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APPENDICES

Appendix A Raw Materials and Product Characterization

A.1 Raw Materials

A.1.1 Iron Ore

Iron ore, obtained from Phu Khoud, is the iron oxide used in the iron production. In the present work, a low grade Iron ore was used which has %Fe between 40-50 %. The iron ore (XK-03) was characterized for the wt % of elements by XRF (X-ray fluorescence spectrophotometer) and the particle diameter by PSA (Particle Size Analyzer). Characterization methods and results are presented in A.2 and A.3 respectively.

A.1.2 Reductant

Reductant is a substance used to reduce oxygen in an iron ore. In the present study, FIRST coal, obtained from FIRST Co., Ltd., was analyzed for the fixed carbon by the proximate analysis and the particle diameter by PSA (Particle Size Analyzer). Characterization methods and results are shown in A.2 and A.3 respectively.

A.1.3 Flux

Limestone is a flux used to separate iron from slag or other components during the reduction process. Limestone was obtained from Petch Thai Chemical Co., Ltd. (Thailand) and used in our experiment; the specification of the Limestone is shown in A.3 Raw Material Characterization.

A.1.4 Binder

Bentonite is a binder used in making a pellet. Sodium bentonite was obtained from Dhebkaset Industry Co., Ltd. and used in our experiments. The specification of a Bentonite from Volclay Siam Ltd. is shown in A.3 Raw Material Characterization.

A.2 Characterization

A.2.1 Energy Dispersive X-Ray Fluorescence (EDXRF)

Samples were characterized for wt % of elements by EDX (Horiba, model 51-ADD0014), an energy dispersive X-Ray fluorescence spectrometer (Hitachi, model S-4800), connected to a scanning electron microscope. The samples were ground into fine particles (0.043 mm in average diameter as shown in Table A-1). The SEM accelerating voltage and current were 25 kV and 20 μA, respectively. The magnification was 100X. The pellets were stacked onto stubs by using sticker carbon papers. The specimens were coated with platinum using an ion coating machine (Hitachi, model E-1010) for 90 sec, for enhancing the electron conductivity. The specimens were clamped on a holder and placed into a high vacuum SEM chamber for preventing the attenuation of X-ray by the air molecules. 3 measurements were taken from different parts of each sample. The peaks of platinum were subtracted out before calculating the total wt % element and the % atomic of the specimens.

A.2.2 X-Ray Fluorescence (XRF)

Samples were characterized for wt % of elements by XRF (PANalytical, model AXIOS PW4400). The samples were mixed with boric acid in the pan and compressed at 6,000 psi for 2 minutes. The specimens were clamped on a holder and placed into a chamber. The XRF spectrometer measures the individual component wavelengths of the fluorescent emission produced by a sample when irradiated with X-Rays.

A.2.3 Particle Size Analyzer (PSA)

Samples were characterized for the size of diameter by PSA (Malvern, Mastersizer X). The Mastersizer X used lenses of 300 mm. The samples were placed in the Sample Presentation Unit (SPU) and dispersed in water. The water was used as a medium containing particles visible to the cell window.

A.2.4 Gas Pycnometer (GP)

Samples were characterized for density by GP (Quantachrome, Ultrapycnometer 1000). The samples were weight and placed in the chamber. The Helium was used as a medium gas to determine the volume of the sample. The density of samples can be calculated from weight and volume.

A.2.5 Polarized Optical Microscope (POM)

Samples were analyzed the surface appearances by POM (Leica, CH-9453). The samples were place on the holder. The POM provided light source to the samples and reflect to the objective lens, thought to the detector.

A.2.6 Scanning Electron Microscope (SEM)

Sample were analyzed the morphology by SEM (Hitachi, model S-4800). The SEM accelerating voltage, current, and magnification are specified in the SEM figures. The samples were stacked onto stubs by using sticker carbon papers. The samples were clamped on the holder and placed into the high vacuum chamber for preventing the attenuation of X-ray by the air molecules.

A.2.7 X-Ray Diffraction (XRD)

The sample was characterized for its structures by XRD or a X-Ray diffraction spectrometer (Rigaku D/max; model 2000). The specimens were placed on a glass slide, clamped on the sample holder, and then exposed to the X-ray source. The anode tube of the X-ray source was Copper K-alpha. The operating voltage and current were 40 kV and 30 mA, respectively. The measurement angle (2Θ) was from 5 degree to 90 degree with a scanning speed of 5 degree/min, and under the wide angle mode. One sample was divided into 3 specimens for each measurement. Each specimen was chosen randomly from the whole lot of the sample.

A.2.7 Wet Chemical Analysis

XK-03 iron ore was also analyzed for its compositions by the Wet Chemical Analysis at the Thai Pride Cement Co., Ltd.

A.2.8 Proximate Analysis

The FIRST coal was analyzed by the Proximate Analysis at the Thai-Pride Cement Co., Ltd.

A.3 Raw Material Characterization

A.3.1 PSA Characterization

The sizes of particle were characterized by PSA. The results are shown in Table A1.

Table A1 Particle size of the raw materials

No.	Mean Diameter of Particle (μm)			
	XK-03	**FIRST Coal**	**Bentonite**	**Limestone**
1	276.87	383.41	58.35	16.90
2	224.10	363.50	57.41	14.40
3	248.51	376.53	51.19	36.06
4	246.23	358.16	58.96	24.87
5	246.34	371.13	64.05	34.92
6	241.37	361.46	81.45	21.44
7	231.11	362.82	59.27	23.20
8	280.81	366.64	77.71	53.50
9	228.86	365.53	88.32	27.88
10	216.45	368.75	65.13	24.42
Avg	**244.07**	**367.79**	**66.18**	**27.76**
SD	21.14	7.56	12.13	11.35

A.3.2 EDX Characterization

The % wt of element of the XK-03 iron ore from EDX is shown in Table A2.

