THE ANALYSIS OF SLAGS AND RELATED OXIDE-TYPE MATERIALS

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W. Ramsden

The Application of Multi-Channel Spectrometers to the Elemental Analysis of Oxide Materials

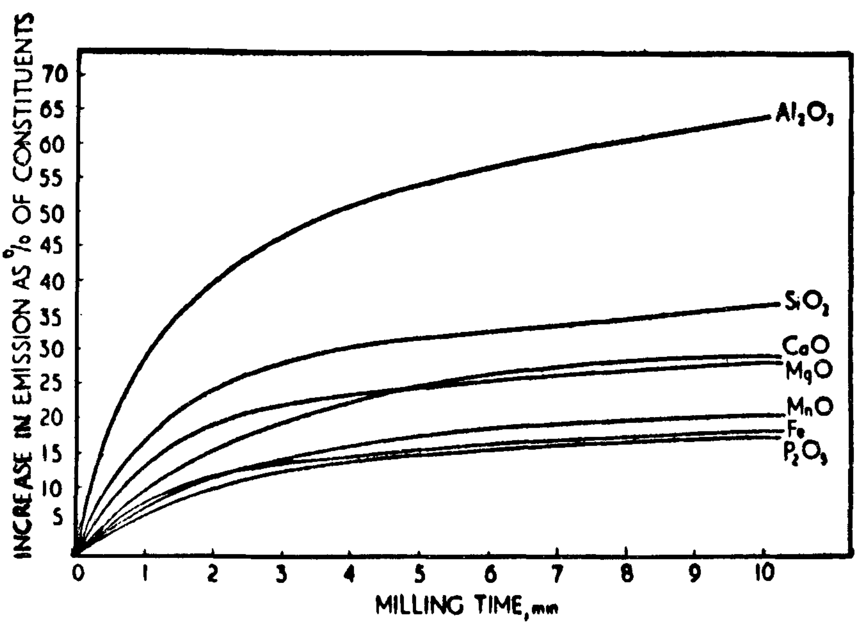
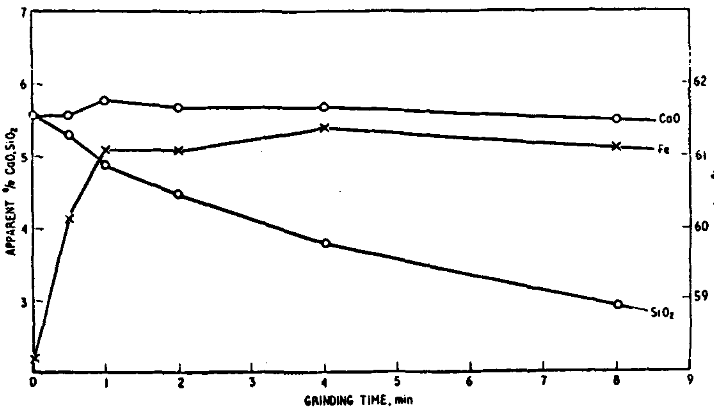
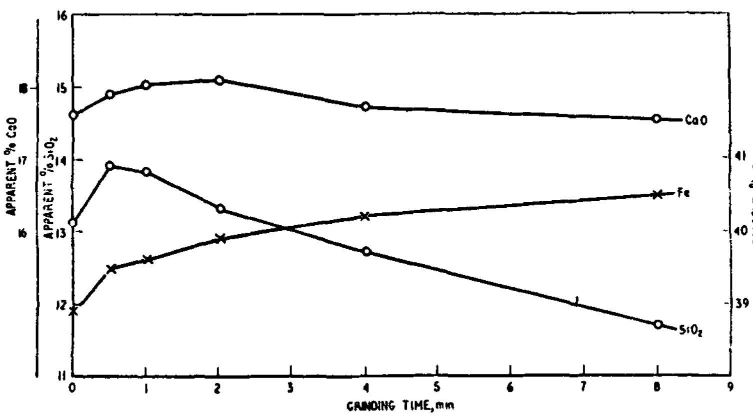


FIG. 1 -- Effect of particle size on emission.



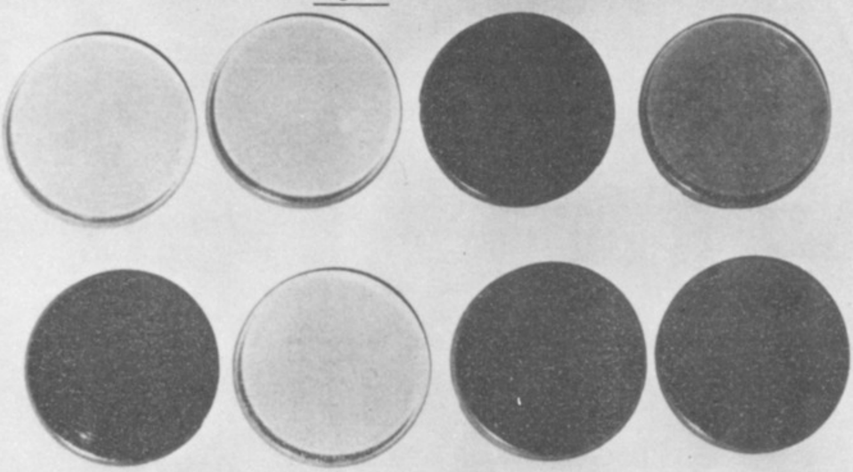
Influence Of Grinding Time, High Grade Sinter, Mean Of Laboratory Results.



Influence Of Grinding Time, Low Grade Sinter, Mean Of Laboratory Results.

Fig. 2 Effect Of Grinding Time on XRF Analysis Of Sinters.

Fig. 3



A selection of typical beads prepared on the Schoeps machine.

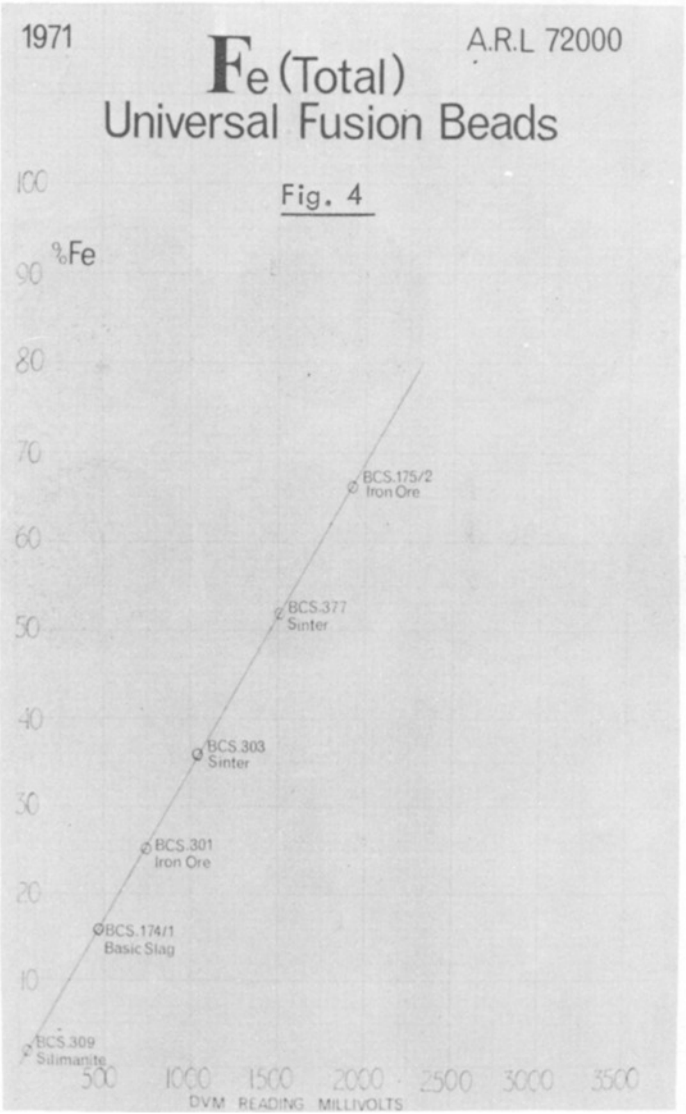
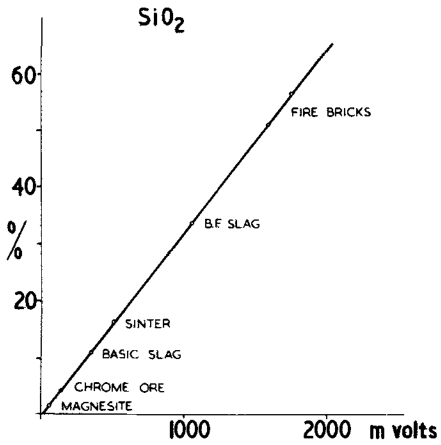
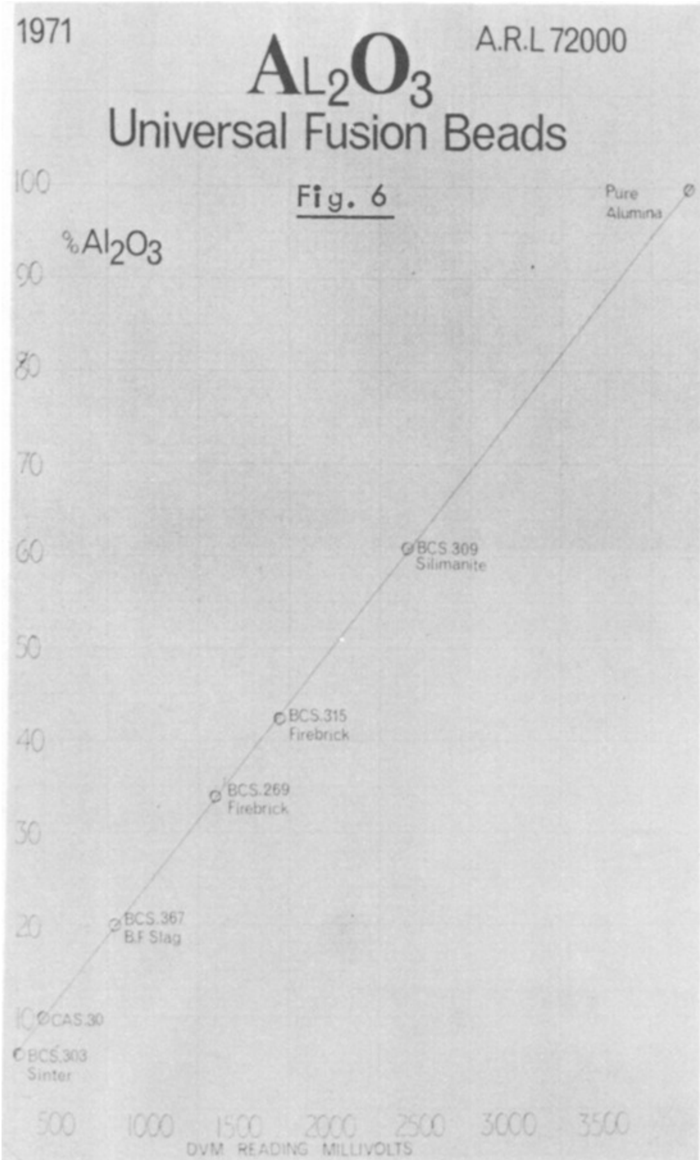

