

A Study of Physical and Chemical Properties for Dry Active Waste Glasses

149

	100				KEP-A 6
Ash		CaO, SiO ₂	TiO ₂	51.09 wt%, 15.66 wt%, 15.16 wt%	가
. 6	FA/MA	CE22	1,100 ~ 1,250	28 ~ 94 poise	
			1,100	6	가
0.19 ~ 0.58 S/cm					
	. KEP-A	FA/MA	CE22	50 poise	
(T _M)	1,122 ~ 1,195		(T _L)	1,022 ~ 1,095	

Abstract

To find out the optimum glass formulation of Dry Active Waste(DAW), Several glass additives were used such as a KEP-A, fly ash, window glass, Nepheline, FA/MA and CE22. The main components of ash were CaO, SiO₂ and TiO₂ concentrations of 51.09wt%, 15.66wt%, and 15.16wt%, respectively. The viscosity of the FA/MA and CE22 were well within the desired operating viscosity range as 28 ~94 poise in the 1,100 ~ 1,250 range. All of six glasses at 1,100 were showed the electrical conductivity as 0.19 to 0.58 S/cm which are also the desired operational condition. But they were showed higher electrical conductivity above that temperature. The KEP-A, FA/MA and CE22 were calculated the melting temperature(T_M) as 1,122 ~ 1,195 and liquidus temperature(T_L) as 1,022 ~ 1,095 . These results help to determine the optimum glass formulation of DAW and to contribute the process control of vitrification.

2)

(2)

EA 1108)

10ppm,

(CE, Elemental analyzer

0.1 100mg

3)

/

(3)

Ash

/

. 575

ash

Si

ICP-AES

3

ash

1

6 가

100kg 가

575 muffle furnace

Ash

. Ash

ash

ash

가

ash

가

ash

6.78wt%

ash

가

ash

ash

/

1

ash

2

ash

/

3

가

가

. 3

CaO가 51.09wt%

가

SiO₂

TiO₂가

15.66, 15.16wt%

. CaO

(,)

2가

1가

. SiO₂

Si-O

가

가

. TiO₂

가

가

.⁽⁴⁾

6

가

가

가

4

6가

가

KEP-A

가

FA/MA

Nepheline

CE22

Si

Na, Ca

가

가

가

3.

가

가. 100

1

100g

904 cm³

100g

ash

1.104g

ash 100g

9,803g

81,884 cm³

100

가

819 cm³

Ash

glass form code

/

3.31g/cm³

2.42g/cm³ (KEP-A)

100g

1,909 g

KEP-A

100

가

5

100 , FA/MA, Nepheline CE22
 1,967, 2,154, 1,980, 1,973 1,846 g .
 3 4

5 .

가 . , ,

1,100

가 Savannah River Lab.

(5)

$$\text{Log (poise)} = -0.61 + 4472.45 / [T()] - 1.534 \text{ NBO} \quad R^2 = 0.976 \text{ ----- (1)}$$

:

T :

NBO : (Non-bridging Oxygen) :

$$\text{NBO} = \frac{2(\text{M}_2\text{O} + \text{Fe}_2\text{O}_3 + \text{Al}_2\text{O}_3) + \text{B}_2\text{O}_3}{\text{SiO}_2}$$

$$\text{M}_2\text{O} : \text{Na}_2\text{O} + \text{K}_2\text{O} + \text{Cs}_2\text{O} + \text{Li}_2\text{O}$$

KEP-A 6

가 6 . 가 , 가 ,
 가 . 20 poise가 .

가 ,
 100 poise . 6 1,100 ~ 1,250 가
 Nepheline
 KEP-A 1,150 ~ 1,250
 41 ~ 83 poise FA/MA CE22 28 ~ 94 poise

. Savannah River Lab.

(6)

$$\text{Log } (\text{ } -\text{cm}) = (-2.48) + (4399.57)/[T(\text{K})] - 0.45 \text{ NBO} \text{ ----- (2)}$$

$$\text{ : } \text{ : } (\text{S/cm}) = 1/ (\text{ } -\text{cm})$$

:

T :

NBO : Non bridging Oxygen

0.1 ~0.6 S/cm . 7
 1,100 6 가 0.19 ~ 0.58 S/cm
 1,150 Nepheline 0.24 ~ 0.60 S/cm
 1,200 1,250 0.31 0.39
 5
 가 가

50 poise (melting
 temperature; T_M) (liquidus
 temperature; T_L)

Pacific Northwest National Lab.

(7)

$$T_M = \sum_{i=1}^n T_i g_i \text{ ----- (3)}$$

$$= T_M - T_L \quad 100 \text{ ----- (4)}$$

g_i : i

n :

T_M :

T_L :

T_i : i

:

8			(T_M)		(T_L)	가
1,847	1,747	가	Nepheline	1,409	1,309	, 1,344
1,244			KEP-A FA/MA	CE22		
(T_M)	1,122 ~ 1,195		(T_L)	1,022 ~ 1,095		

4.

1. ash 가 ash 가
- ash 6.78wt%
2. / CaO가 51.09wt% 가 SiO₂ TiO₂
가 15.66wt%, 15.16wt%
3. 6 100 100g KEP-A, , ,
FA/MA, Nepheline CE22 1,909, 1,967, 2,154, 1,980, 1,973 1,846 g

4. KEP-A	1,150 ~ 1,250		41 ~ 83 poise	FA/MA	CE22
			28 ~ 94 poise		
5.	1,100	6	가	0.19 ~ 0.58 S/cm	
6. KEP-A	FA/MA	CE22	(T _M)	1,122 ~ 1,195	(T _L)
	1,022 ~ 1,095				
			가		
	100	,			가
	FA/MA	CE22		가	
				가	

5.