Table A2 EDX Analysis of iron ore (XK-03)

Sample Name	C	O	Al	Si	Mn	Fe	Zr	Ca	P	K	Mg	Cl	Na	Zn	Ti	As	S	Cr
XK-03 (1st specimen)	0.0	42.68	4.30	6.53	0.58	45.10	0.0	0.0	0.09	0.66	0.0	0.0	0.05	0.0	0.00	0.00	0	0.0
XK-03 (2nd specimen)	0.0	38.94	3.17	6.53	7.15	47.01	0.0	0.0	0.27	0.64	0.0	0.0	0.00	0.0	0.00	0.00	0	0.0
XK-03 (3rd specimen)	0.0	36.91	5.14	8.92	1.48	45.66	0.0	0.0	0.31	1.51	0.0	0.0	0.06	0.0	0.00	0.00	0	0.0
XK-03 (4th specimen)	0.0	39.47	5.15	6.33	0.59	45.90	0.0	0.7	0.46	1.33	0.0	0.00	0.00	0.0	0.09	0.00	0	0.0
XK-03 (5th specimen)	0.0	43.97	4.92	4.33	1.21	43.62	0.0	0.0	0.26	1.39	0.0	0.0	0.00	0.0	0.29	0.00	0	0.0
Average	0.0	40.39	4.54	6.53	2.20	45.46	0.0	0.1	0.28	1.11	0.0	0.0	0.02	0.0	0.08	0.00	0	0.0
SD	-	2.88	0.84	1.63	2.79	1.24	-	0.3	0.13	0.42	-	-	0.03	-	0.13	-	-	-

A.3.3 XRF Characterization

The % wt of element of the XK-03 iron ore from XRF spectrophotometer is shown in Table A3.

Table A3 Composition of the XK-03 iron ore by XRF Spectrophotometer

Element	% wt
Al	4.824
Ca	0.07098
Cs	0.5234
Fe	41.62
K	0.8889
Mg	0.3062
Mn	2.911
Na	0.1928
O	36.91
P	0.3598
S	0.026
Si	11.2
Ti	0.1676

A.3.4 Wet Chemical Analysis Results

Results of the XK-03 iron ore from the Thai Pride Cement Co., Ltd. are shown in Table A4.

Table A4 Composition of the XK-03 iron ore by the Wet Chemical Analysis from the Thai Pride Cement Co., Ltd.

Composition	% weight
SiO_2	20.13
Al_2O_3	7.59
Fe_2O_3	56.77
CaO	0.80
MgO	1.92
SO_3	0.00
Na_2O	0.39
K_2O	0.99
LOI	10.51

For the experiment, the XRF characterization result of XK-03 has been chosen to calculate the molar ratios and the weights of the component in the pellet mixture. Because this method can determine the %element from the whole sample or in bulk (EDX probes only a specific area of the sample) giving more accurate data.

A.3.5 Proximate Analysis

The Proximate Analysis of the FIRST coal was obtained from The Pride Cement Co., Ltd. The results are shown in Table A5

Table A5 Proximate Analysis of the FIRST coal

Moisture	% TM	1.23
Properties : Air dried basis	% IM	0.97
	% ASH	23.84
	VM	9.89
	% FC	65.30
	% S	0.49
	GCV (Kcal/kg)	6199.00

A.3.6 Specifications of Bentonite and Limestone

Table A6 shows the composition of the bentonite from Dhebkaset Industry Co., Ltd. It has an average molecular weight of 83.26 of g/mol.

Table A6 Composition of Sodium Bentonite from Dhebkaset Industry Co., Ltd.

Composition	**% by weight**	**M_w**	**% by weight x M_w of Composition**
CaO	2.54 %	56.08	1.42
Al_2O_3	16.52 %	101.96	16.84
SiO_2	57.02 %	60.08	34.26
Fe_2O_3	15.64 %	159.69	24.98
K_2O	0.64 %	94.20	0.60
Na_2O	5.29 %	61.98	3.28
TiO_2	2.35 %	79.87	1.88
Average			83.26

The composition of Limestone from Petch Thai Chemical Co., Ltd. is shown in Table A7. Limestone has an average molecular weight of 100.07 g/mol.

Table A7 Composition of Limestone from Petch Thai Chemical Co., Ltd.

Composition	**% by weight**	**M_w**	**% by weight x M_w of Composition**
$CaCO_3$	99.87%	100.09	99.96
$MgCO_3$	0.13%	84.36	0.11
Average			100.07

Appendix B Calculations of Pellet Mixtures

B.1 Mol Ratio of C/Fe

The molar ratios of C/Fe can be calculate from the reduction equation of Hematite (Fe_2O_3) to iron (Fe) that shown in Eq. E-1 and E-2

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2 \qquad \text{Eq. E1}$$

$$CO_2 + C \rightarrow 2CO \qquad \text{Eq. E2}$$

Table B1 Molecular Weight

Substance	M_w (g/mol)
Fe	55.85
C	12
O	16
Fe_2O_3	159.7

% Fe in Iron Ore (XK–03) = 41.62 %, Appendix A

% Fixed Carbon in the reductant (FIRST Coal) = 65.3 %, Appendix A

From Eq. (E1)

1 mol Fe_2O_3 : 3 mol CO
2 mol Fe : 3 mol C
1 mol Fe : 1.5 mol C

$$1 \text{ mol Fe} \times \frac{55.85 \text{ g Fe}}{1 \text{ mol Fe}} \times \frac{1 \text{ g XK-03}}{0.4162 \text{ g Fe}} = 134.19 \text{ g XK-03}$$

$$1.5 \text{ mol C} \times \frac{12.01 \text{ g C}}{1 \text{ mol C}} \times \frac{1 \text{ g FIRST Coal}}{0.653 \text{ g C}} = 27.59 \text{ g FIRST Coal}$$

Iron ore : Reductant ratio from Eq. E1 is:

$$1\ \text{kg XK-03} \times \frac{1000\ \text{g XK-03}}{1\ \text{kg XK-03}} \times \frac{27.59\ \text{g FIRST Coal}}{134.19\ \text{g XK-03}} = 205.60\ \text{g FIRST Coal}$$

The other C/Fe molar ratios are calculated the same as these steps and shown in Table B2