1971
Fe (Total)
A.R.L 72000
Universal Fusion Beads
Fig. 4
%Fe
100
90
80
70
60
50
40
30
20
10
BCS.175/2
Iron Ore
BCS.377
Sinter
BCS.303
Sinter
BCS.301
Iron Ore
BCS.174/1
Basic Slag
BCS.309
Silimanite
500 1000 1500 2000 2500 3000 3500
DVM READING MILLIVOLTS

Fig. 5


SiO_2
60
40
%
20
FIRE BRICKS
B.F SLAG
SINTER
BASIC SLAG
CHROME ORE
MAGNESITE
1000
2000
m volts


1971
Al_2O_3
A.R.L 72000
Universal Fusion Beads
Fig. 6
%Al_2O_3
100
90
80
70
60
50
40
30
20
10
Pure Alumina
BCS 309 Silimanite
BCS.315 Firebrick
BCS.269 Firebrick
BCS.367 B.F Slag
CAS.30
BCS.303 Sinter
500
1000
1500
2000
2500
3000
3500
DVM READING MILLIVOLTS

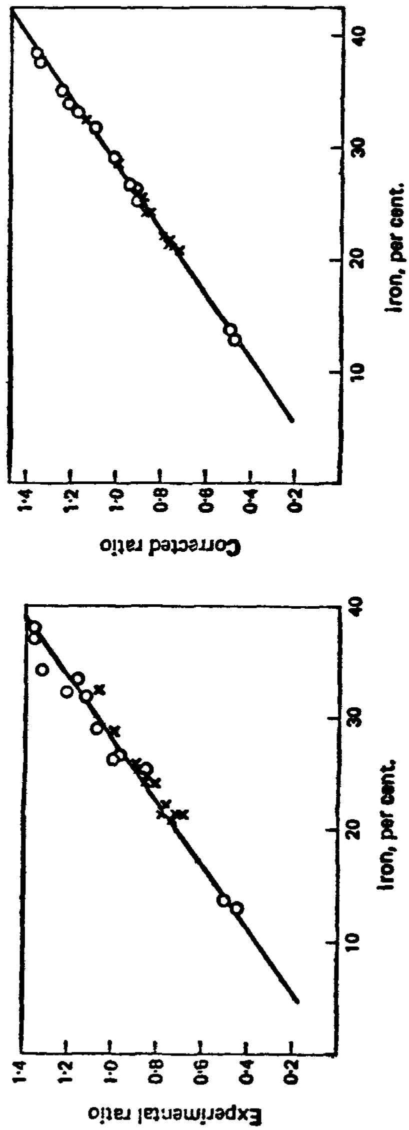
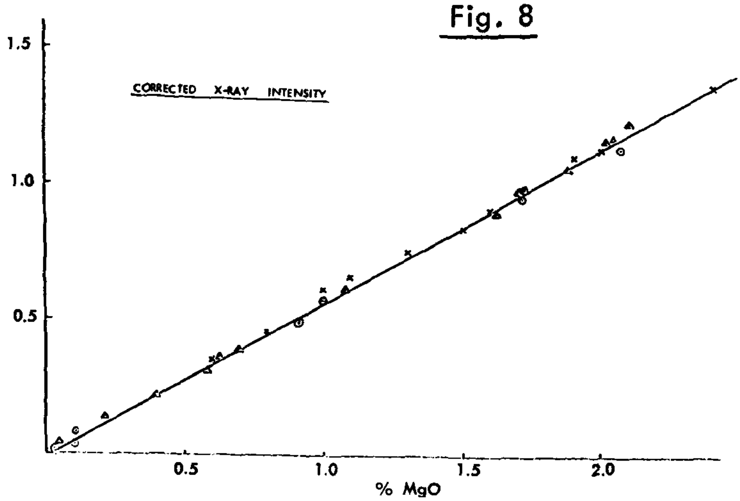
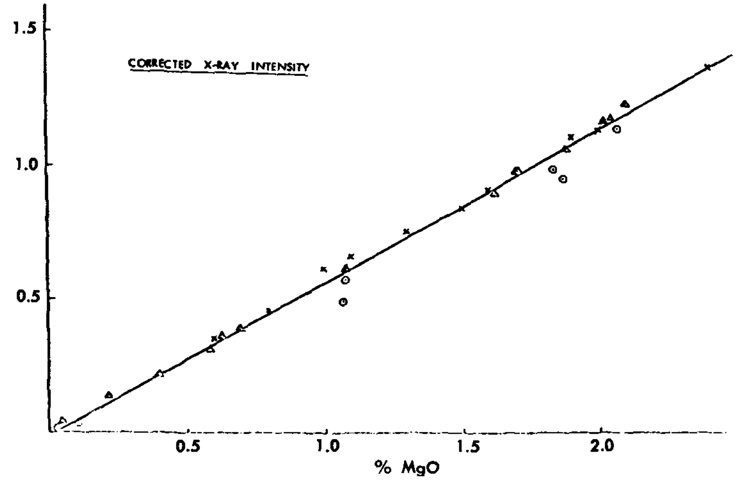


FIG. 7 -- Effect of absorption corrections on calibration for Fe in iron ores and sinter.

