3.25	3.21	2.86
ASR	0.79	1.95	0.62	0.57	0.63

2 가 가
 1 가

100 %

/

REFERENCE

1. [Redacted], “ SD [Redacted] ”, 28 [Redacted], p.32, (2001)
2. Lene, J.C., “High sulfur fuels fired for action”, World Cement, 12/2001, 29~30.
3. Holderbank Cement Seminar, Process Technology II (Chap.10 Circulation phenomena).