Table B2 Weight Iron ore (XK−03): Reductant (FIRST coal)

Mol ratio Fe	Weight Fe (g)	Weight of Iron Ore (g)	Mol ratio C	Weight C (g)	Weight of Reductant (g)	g Reductant/ kg Iron ore
1.00	55.85	122.86	1.4	16.81	25.75	191.87
			1.6	19.22	29.43	219.31
			1.8	21.62	33.11	246.72
			2.0	24.02	36.79	274.11
			2.2	26.42	40.46	301.50

B.2 Mol Ratio of Limestone/ $Al_2O_3 + SiO_2$

From data of Iron Ore (XK-03), Appendix A

XK−03 has % Al = 4.82

% Si = 11.20

Table B3 Molecular Weights

Substance	M_w (g/mol)
Al	26.98
Si	28.09
Al_2O_3	101.96
SiO_2	60.08
Limestone (Appendix A)	100.07

At 1000 g XK−03:

$$1\ \text{kg XK-03} \times \frac{1000\ \text{g XK-03}}{1\ \text{kg XK-03}} \times \frac{4.82\ \text{g Al}}{100\ \text{g XK-03}} \times \frac{1\ \text{mol Al}}{26.98\ \text{g Al}} \times \frac{1\ \text{mol Al}_2\text{O}_3}{2\ \text{mol Al}} = 0.893\ \text{mol Al}_2\text{O}_3$$

$$1\ \text{kg XK-03} \times \frac{1000\ \text{g XK-03}}{1\ \text{kg XK-03}} \times \frac{11.20\ \text{g Si}}{100\ \text{g XK-03}} \times \frac{1\ \text{mol Si}}{28.09\ \text{g Si}} \times \frac{1\ \text{mol SiO}_2}{1\ \text{mol Si}} = 3.987\ \text{mol SiO}_2$$

Moles of Al_2O_3+SiO_2 = 4.880 mol

At molar ratio of Limestone/Al_2O_3+SiO_2 = 0.75

$$4.880\ \text{mol Al}_2\text{O}_3 + \text{SiO}_2 \times 0.75 \times \frac{1\ \text{mol Limestone}}{1\ \text{mol Al}_2\text{O}_3 + \text{SiO}_2} \times \frac{100.07\ \text{g Limestone}}{1\ \text{mol Limestone}} = 366.29\ \text{g Limestone}$$

Table B4 Weight Limestone: 1 kg Iron ore

Iron Ore (g)	FIRST Coal at mol ratio C/Fe = 1.50	Mol ratio Limestone/ mol Al_2O_3+SiO_2	Mol of Limestone	g Limestone/ kg Iron ore
1000	224.57	0.45	2.196	219.77
		0.55	2.684	268.61
		0.65	3.172	317.45
		0.75	3.660	366.29
		0.85	4.148	415.13
		0.95	4.636	463.97
		1.05	5.124	512.80

B.3 Mol Ratio of Bentonite/Fe

% Fe in iron ore (XK-03) = 41.62 %, Appendix A

Molecular Weight of Bentonite = 83.26 g/mol, Appendix A

At molar ratio of Bentonite/Fe = 0.035

$$0.035 \text{ mol Bentonite} \times \frac{83.26 \text{ g Bentonite}}{1 \text{ mol Bentonite}} = 2.914 \text{ g Bentonite}$$

$$1 \text{ mol Fe} \times \frac{55.85 \text{ g Fe}}{1 \text{ mol Fe}} \times \frac{1 \text{ g XK-03}}{0.4162 \text{ g Fe}} = 134.19 \text{ g XK-03}$$

1 kg of Iron Ore : Bentonite Ratio (by weight) is:

$$1 \text{ kg XK-03} \times \frac{1000 \text{ g XK-03}}{1 \text{ kg XK-03}} \times \frac{2.914 \text{ g Bentonite}}{134.19 \text{ g XK-03}} = 21.72 \text{ g Bentonite}$$

The other Bentonite/Fe molar ratios are calculated the same as above steps and shown in Table B1.

Table B5 Weight of Iron ore (XK-03): Binder (Bentonite)

Mol ratio Fe	Weight Fe (g)	Weight iron ore (g)	Mol ratio Bentonite	Weight of Binder (g)	g Binder/ Kg iron ore
1	55.85	134.19	0.015	1.249	9.31
			0.025	2.082	15.51
			0.035	2.914	21.72
			0.075	6.245	46.53

Appendix C Sample Preparation

C.1 Grinding Raw Materials

The XK-03 and FIRST coal were grinded by a cylindrical ball mill. The diameter and length of the chamber are 70 cm and 100 cm respectively. The media is 1 kg of spherical metallic ball, with 15 balls. The critical speed is 60 rpm. The product was screened by a mesh 20 (300 μm) and the oversize was grinded again. The grinding step is shown in Figure C1. The weight of XK-03 and FIRST coal is shown in Table C1.

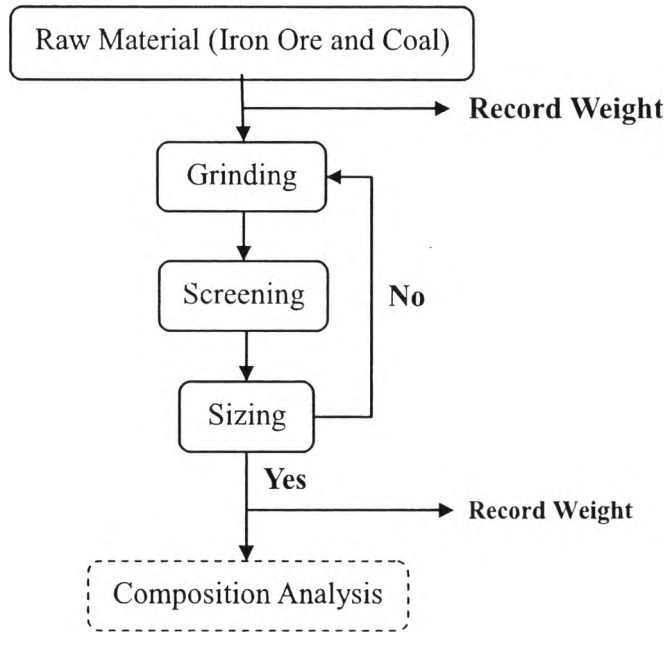


Figure C1 Grinding step of raw material.