Fig. 8


CORRECTED X-RAY INTENSITY
1.5
1.0
0.5
0.5
1.0
1.5
2.0
% MgO


CORRECTED X-RAY INTENSITY
1.5
1.0
0.5
0.5
1.0
1.5
2.0
% MgO

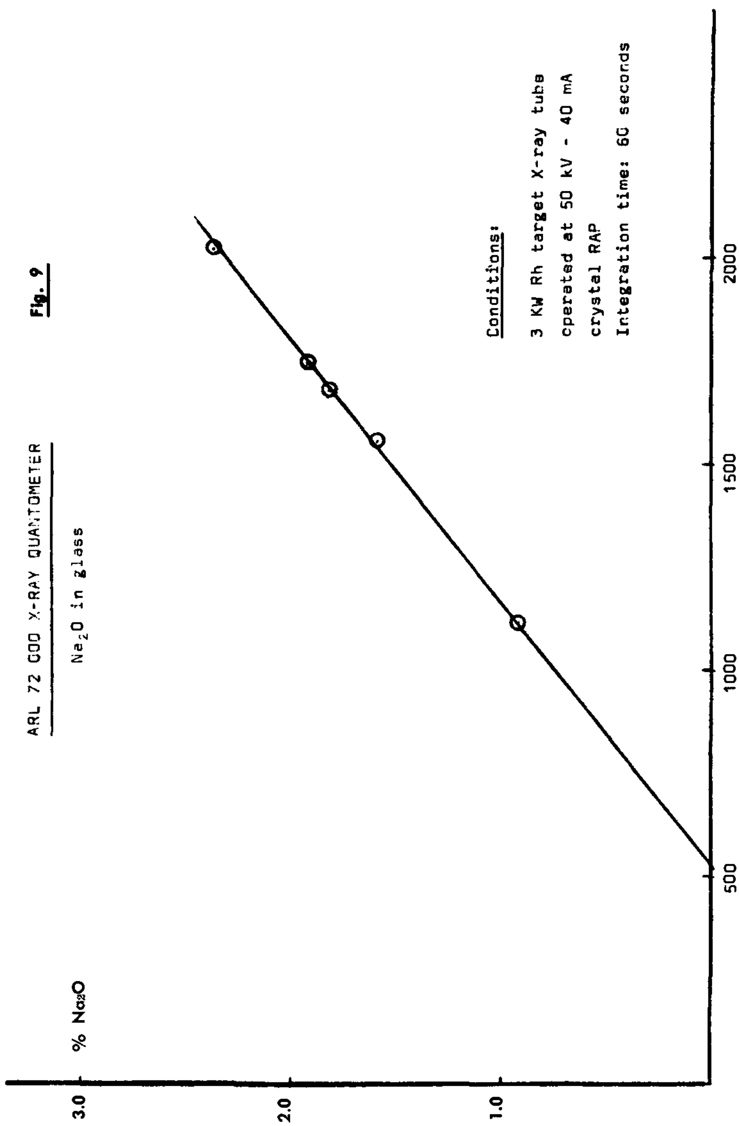
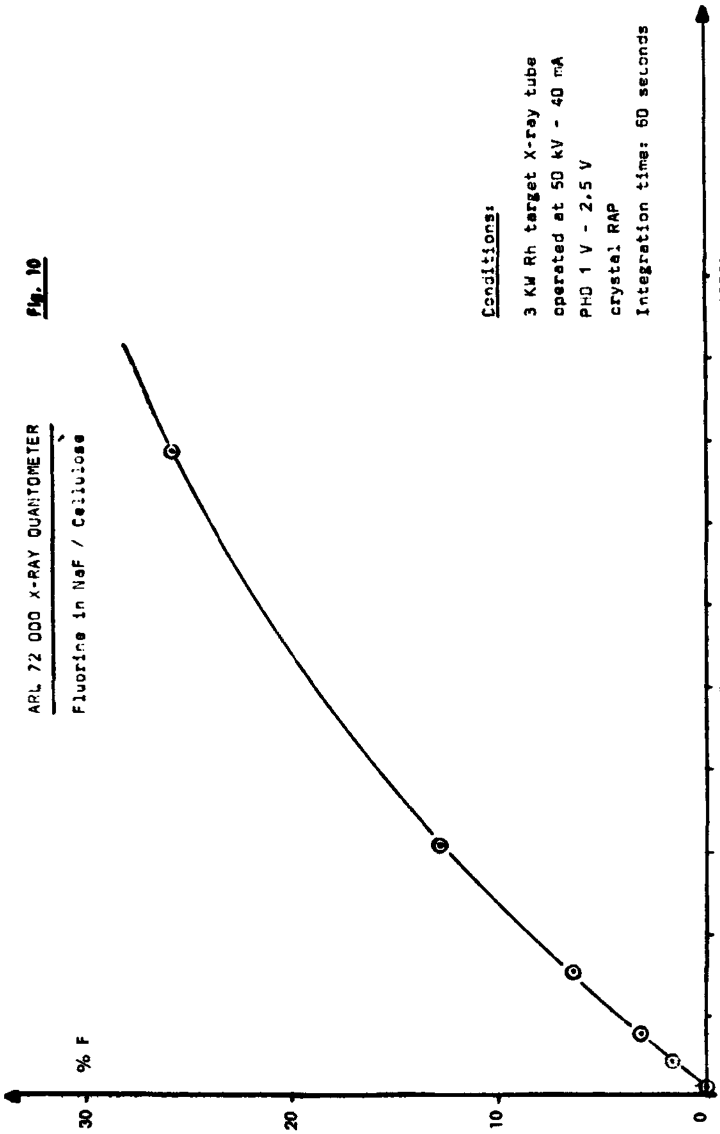

ARL 72 000 X-RAY QUANTOMETER
Na_2O in glass
Conditions:
3 KW Rh target X-ray tube
operated at 50 kV - 40 mA
crystal RAP
Integration time: 60 seconds
% Na_2O
3.0
2.0
1.0
500
1000
1500
2000

Fig. 9


ARL 72 000 X-RAY QUANTOMETER
Fluorine in NaF / Cellulose
Fig. 10
Conditions:
3 KW Rh target X-ray tube
operated at 50 kV - 40 mA
PHD 1 V - 2.5 V
crystal RAP
Integration time: 60 seconds
% F
30
20
10
0
5000
10000 mV

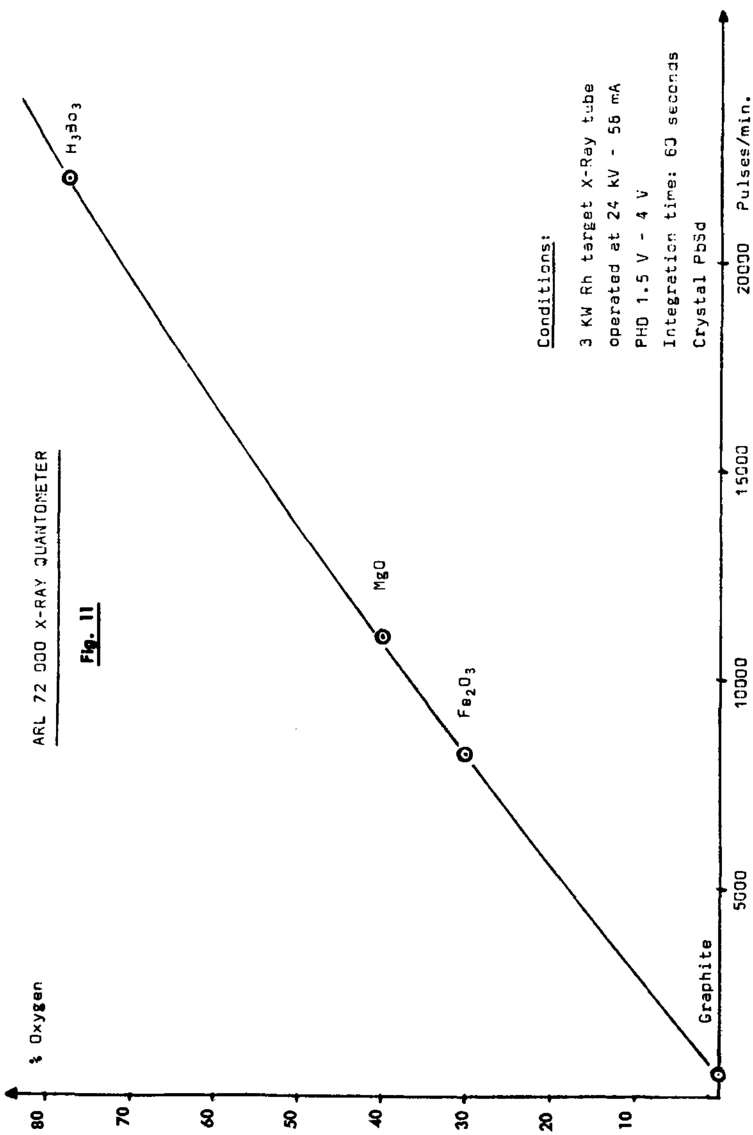

ARL 72 000 X-RAY QUANTOMETER
% Oxygen
80
70
60
50
40
30
20
10
Graphite
Fe_2O_3
MgO
H_3BO_3
5000
10000
15000
20000
Pulses/min.
Conditions:
3 KW Rh target X-Ray tube
operated at 24 kV - 56 mA
PHD 1.5 V - 4 V
Integration time: 60 seconds
Crystal PbSd