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1. ash

	(100kg base)		(cm ³)	ash (wt%)	Ash (g)
	9.47	0.21	45070	0.41	38.81
	6.66	0.21	31740	0.87	57.98
	8.46	0.21	40280	0.32	27.07
	50.14	0.07	726650	0.46	230.63
	16.10	0.37	43160	6.78	1091.60
	9.17	0.53	17440	2.4	220.16
	100		904340		

2. ash /

(mg/ kg)

Al	3320	2080	23500	19300	1850	4780
B	2400	201	12	61	21	10
Ca	9530	38700	301000	242000	289000	92700
Fe	2410	2070	5920	8040	736	6930
K	7160	309700	13300	52300	646	12100
Mg	138000	45500	38600	61800	1330	81300
Mn	120	216	6070	3660	60	261
Na	84900	16700	47100	31100	151	7360
P	8470	14400	8900	11300	4720	9990
S	3810	11300	45900	64100	3710	85900
SiO ₂	28700	190000	190000	352000	60722	12248
Ti	323000	108000	10500	8400	75600	592

3. Ash /

	(mg/kg)		(mg/kg)	(wt%)
Al	84.09	Al ₂ O ₃	158.88	1.44
Ca	4024.57	CaO	5642.44	51.09
K	340.27	K ₂ O	409.89	3.71
Mg	426.42	MgO	707.19	6.40
Na	144.96	Na ₂ O	175.84	1.59
Ti	1036.73	TiO ₂	1729.33	15.66
P	113.62	P ₂ O ₅	260.38	2.36
Fe	45.57	Fe ₂ O ₃	65.16	0.59
Mn	11.49	MnO ₂	18.18	0.16
Si		SiO ₂	1674.38	15.16
B	1.44	B ₂ O ₃	3.72	0.03
S	79.58	SO ₃	198.95	1.80
			11044.34	100

4.

(wt %)

	KEP- A			FA/MA	Nepheline
SiO ₂	56.0	63.49	72.0	46.5	54.0
Na ₂ O	21.0	0.74	13.0	20.0	28.0
B ₂ O ₃	15.0	-	-	18.5	-
Al ₂ O ₃	5.0	26.70	1.0	10.0	18.0
Fe ₂ O ₃	3.0	3.09	-	5.0	-
TiO ₂		1.22	-		
CaO		1.98	9.0		
K ₂ O		1.46	1.0		
MgO		0.88	4.0		
		0.44	-		

5.

	KEP - A						FA/MA		Nepheline		CE22	
SiO ₂	56.0	53.97	63.49	61.60	72.0	69.24	46.5	44.99	54.0	52.12	56.0	54.94
Na ₂ O	21.0	20.03	0.74	0.78	13.0	12.45	20.0	19.11	28.0	26.72	17.0	16.52
B ₂ O ₃	15.0	14.25	-	0.00	-		18.5	17.61	-		25.0	24.17
Al ₂ O ₃	5.0	4.82	26.70	25.69	1.0	1.02	10.0	9.59	18.0	17.20		0.08
Fe ₂ O ₃	3.0	2.88	3.09	2.99	-	0.03	5.0	4.79	-	0.03		0.03
TiO ₂		0.78	1.22	1.87	-	0.76		0.75		0.76		0.82
CaO		2.55	1.98	4.18	9.0	11.04		2.46		2.47		2.68
K ₂ O		0.18	1.46	1.57	1.0	1.13		0.18		0.18		0.19
MgO		0.32	0.88	1.13	4.0	4.12		0.31		0.31		0.34
		0.78	0.44	0.20	-	0.21		0.20		0.20		0.22

6.

	KEP - A						FA/MA		Nepheline		CE22	
	(poise)											
1100	122	125	12034	11651	826	823	82	85	328	331	92	94
1150	81	83	8010	7755	550	548	55	57	219	221	61	63
1200	56	57	5515	5340	378	377	38	39	151	152	42	43
1250	40	41	3913	3788	268	268	27	28	107	108	30	31

: (20 ~ 100 poise)

7.

	KEP - A						FA/MA		Nepheline		CE22	
	(s/cm)											
1100	0.44	0.49	0.17	0.19	0.43	0.47	0.46	0.52	0.38	0.42	0.52	0.58
1150	0.58	0.64	0.22	0.24	0.55	0.60	0.60	0.67	0.49	0.54	0.67	0.75
1200	0.73	0.81	0.29	0.31	0.70	0.77	0.76	0.85	0.63	0.69	0.85	0.96
1250	0.92	1.02	0.36	0.39	0.88	0.96	0.96	1.07	0.79	0.87	1.07	1.20

: (0.1 ~ 0.6 s/cm)

8.

	KEP - A						FA/MA		Nepheline		CE22	
T _m (°C)	1234	1195	1907	1847	1458	1409	1181	1146	1390	1344	1150	1122
T _l (°C)	1134	1095	1807	1747	1358	1309	1081	1046	1290	1244	1050	1022

T_m (melting temp.) - T_l (liquidus temp.) ≈ 100 °C,