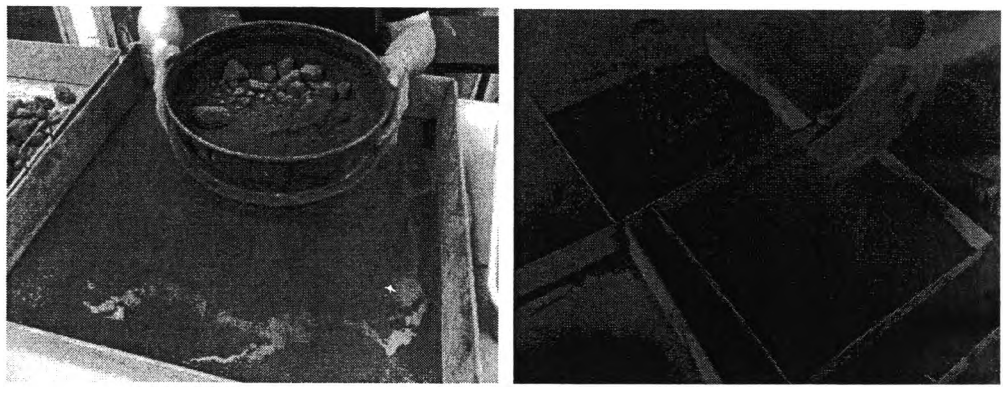


Figure C2 Screening step of XK-03 (Left) and FIRST Coal (Right).

Table C1 Weight of XK-03 and FIRST Coal from grinding

Raw Material	Weight Before Grinding (kg)	Weight After Grinding (kg)	
		Undersize (500 μm)	Oversize (500 μm)
XK-03	103.75	82.26	18.38
FIRST Coal	112.31	84.40	24.66

The size of particle after grinding was measured by PSA (Malvern, Mastersizer X). The results are shown in Table A1 in Appendix A.3.

C.3 Mixing and the Pellet Preparation

C.3.1 Amounts of the Raw Materials in Mixtures of Experiments 1-5

XK-03, FIRST Coal, Limestone, and Bentonite were mixed by using molar ratios that tabulated in Table C2. Water of 10% by weight of the mixture was added. The mixture was mixed until it becomes homogenous phase. Figure C3 shows the raw materials before and after the mixing.

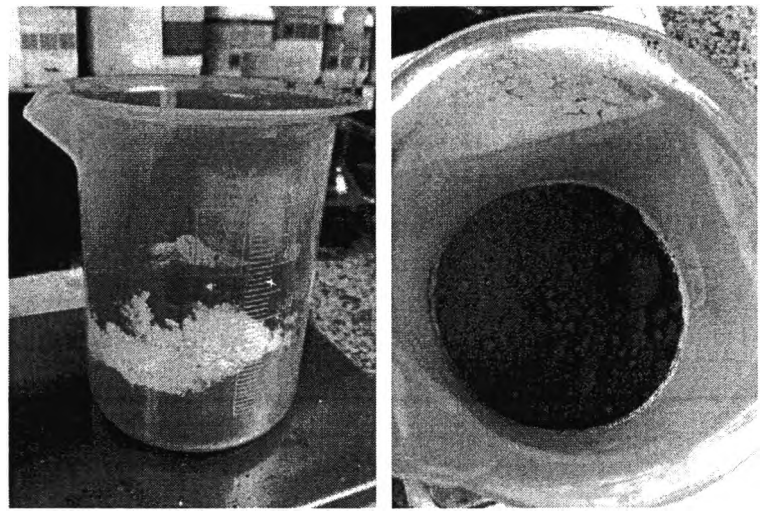


Figure C3 The raw materials before mixing (left) and after mixing (right).

Table C2 Amounts of the raw materials in the mixtures of the experiment 1-7

Experiment	No.	Mol ratio				Weight (g)			
		Fe	C/Fe	Limestone/Al_2O_3+SiO_2	Bentonite/Fe	XK-03	FIRST Coal	Limestone	Bentonite
1	1-2	1	1.6	0.49	0.016	200	44.91	47.52	2.03
	3-6				0.075				3.39
	7-10				0.085				4.74
2	1-3	1	1.6	0.49	0.038	200	44.91	47.52	4.74
	4-6				0.082				10.17
3	1-4	1	1.6	0.49	0.038	200	44.91	47.52	4.74
4	1	1	1.4	0.75	0.035	200	38.38	73.26	4.34
	2		1.6				43.86		
	3		1.8				49.34		
	4		2.0				54.83		
	5		2.2				60.31		
5	1	1	1.6	0.45	0.035	200	43.86	43.95	4.34
	2			0.55				53.72	
	3			0.65				63.49	
	4			0.75				73.26	
	5			0.85				83.03	
	6			0.95				92.79	
	7			1.05				102.56	
6	1-3	1	1.6	0.65	0.035	200	43.86	63.49	4.34
7	1-3	1	1.6	0.65	0.025	200	43.86	63.49	3.10
	4-6				0.035				4.34
	7-9				0.045				5.58

C.3.2 Pellet Preparation

The mixture was compress by the cylindrical mold (4 cm of diameter) for making pellets. The pellet was compressed at 6,000 psi, 2 minutes and then dried at 80°C for 24 hours. The pelletizer step is shown in Figure C4. The size of pellet is shown in Figure C5.