Fig. 11

TABLE 1

COMPOSITION OF INDUSTRIALLY IMPORTANT OXIDES

Constituent	Iron Ore Sinter	Fe Slags	Refractories Ceramics	Cement Limestone	Glass	Cryolite Bauxite
F		0.1-10				40-60
Na_2O	0.1-1		0.05-0.2	0.05-1	10-15	20-30
Al_2O_3	0.4-25	0.3-25	0.1-98	0.5-20	1-3	10-65
MgO	0.1-6	0.1-25	0.01-65	0.1-6	0.1-5	
SiO_2	0.5-40	0.2-60	0.5-99	1-65	65-75	1-40
P_2O_5	0.01-10	0.1-20				
SO_3	0.005-0.5	0.01-10		0.02	0.05-0.5	
K_2O	0.2-1.5		0.01-11	0.1-3	0.5-1.5	
CaO	0.1-25	0.4-60	0.06-3	1-55	10-15	3-6
TiO_2	0.04-1	0.02-2.5	0.01-2	0.1-0.2		0.5-3
Cr_2O_3		0.01-6.5	0.01-40		0.15-0.25	
MnO	0.05-2.5	0.1-20	0.01-0.5	0.05-0.2		0.5-50
Fe_2O_3			0.03-16	0.1-10	0.04-0.5	
Fe	18-70	0.2-70				

TABLE 2

DAY-TO-DAY REPRODUCIBILITY OF IRON ORE SINTER ANALYSIS (QUANTOVAC - BRIQUETTE)

Day	Fe	CaO	SiO_2	P_2O_5	MnO	MgO	Al_2O_3	S
1	54.8	7.2	8.05	0.33	1.55	1.10	3.00	0.010
2	54.6	7.3	8.12	0.35	1.57	1.10	3.03	0.009
3	54.6	7.3	8.20	0.33	1.53	1.07	2.96	0.009
4	54.7	7.4	8.07	0.35	1.56	1.13	2.79	0.009
5	55.0	7.2	7.83	0.34	1.58	1.10	2.79	0.009
6	54.7	7.2	8.09	0.34	1.49	1.10	3.06	0.007
7	54.4	7.6	8.22	0.35	1.56	1.09	2.92	0.007
8	54.4	7.5	8.22	0.34	1.56	1.12	2.98	0.008
9	54.5	7.4	8.18	0.35	1.56	1.08	3.00	0.008
10	54.5	7.4	8.24	0.34	1.57	1.09	3.02	0.009
11	54.7	7.2	8.18	0.35	1.60	1.10	3.08	0.007
Mean analysis	54.6	7.3	8.13	0.34	1.56	1.10	2.97	0.008
Range: min.	54.4	7.2	7.83	0.33	1.49	1.07	2.79	0.007
max.	55.0	7.6	8.24	0.35	1.60	1.13	3.08	0.010
Standard deviation	0.18	0.14	0.118	0.008	0.028	0.017	0.089	0.0010

A.C. Knott, E.D. Aldaya. J. Iron & Steel Institute
November 1964

TABLE 3

PERFORMANCE OF MULTICHANNEL XRF SYSTEMS ON OXIDE MATERIALS (1960-65)

Material	Constituent	Precision s.d. at %	Accuracy Av.Dev.	% Range
Slag	Fe	0.055@61%	0.25	52-64%
Slag	Fe 0	0.02 @ 25%	0.45	14-30%
Slag	Fe 0	0.02 @ 27%	0.6	20-30%
Sinter	Fe	0.055@61%	0.25	52-64%
Sinter	Fe	0.01 @ 57%	0.1	55-65%
Cement	Fe_2 0_3	0.009@3.4%	0.08	2-4.5%
Slag	Ca 0	0.07 @ 35%	0.15	14-54%
Slag	Ca 0	0.038@38%	0.37	35-45%
Sinter	Ca 0	0.004@7.5%	0.25	5-10%
Sinter	Ca 0	0.01 @ 5.3%	0.09	2-10%
Cement	Ca 0	0.02 @ 41%	0.10	38-48%
Slag	Si 0_2	0.15 @ 24%	0.28	5-56%
Slag	Si 0_2	0.08 @ 33%	0.6	30-36%
Sinter	Si 0_2	0.06 @ 5.4%	0.1	4-13%
Sinter	Si 0_2	0.17 @ 6%	1.5	4-7%
Cement	Si 0_2	0.11 @ 17%	0.07	8-18%

TABLE 4

EFFECT OF GRINDING TIME ON XRF INTENSITIES OF IRON ORE SINTER

Grinding time (min).	0	0.5	1	2	4	8
Low Grade Ore						
Apparent Fe %	38.9	39.5	39.6	39.9	40.2	40.5
Apparent Ca 0 %	17.6	17.9	18.0	18.1	17.7	17.5
Apparent Si 0_2 %	13.1	13.9	13.8	13.3	12.7	11.7
High Grade Ore						
Apparent Fe %	58.2	60.15	61.1	61.1	61.4	61.1
Apparent Ca 0 %	5.6	5.6	5.8	5.7	5.7	5.5
Apparent Si 0_2 %	5.6	5.3	4.9	4.5	3.8	2.9

TABLE 5

EFFECT OF GRINDING TIME ON XRF INTENSITIES AFTER FUSION - IRON ORE SINTER (1 : 5)

Grinding time (min).	0.5	4
Apparent Fe %	59.0	59.0
Apparent Ca 0 %	6.0	5.8
Apparent Si 0_2 %	5.5	5.5

TABLE 6

TYPICAL 72000 X-RAY QUANTOMETER ARRAY FOR OXIDE MATERIALS

Element	Wave-length	Crystal	Detector
Na Kα	11.909 Å	4" RAP	Flow Prop. P-10. P.H.D.
Mg Kα	9.889 Å	4" ADP	Ne Prop. Al Window P.H.D.
Al Kα	8.339 Å	4" E DDT	Ne Prop. Al Window P.H.D.
Si Kα	7.126 Å	4" E DDT	Ne Prop. Be Window P.H.D.
P Kα	6.155 Å	4" Ge	Ne Prop. Be Window P.H.D.
S Kα	5.373 Å	4" Ge	Ne Prop. Be Window P.H.D.
K Kα	3.744 Å	4" LiF	Ne Multitron Be Window
Ca Kα	3.360 Å	4" LiF	Ne Multitron Be Window
Ti Kα	2.750 Å	4" LiF	Ne Multitron Be Window
Cr Kα	2.291 Å	4" LiF	Ne Multitron Be Window
Mn Kα	2.103 Å	4" LiF	Ne Multitron Be Window
Fe Kα	1.937 Å	4" LiF	Ne Multitron Be Window

X-ray Tube: Rh; 50 Kv 40 ma

TABLE 7

COMPARISON OF SHORT-TERM PRECISION OF 72000 - FUSION TECHNIQUE (1972) AND BRIQUETTING TECHNIQUE (1960 - 1965)

Constituent	Material	Briquette (1962)	72000 - Fusion (1972)	
		S.D.	Dil. Factor	S.D.
Fe	Sinter Ores	0.01-0.05 @ 50-60%	11,28	0.02-0.04@ 45-67%
	Slag	0.008 @ 1%	5.6	0.001-0.002@0.4-2%
Mn	Any	0.001-0.1 @0.2-2%	5.6, 11,28	0.001-0.004@0.05-2%
SiO_2	Any	0.06-0.4 @ 5-35%	5.6, 11,28	0.02-0.07@ 1-40%
CaO	Any	0.01-0.07@ 30-40%	5.6, 11,28	0.01-0.04 @ 1-45%
MgO	Any	0.05-0.06 @ 2-10%	5.6, 11,28	0.02-0.04 @0.02-6.5%
Al_2O_3	Any	0.03-0.1 @ 2-10%	5.6, 11,28	0.01-0.02 @ 0.2-15%

STP542-EB/Mar. 1973

R. Jenkins

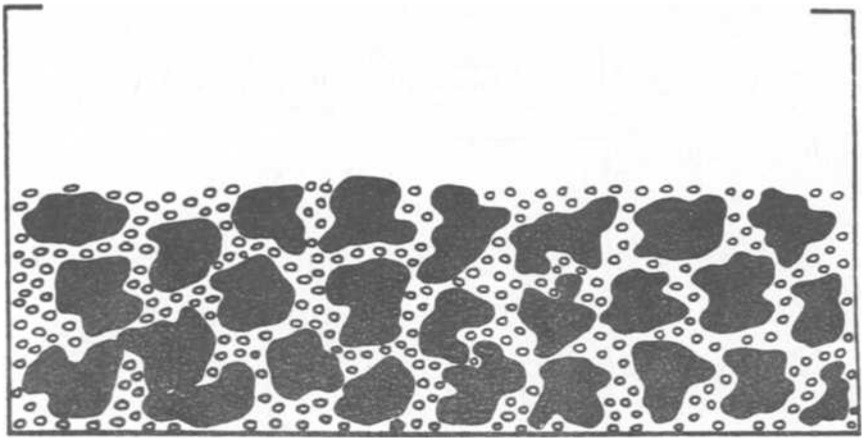
Current Status of X-ray Emission Analysis for the Analysis of Slags and Related Oxide-Type Materials

Sources of error in X-ray fluorescence spectrometry

Random errors	Sampling Counting statistics (dependent only on time) Generator and X-ray tube stability(0.1%) Equipment errors (< 0.05%)	
Systematic errors	Sample errors	Sampling Absorption (100%) Enhancement (10%) Particle effects (100%) Chemical state (5%)
	Equipment errors (< 0.05%)	

Note: All errors quoted are given in terms of 1 σ

Figure #1



Phase	Fluorescing element	Absorption for measured wavelength	Effect
Phase 1 Phase 2	Present Absent	Same	Grain size
Phase 1 Phase 2	Present Absent	Different	Inter-mineral
Phase 1 Phase 2	Present Present	Different	Mineralogical

The particle effect in X-ray fluorescence spectrometry (see text).

Figure # 2

EXCITATION EFFICIENCY

$$I_j = P_j \cdot W_j \int_{\lambda_{min}}^{\lambda_{edge}} J(\lambda) \cdot C(\lambda\lambda_j) \cdot d\lambda$$

for same equipment using fixed excitation conditions for a fixed wavelength (λ_j) slope of calibration curve $m \propto C(\lambda\lambda_j)$ i.e. the efficiency factor

$$C(\lambda\lambda_j) = \frac{\mu_j(\lambda)}{\sum_i C_i \left[\mu_i(\lambda) + A \cdot \mu_i(\lambda_j) \right]}$$

where (λ) is the "optimum excitation wavelength"

Figure #3

$$C\left[\lambda\lambda_{Fe}\right] = \frac{161}{\underset{292}{Fe(161+131)} + \underset{819}{Cr\,(131+668)}}$$

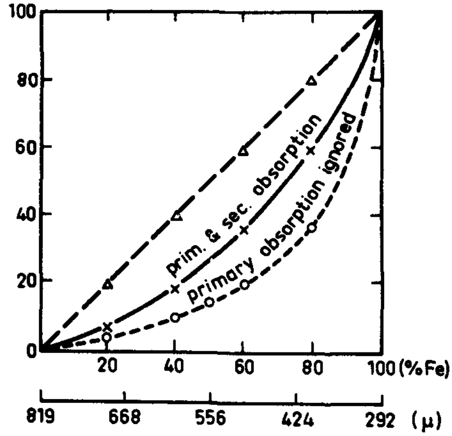


Figure #4

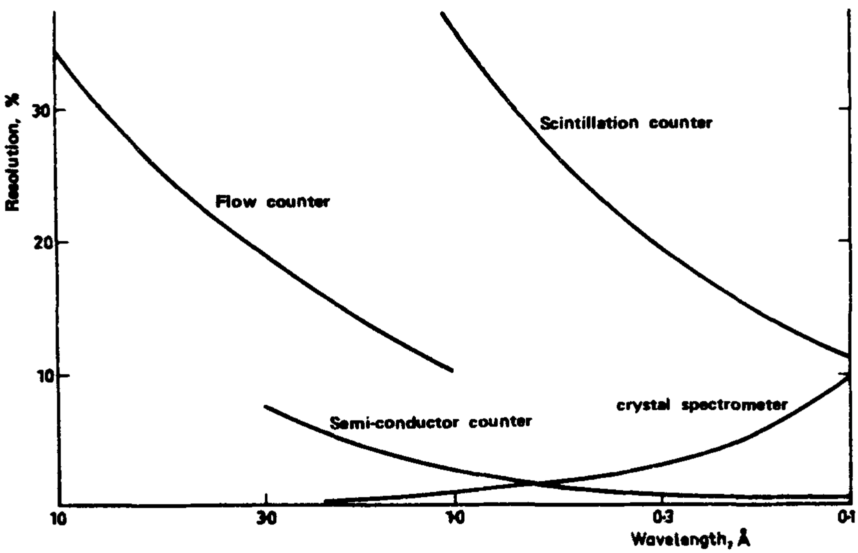
ALGORITHMS FOR MATRIX CORRECTION

$$I_i = \frac{W_i \; K_i}{\sum_j W_j \; \alpha_j}$$

$$I_i = \frac{W_i \; K_i}{1 + \sum_j \alpha_{ij} \; W_j}$$

$$I_i = \frac{W_i \; K_i}{1 + \sum_j k_{ij} \; I_j}$$

Figure # 5



Comparative resolutions of the flow counter, the scintillation counter, the semiconductor counter, and the crystal spectrometer.

Figure #6

M. D. Amos

Atomic Absorption Spectrophotometry in the Analysis of Slags and Oxides

Concentration Ranges (%) (5 g / 100 ml)

	Zn	Fe	Al	Si	Ca
Detection Limit	0·000002	0·00001	0·00004	0·0005	0·000004
Abs = 0·88	0·004	0·025	0·3	0·6	0·012
Burner at 90°	0·08	0·5	6	12	0·24

FIG. 1

Concentration of Analyte = 0·100 %
Solution of 1g / 1000 ml
Dilution is 1000 : 1
Concentration in Solution is 1·00 mg / l
If Analytical Measurement is in
Error by 1 % (+ve)
Concentration Found will be 1·01 mg / l
and Result Obtained will be 0·101 %
i.e. 1 % Error

FIG. 2

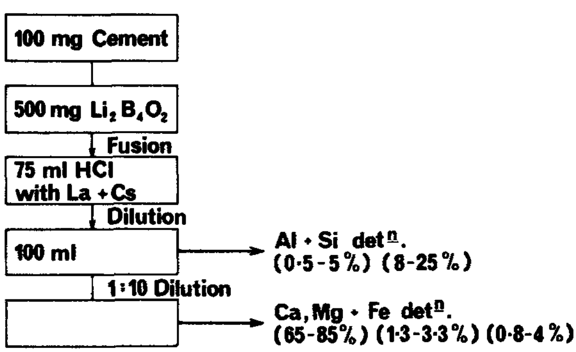


FIG. 3

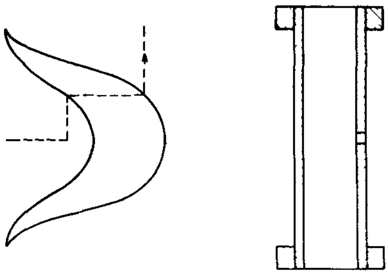


FIG. 4

If Dilution Error of 1 % (−ve) is Made, Result will be 0·102 % i.e. 2 % Error

If Dilution Error of 0·1% (−ve) is Made, Result will be 0·1011 % i.e. 1·1 % Error

FIG. 5

DISADVANTAGES OF SOLUTION METHODS

1. Requirement to Devise Solution Method
2. Additional Handling
3. Possibility of Dilution or Calculation Errors

FIG. 6

ADVANTAGES OF SOLUTION METHODS

1. Minimization of Inhomogeneity Errors
2. Ideal "Iso Formation"
3. Ease of Standardization
4. Ease of Dilution

FIG. 7

	SiO_2	Fe_2O_3	Al_2O_3	CaO
1	14.93	2.23	2.62	42.74
2	15.09	2.28	2.62	42.60
3	15.04	2.20	2.54	42.74
4	15.09	2.20	2.62	42.74
5	14.85	2.23	2.62	42.46
6	15.09	2.18	2.62	42.87
7	14.89	2.20	2.62	42.87
8	15.09	2.29	2.69	42.60
9	14.82	2.23	2.62	42.60
10	14.99	2.14	2.62	42.46
11	15.09	2.15	2.62	43.01
12	14.99	2.20	2.62	42.72
Deviation	0.336	0.029	0.037	0.166
Average	14.98	2.21	2.62	42.70
C.O.V.	0.80%	2.0%	1.18%	0.39%

FIG. 8

$$CaO \rightarrow Ca^{\circ} + (O)$$

$$\left.\begin{matrix} CaO \\ SiO_2 \end{matrix}\right\} \rightarrow CaO.SiO_2$$

$$\left.\begin{matrix} CaO \\ SiO_2 \\ SrO \end{matrix}\right\} \rightarrow \begin{matrix} Ca^{\circ} + (O) \\ SrO.SiO_2 \end{matrix}$$

FIG. 9

$$Na^{o} \rightleftharpoons Na^{+} + e^{-}$$

$$K^{o} \rightleftharpoons K^{+} + e^{-}$$

FIG. 10

Concentration Ranges (%) (0·1 g / 100 ml)

	Zn	Fe	Al	Si	Ca
Detection Limit	0·0001	0·0005	0·002	0·025	0·0002
Abs = 0·88	0·2	1·25	15	30	0·6
Burner at 90°	4	25	100	100	12

FIG. 11

Concentration Ranges (%) (1 g / 100 ml)

	Zn	Fe	Al	Si	Ca
Detection Limit	0·00001	0·00005	0·0002	0·0025	0·0002
Abs = 0·88	0·02	0·125	1·5	3	0·06
Burner at 90°	0·4	2·5	30	60	1·2

FIG. 12

STP542-EB/Mar. 1973

J. R. Ryan and R. K. Scott

Utility of the Optical Emission Spectrometer in the Analysis of Refractories, Slags, and Other Oxide Materials

No Figures or Tables.