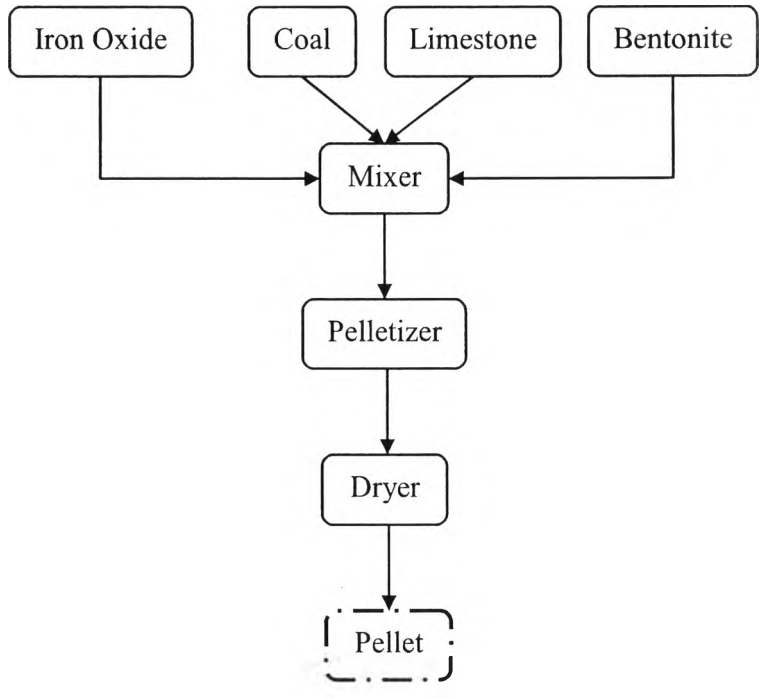


Figure C4 Preparation of the pellet.

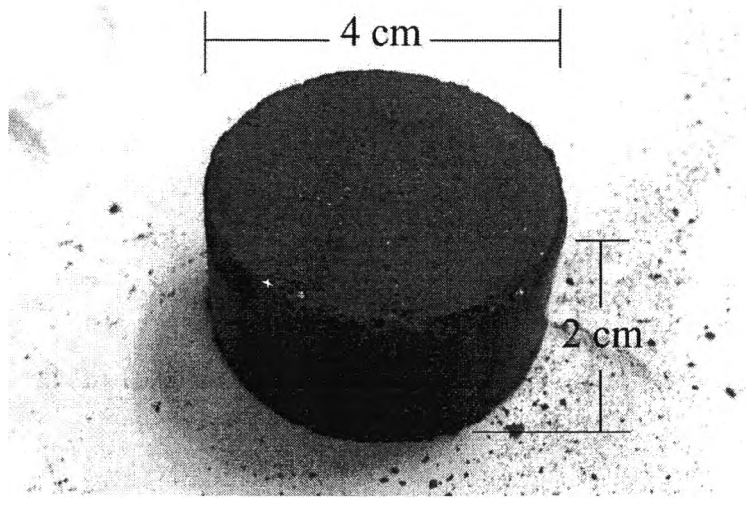


Figure C5 Size of the pellet after pelletizer.

Appendix D Results of Experiment 1-2

D.1 Experiment 1

XK-03, FIRST coal, Petch Thai Limestone, and Dhebkaset Bentonite were mixed by using the molar ratios as shown in Table D1. The pellets were dried at 80 °C.

Table D1 Experiment 1; the mole ratio of mixture and drying time

No.	Mol ratio				Weight (g)					Drying Time
	Fe	C/Fe	Limestone/Al_2O_3+SiO_2	Bentonite/Fe	XK-03	FIRST Coal	Limestone	Bentonite	Water	(hrs)
1	1	1.64	0.49	0.016	200	44.91	47.52	2.03	30	3
2										6
3				0.027				3.39		1
4										2
5										3
6										6
7				0.038				4.74		1
8										2
9										3
10										6

The pellet was dropped to the ground (polished stone floor) from one meter high at room temperature. The results are shown in Table D2.

Table D-2 Experiment 1; results of drop test at room temperature

Mol ratio Bentonite/Fe	Drying Time (hrs)	Sample	Drop Time			
			1	2	3	4
0.016	3	1-1	Nick	Break		
		1-2	Nick	Break		
	6	1-3	Break			
		1-4	Nick	Break		
0.027	1	1-5	Nick	Nick	Break	
		1-6	Nick	Nick	Break	
	2	1-7	Nick	Nick	Break	
		1-8	Nick	Break		
	3	1-9	Nick	Crack	Break	
		1-10	Nick	Nick	Crack	Break
	6	1-11	Crack	Break		
		1-12	Break			
0.038	1	1-13	Perfect	Nick	Nick	Break
		1-14	Nick	Nick	Crack	Break
	2	1-15	Nick	Nick	Break	
		1-16	Nick	Nick	Break	
	3	1-17	Nick	Nick	Nick	Break
		1-18	Nick	Crack	Break	
	6	1-19	Nick	Nick	Break	
		1-20	Nick	Break		

From Experiment 1, with the drying temperature at 80 °C, and one meter height, the pellet will be broken within 4 drops depending on the material ratio and the drying time. The results show that the higher ratio of Bentonite/Fe and the high amount of water contain provides a stronger resistance to break for the pellet.

However, when the pellet was fed to the furnace while it contain amount of water content, the temperature was changed rapidly. The water inside the pellet was vigorously evaporate which break the pellet and damages the furnace. For this reason, a new experimental process (Experiment 2) was designed to remove the water content in the pellets prior to reduction process in the furnace. By drying the pellets for 24 hours, it is assumed that all the specimens had no water content left.

D.2 Experiment 2

XK-03, FIRST coal, Petch Thai Limestone, and Dhebkaset Bentonite were mixed by using the molar ratios as shown in Table D3. The pellets were dried at 80 °C, 24 hours. The results are shown in Table D4.