STP542-EB/Mar. 1973

J. C. Cline and R. A. Pontello

X-Ray Emission Spectrometer Analysis of Slags and Related Materials

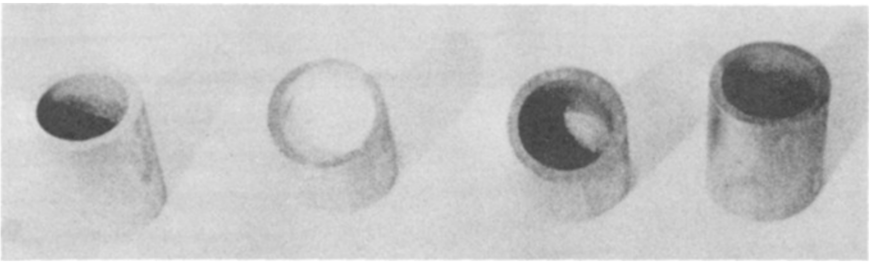


FIG. 1

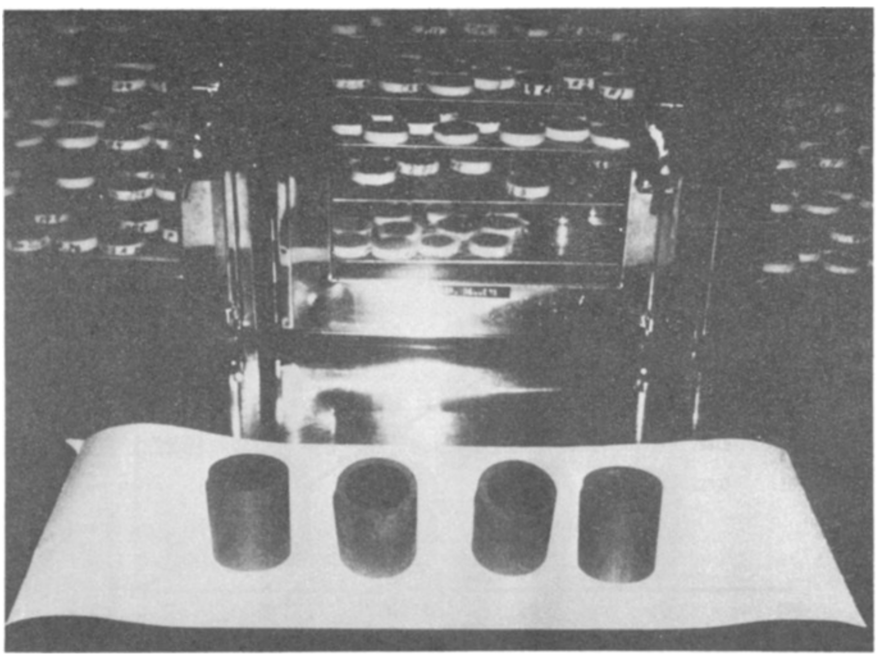


FIG. 2

TABLE 1

CR_2O_3 *SWEDE SLAGS

NO.	CERTIFIED	DIRECT	FUSION	HV.ABS. FUSION
1	.20	.28	.22	-
2	.10	.15	.080	-
3	0	-	-	-
4	0	-	-	-
5	.15	.37	.25	-
6	.09	.082	.081	-
7	.46	.45	.43	-
8	3.70	3.45	3.82	-
ADJ. COEF OF COREL		.9973	.9991	-
STD. ERROR OF EST.		.0741	.0442	

TABLE 2

SiO_2 *SWEDE SLAGS

NO.	CERTIFIED	DIRECT	FUSION	HV.ABS. FUSION
1	19.40	19.64	18.94	19.26
2	5.50	5.89	5.46	5.80
3	34.0	32.88	34.41	33.90
4	34.10	31.35	34.40	33.44
5	57.00	57.20	56.91	56.39
6	23.70	26.03	24.20	24.00
7	20.50	19.68	20.01	20.00
8	39.90	40.90	40.82	40.79
ADJ. COEF OF COREL.		.9918	.9992	.9990
STD. ERROR OF EST.		1.4098	.4321	.4883

TABLE 3

FEO *SWEDE SLAGS

NO.	CERTIFIED	DIRECT	FUSION	HV.ABS. FUSION
1	16.60	17.83	17.11	16.45
2	25.00	20.45	21.21	23.66
3	1.10	1.01	1.16	1.32
4	.40	.35	.44	.60
5	26.80	26.40	26.77	28.75
6	4.20	4.07	3.92	4.27
7	18.70	18.05	17.65	17.74
8	.80	.70	.94	1.06
ADJ. COEF OF COREL.		.9845	.9903	.9935
STD. ERROR OF EST.		1.4050	1.1108	.9137

TABLE 4

MNO *SWEDE SLAGS

NO.	CERTIFIED	DIRECT	FUSION	HV.ABS. FUSION
1	18.60	15.92	18.56	18.40
2	4.80	4.16	4.60	4.65
3	2.40	2.50	2.45	2.33
4	1.60	1.94	1.76	1.58
5	9.80	13.26	13.17	10.59
6	2.20	2.17	2.09	2.13
7	5.30	4.67	5.13	5.10
8	4.70	4.67	4.97	4.73
ADJ. COEF OF COREL.		.9291	.9624	.9971
STD. ERROR OF EST.		1.5039	1.0947	.3017

TABLE 5

AL_2O_3 *SWEDE SLAGS

NO.	CERTIFIED	DIRECT	FUSION	HV. ABS. FUSION
1	3.10	3.50	3.07	3.13
2	.70	.57	.67	.69
3	9.40	9.67	9.33	9.29
4	12.40	12.26	12.25	12.11
5	1.70	1.57	1.74	1.66
6	1.90	1.79	1.83	1.81
7	2.10	2.17	2.06	2.07
8	6.80	6.86	6.94	6.92
ADJ. COEF OF COREL.		.9980	.9997	.9995
STD. ERROR OF EST.		.1913	.0758	.0922

TABLE 6

CAO *SWEDE SLAGS

NO.	CERTIFIED	DIRECT	FUSION	HV. ABS. FUSION
1	32.60	34.56	33.42	33.07
2	43.90	45.68	45.04	44.18
3	42.20	38.61	40.53	41.76
4	40.00	36.35	38.84	39.55
5	2.20	3.32	2.55	2.22
6	59.10	58.25	58.92	59.25
7	44.00	45.15	45.09	43.90
8	36.50	35.60	35.95	36.30
ADJ. COEF OF COREL.		.9842	.9964	.9996
STD. ERROR OF EST.		2.0401	.9753	.3078

TABLE 7

TiO_2 *SWEDE SLAGS

NO.	CERTIFIED	DIRECT	FUSION	HV. ABS. FUSION
1	.53	.57	.60	.61
2	.17	.16	.18	.21
3	.89	.75	.85	.84
4	1.25	1.10	1.23	1.24
5	.42	.78	.65	.63
6	.18	.13	.16	.136
7	.34	.32	.35	.35
8	.26	.25	.26	.30
ADJ. COEF OF COREL		.8726	.956	.9604
STD. ERROR OF EST.		.1360	.0799	.0759