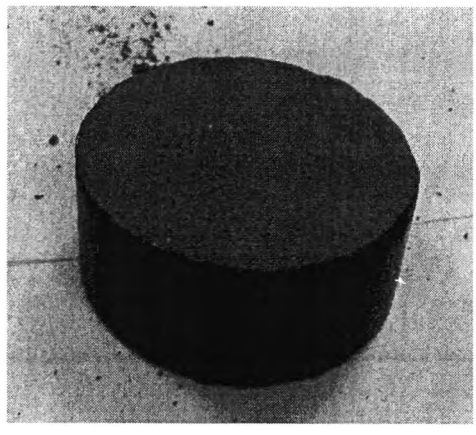
Table D3 Experiment 2; the mole ratio of mixture

No.	Mol ratio				Weight (g)				
	Fe	C/Fe	Limestone/Al2O3+SiO2	Bentonite/Fe	XK-03	FIRST Coal	Limestone	Bentonite	Water
1	1	1.64	0.49	0.038	200	44.91	47.52	4.74	30
2									
3									
4				0.082				10.17	
5									
6									

Table D4 Experiment 2; results of drop test at room temperature

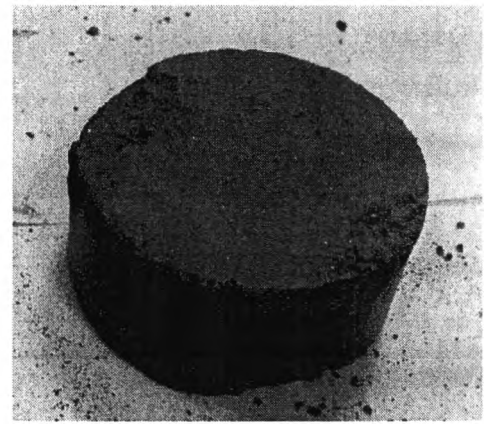
Mol ratio Bentonite/Fe	Sample	Drop Time					
		1	2	3	4	5	6
0.038	2-1	Perfect	Nick	Nick	Nick	Crack	Break
	2-2	Perfect	Nick	Crack	Crack	Break	
	2-3	Perfect	Crack	Break			
0.082	2-4	Nick	Nick	Break			
	2-5	Perfect	Nick	Nick	Break		
	2-6	Perfect	Nick	Creck	Crack	Break	

From Experiment 2, with the drying condition at 80 °C, 24 hours and one meter height, the pellet was broken within 6 drops. The best result is molar ratio of Bentonite/Fe = 0.035. Figure D-1 shows the different appearances of the pellets after droping to the floor.



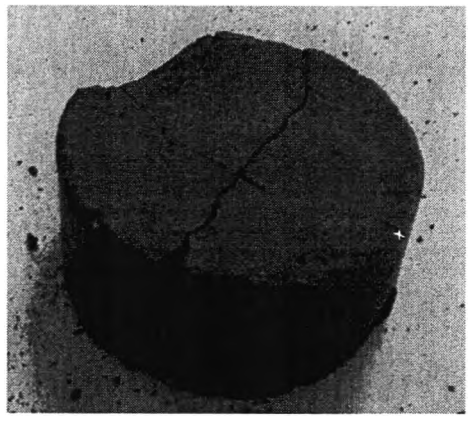
Perfect Pellet

No.2-2 after 1st drop time



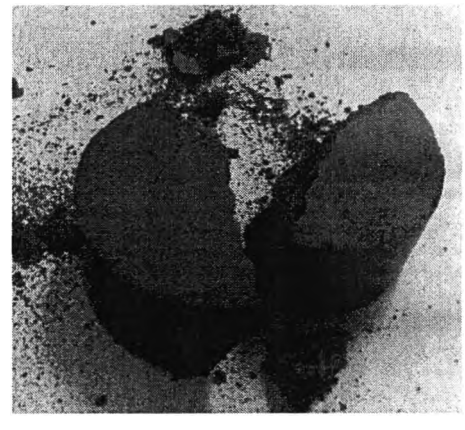
Nicked Pellet

No.2-2 after 2nd drop time



Crack Pellet

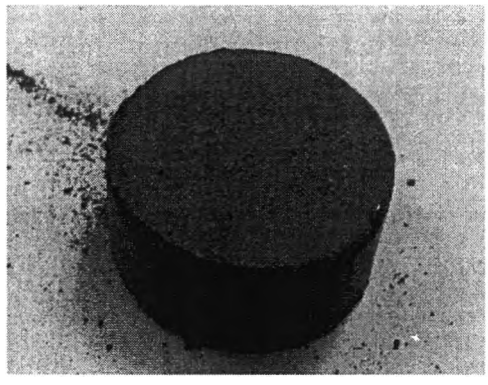
No.2-3 after 2nd drop time



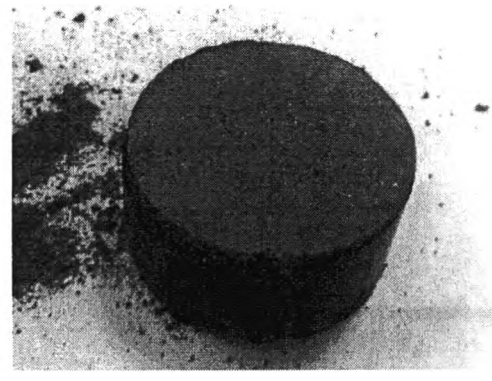
Broken Pellet

No.2-4 after 3rd drop time

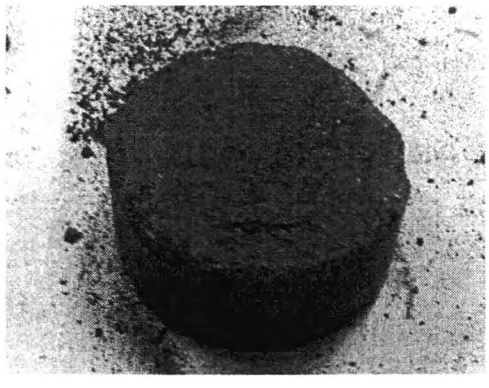
Figure D1 Appearances of the pellet from drop test.