TABLE 8

MGO *SWEDE SLAGS

NO.	CERTIFIED	DIRECT	FUSION	HV. ABS. FUSION
1	8.00	6.48	8.37	8.08
2	8.70	6.56	8.89	8.58
3	5.20	6.29	5.03	5.02
4	6.70	7.60	6.91	6.14
5	1.50	2.32	1.94	1.37
6	5.90	6.30	5.99	5.73
7	6.70	6.10	6.55	6.45
8	5.70	6.67	5.45	5.61
ADJ. COEF OF COREL.		.8542	.9879	.9939
STD. ERROR OF EST.		.8322	.2393	.1698

TABLE 3A

FEO $(R'_{Fe} = R_{Fe} \exp G R_{Ca})$[1]

NO.	CERTIFIED	FUSION OBSERVED	FUSION CORRECTED	N.A. FUSION OBSERVED	N.A. FUSION CORRECTED
1	16.6	17.1	17.6	16.5	16.9
2	25.0	21.2	24.2	23.7	25.5
3	1.1	1.16	.96	1.32	1.07
4	.4	.44	.21	.60	.28
5	26.8	26.8	26.6	28.8	26.8
6	4.2	3.92	4.10	4.27	4.41
7	18.7	17.7	19.1	17.7	18.8
8	.8	.94	.73	1.06	.78
ADJ. COEF OF COREL.		.9903	.9981	.9935	.9998
STD. ERROR OF EST.		1.1108	.4884	.9137	.168

H. G. Zelinske and D. H. Arendt

Analysis of Slags by Atomic Absorption Spectrophotometry

PERCENT CONCENTRATION RANGES OF SLAG CONSTITUENTS

CONSTITUENT	% CONC. RANGE
SILICON OXIDE	0 — 80.0
CALCIUM OXIDE	0 — 80.0
ALUMINUM OXIDE	0 — 60.0
IRON OXIDE	0 — 50.0
CHROMIUM OXIDE	0 — 48.0
MAGNESIUM OXIDE	0 — 40.0
MANGANESE OXIDE	0 — 30.0
TITANIUM OXIDE	0 — 1.25