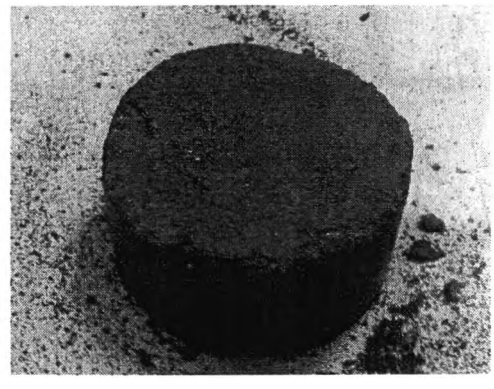
1st drop time



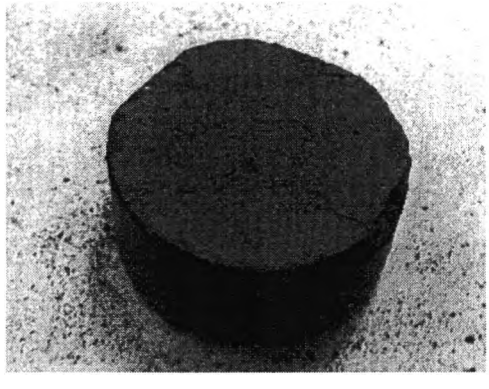
2nd drop time



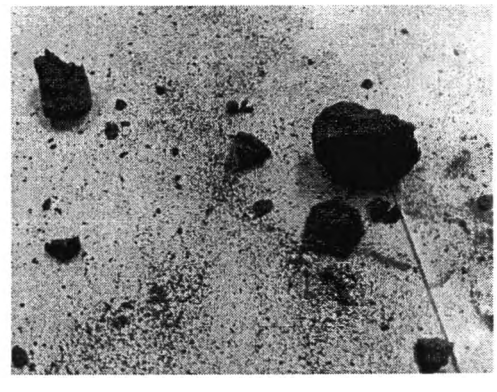
3rd drop time



4th drop time



5th drop time



6th drop time

Figure D2 Appearances of the sample No.2-1 (the best sample) from drop test.

Appendix E Results of Experiment 3

XK-03, FIRST coal, Petch Thai Limestone, and Dhebkaset Bentonite were mixed by using the molar ratios C/Fe = 1.64, Limestone/Al_2O_3+SiO_2 = 0.49, and Bentonite/Fe = 0.038. The reduction condition is shown in Table E1.

Table E1 Experiment 3; the reduction condition

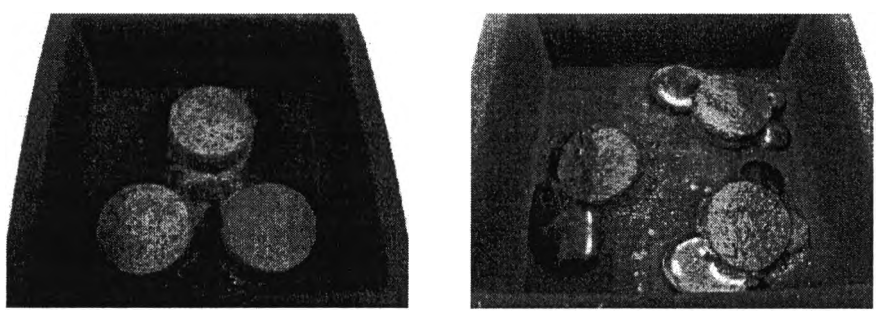
No.	Reduction Temperature (°C)	Soaking Time at Desire Temperature (mins)
1	1200	30
2		60
3	1300	30
4		60

The weight of sample after reduction is shown in Table E-2.

Table E2 Experiment 3; the weight of sample no.1-4 after reduction

No.	Reduction Temperature (°C)	Time (min)			Weight of 3 pellets (g)		
		Heating Time (from room temperature)	Soaking Time	Cooling Time (hr)	Before Reduction	After Reduction	
						Iron Nugget	Slag
1	1200	98	30	24	162.22	110.34	
2	1200	95	60	24	161.34	108.33	
3	1300	117	30	24	162.81	68.43	33.86
4	1300	120	60	24	160.33	53.28	43.39

Products from the reduction were characterized for wt % of element by EDX (Horiba, model 51-ADD0014); the characterization result is shown in Appendix A2. Table E-3 shows the wt % of element of samples No.1-4 in the experiment 3. The separation of the products No.1-2 is shown as the direct reduction and the separation of the products No.3-4 is a complete separation as shown in Figure E1. The % yields of No.1-4 are shown in Table E-4.



Direct Reduction (No.1) Phase Separation (No.3)

Figure E1 Type of product separation.

Table E3 Experiment 3; %weight element of No.1-4 after reduction

Element	% wt of element					
	1	2	3		4	
			Iron Nugget	Slag	Iron Nugget	Slag
C	18.01±2.15	17.16±2.13	11.30±6.64	29.77±3.05	1.78±1.61	21.84±6.81
O	32.24±1	30.03±5.83	26.43±3.37	41.80±3.49	20.43±4.26	43.89±6.63
Na	0.09±0.01	0.26±0.34	1.96±2.04	0.10±0.17	1.57±1.04	0.00
Mg	0.00	0.00	0.00	0.15±0.26	0.00	0.00
Al	2.04±0.36	1.78±0.84	0.44±0.51	3.46±0.59	0.00	4.24±0.76
Si	5.01±0.24	4.32±2.44	0.76±0.84	8.72±1.08	0.17±0.23	10.98±2.02
P	0.38±0.13	0.00	0.02±0.03	0.00	0.00	0.00
S	0.05±0.05	0.29±0.46	2.48±2.4	0 15±0.19	2.17±1.34	0.18±0.09
Cl	0.00	0.00	0.00	0.00	0.00	0.06±0.1
K	0.63±0.07	1.16±1.26	2.37±1.26	0.67±0.18	3.37±2.17	0.80±0.41
Ca	8.51±1.45	6.00±1.07	1.32±1.07	10.63±0.95	0.25±0.43	14.20±4.85
Ti	0.12±0.03	0.09±0.06	0.04±0.06	0.11±0.1	0.00	0.13±0.16
Cr	0.00	0.00	0.00	0.00	0.00	0.00
Mn	2.31±0.7	2.03±0.75	1.71±0.7	3.31±0.67	2.91±1.12	3.64±1.85
Fe	30.60±4.08	36.88±12.43	51.17±7.97	1.13±1.67	67.35±7.82	0.03±0.06
Ni	0.00	0.00	0.00	0.00	0.00	0.00
Cu	0.00	0.00	0.00	0.00	0.00	0.00
Zn	0.00	0.00	0.00	0.00	0.00	0.00
Zr	0.00	0.00	0.00	0.00	0.00	0.00
Cs	0.00	0.00	0.00	0.00	0.00	0.00