FIG. 1

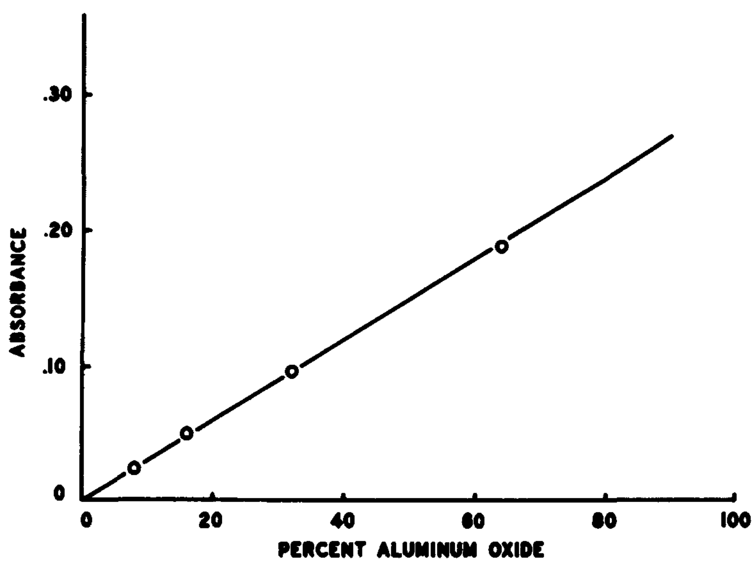


FIG. 2

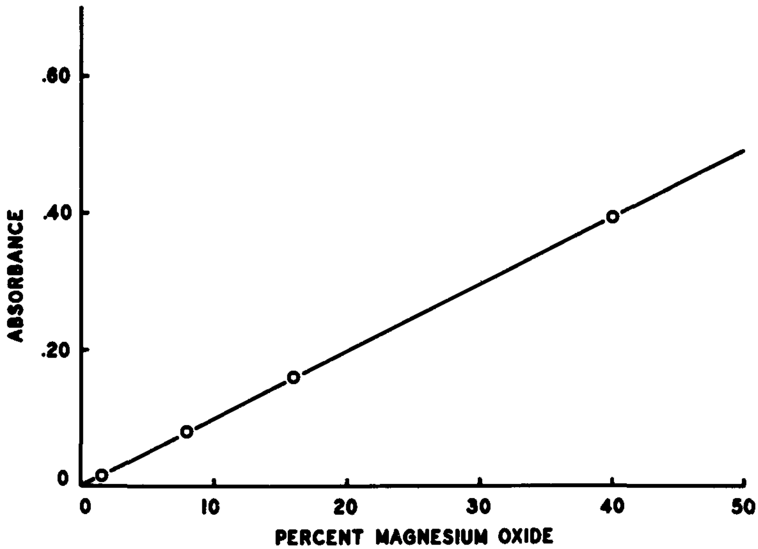

.60
.40
.20
0
ABSORBANCE
0
10
20
30
40
50
PERCENT MAGNESIUM OXIDE

FIG. 3

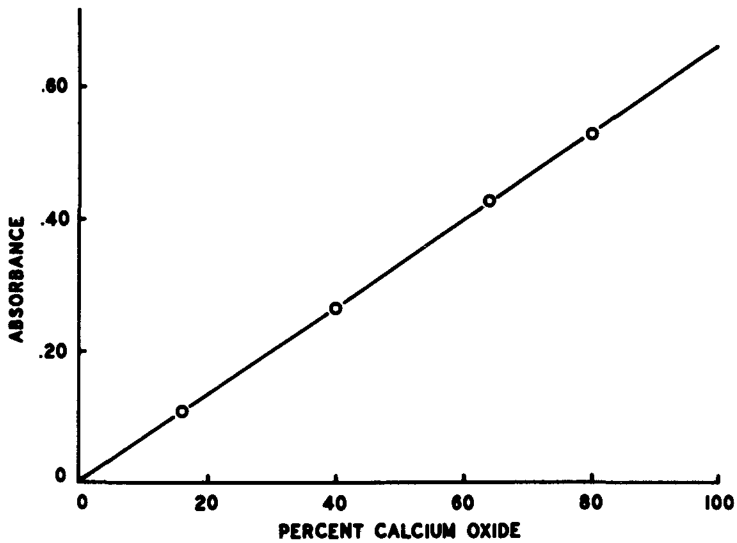

.60
.40
.20
0
ABSORBANCE
0
20
40
60
80
100
PERCENT CALCIUM OXIDE

FIG. 4

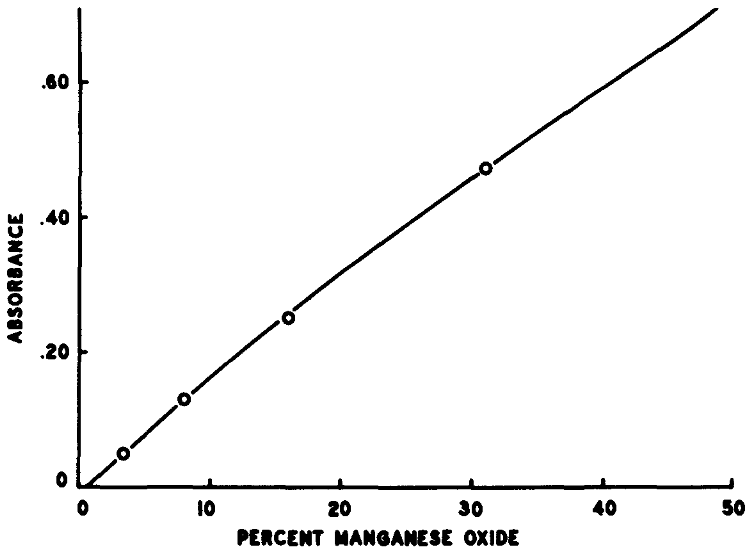

.60
.40
.20
0
ABSORBANCE
0
10
20
30
40
50
PERCENT MANGANESE OXIDE

FIG. 5

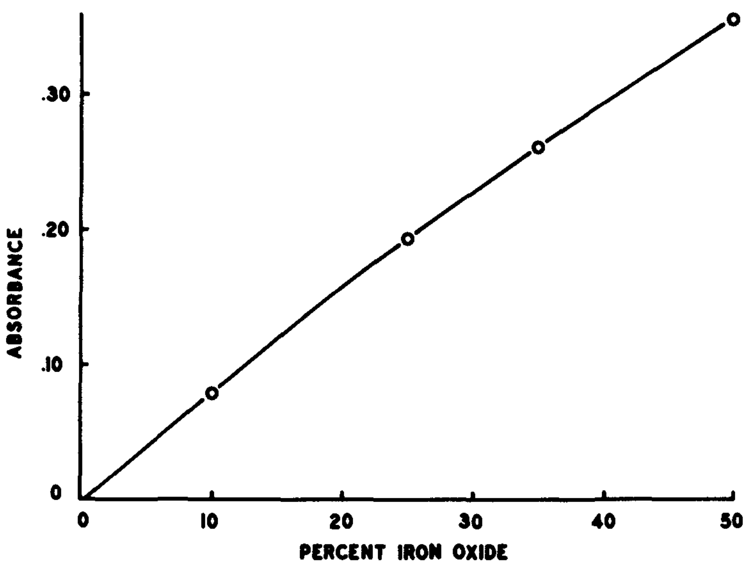

.30
.20
.10
0
ABSORBANCE
0
10
20
30
40
50
PERCENT IRON OXIDE

FIG. 6

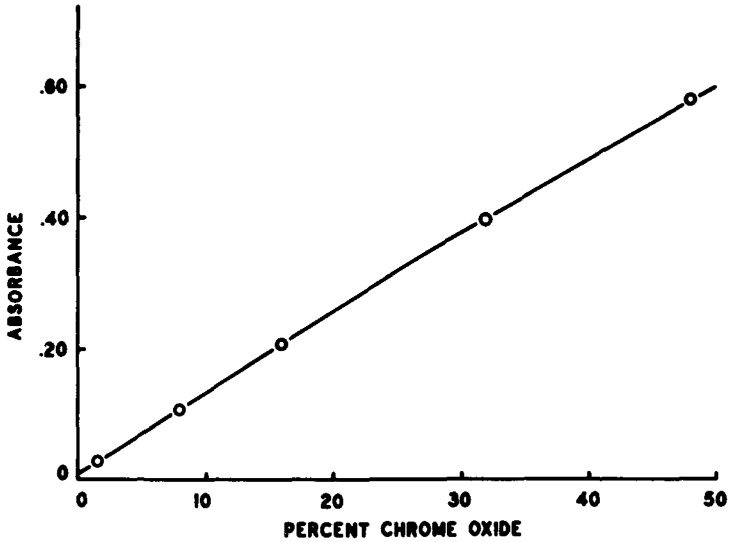

ABSORBANCE
.60
.40
.20
0
0
10
20
30
40
50
PERCENT CHROME OXIDE

FIG. 7

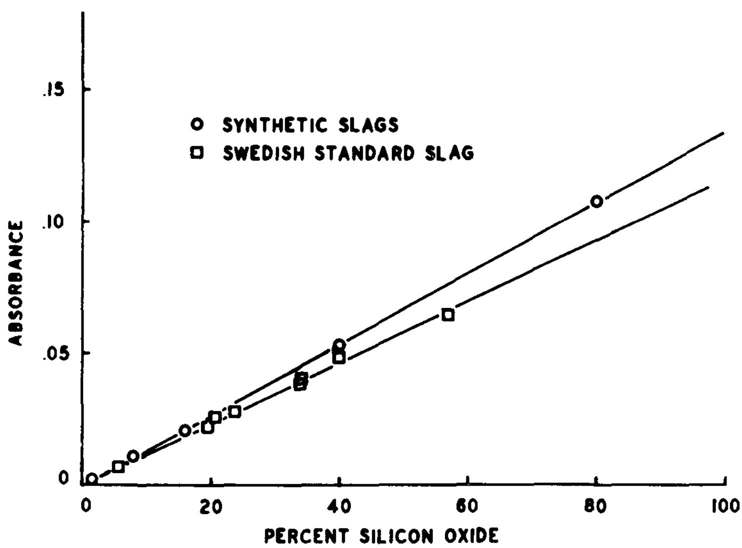
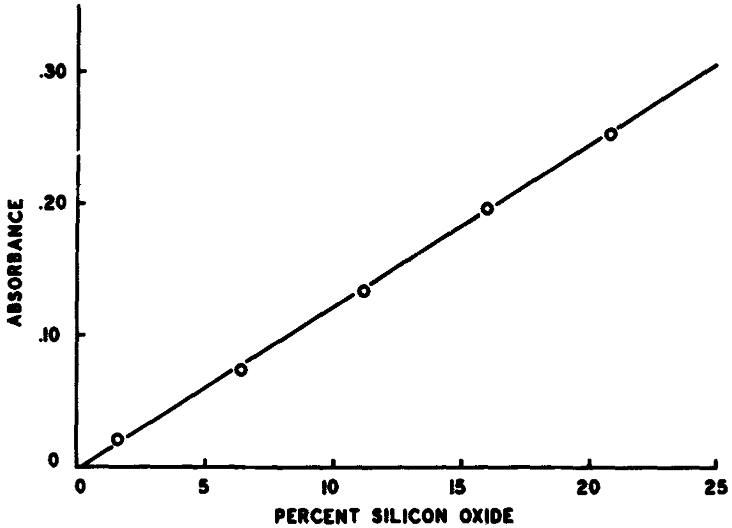
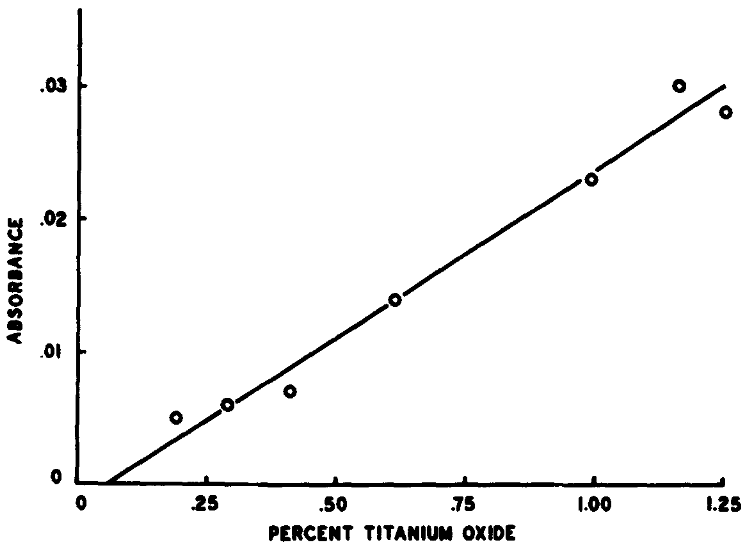

ABSORBANCE
.15
.10
.05
0
SYNTHETIC SLAGS
SWEDISH STANDARD SLAG
0
20
40
60
80
100
PERCENT SILICON OXIDE

FIG. 8



ABSORBANCE
.30
.20
.10
0
0
5
10
15
20
25
PERCENT SILICON OXIDE

FIG. 9



ABSORBANCE
.03
.02
.01
0
0
.25
.50
.75
1.00
1.25
PERCENT TITANIUM OXIDE

FIG. 10

B.O.F. SLAG

CONSTITUENT	LAB. A	AMSTED
CHROMIUM OXIDE	—	.13
MANGANESE OXIDE	4.8	4.56
IRON OXIDE	26.5	25.76
CALCIUM OXIDE	44.2	45.0
MAGNESIUM OXIDE	5.5	5.68
ALUMINUM OXIDE	1.52	2.0
SILICON OXIDE	15.7	16.7

FIG. 11

ELECTRIC FURNACE SLAG

STAINLESS STEEL

CONSTITUENT	LAB. A	AMSTED
CHROMIUM OXIDE	—	.20
MANGANESE OXIDE	.96	.98
IRON OXIDE	3.46	3.21
CALCIUM OXIDE	24.48	24.8
MAGNESIUM OXIDE	6.30	6.12
ALUMINUM OXIDE	17.19	18.4
SILICON OXIDE	45.60	45.5

FIG. 12

BASIC SLAG

B.C.S. NO. 174–1

CONSTITUENT	B.C.S.	AMSTED
CHROMIUM OXIDE	—	—
MANGANESE OXIDE	5.11	5.04
IRON OXIDE	10.88	10.95
CALCIUM OXIDE	44.83	44.1
MAGNESIUM OXIDE	7.18	7.2
ALUMINUM OXIDE	1.72	1.9
SILICON OXIDE	14.69	15.20

FIG. 13

IRON CUPOLA SLAG

CONSTITUENT	LAB. A	LAB. B	AMSTED
CHROMIUM OXIDE	—	—	.328
MANGANESE OXIDE	4.33	3.85	4.29
IRON OXIDE	6.94	7.72	8.55
CALCIUM OXIDE	15.50	15.4	16.0
MAGNESIUM OXIDE	10.00	9.77	10.15
ALUMINUM OXIDE	12.44	9.66	9.4
SILICON OXIDE	50.8	49.72	50.8

FIG. 14