Table E4 Experiment 3; % Yield of No.1-4 after reduction

No.	%wt Iron ore in mixture	%wt Fe in mixture	Dried weight of pellet (g)	Fe input (g)	%Fe Nugget from EDX	Iron Nugget (g)	Fe Output (g)	%Yield
1	67.30	28.01	162.22	45.44	-	-	-	-
2			161.34	45.19	-	-	-	-
3			162.81	45.60	51.17	68.43	35.02	76.78
4			160.33	44.91	67.35	53.28	35.88	79.90

Appendix F Results of Experiment 4

XK-03, Petch Thai Limestone, and Dhebkaset Bentonite were mixed by using the molar ratio as shown in Table F1. The reduction condition and weight of the pellet are shown in Table F2.

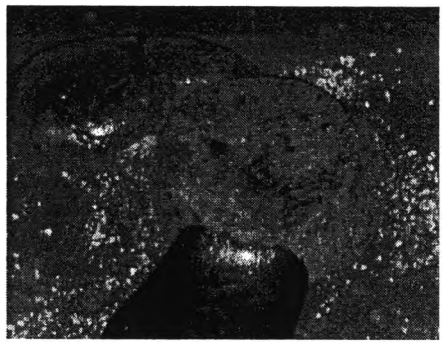
Table F1 Experiment 4; the mole ratio of mixture

No.	Mol ratio				Weight (g)				
	Fe	C/Fe	Limestone/Al_2O_3+SiO_2	Bentonite/Fe	XK-03	FIRST Coal	Limestone	Bentonite	Water
1	1	1.4	0.75	0.035	200	38.38	73.26	4.34	30.00
2		1.6				43.86			
3		1.8				49.34			
4		2.0				54.83			
5		2.2				60.31			

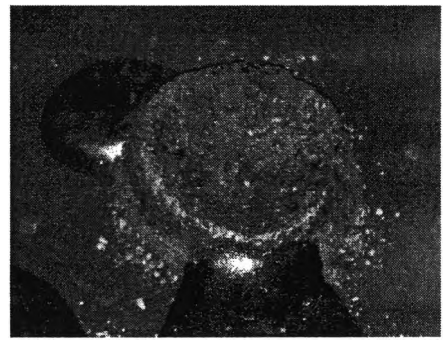
Table F2 Experiment 4; the reduction condition

No.	Mol ratio of C/Fe	Reduction Temperature (°C)	Time (min)			Weight of 3 pellets (g)		
			Heating Time (from room temperature)	Soaking Time	Cooling Time (hr)	Before Reduction	After Reduction	
							Iron Nugget	Slag
1	1.4	1300	120	60	20	162.41	47.76	32.62
2	1.6					161.08	43.03	47.14
3	1.8					163.13	36.90	52.59
4	2.0					162.19	39.94	47.98
5	2.2					160.33	32.85	44.28

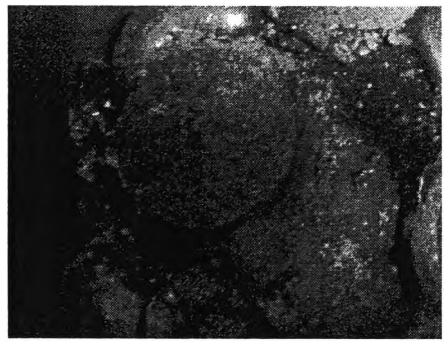
Product from the reduction were characterized for %weight of element by EDX. Table F3 shows the %weight of element of samples No.1-5 in the experiment 4.



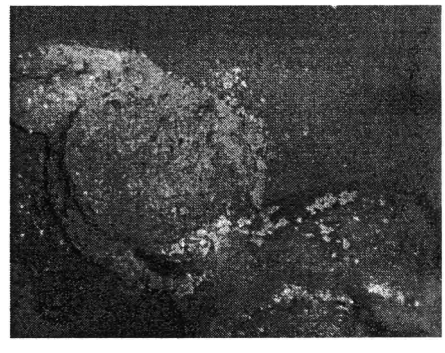
No.1, C/Fe = 1.4
Complete Separation



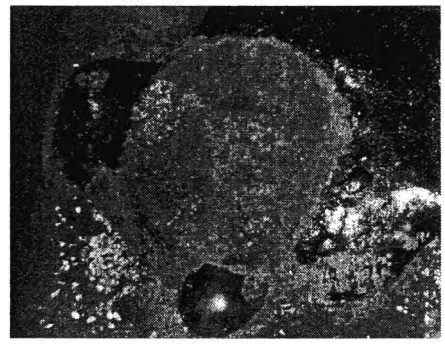
No.2, C/Fe = 1.6
Complete Separation



No.3, C/Fe = 1.8
Complete Separation



No.4, C/Fe = 2.0
Complete Separation



No.5, C/Fe = 2.2
Complete Separation

Figure F1 Experiment 4; the pellets after the reduction.

Table F3 Experiment 4; %weight element of No.1-5 after reduction at 1300°C, 60 mins

Element	% wt of element									
	1		2		3		4		5	
	Iron Nugget	Slag	Iron Nugget	Slag	Iron Nugget	Slag	Iron Nugget	Slag	Iron Nugget	Slag
C	0.19±0.33	18.65±5.14	0.22±0.38	19.35±5.72	0.76±0.95	31.84±2.35	0.09±0.15	18.07±5.01	4.46±4.6	17.53±4.53
O	20.19±5.86	37.82±6.14	11.66±10.04	36.81±4.44	13.65±1.59	41.99±6.52	16.04±6.71	32.50±2.21	16.03±7.83	33.77±1.75
Na	0.19±0.33	0.00	0.26±0.45	0.00	0.00	0.00	0.08±0.13	0.00	0.00	0.00
Mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	0.01±0.02	4.49±0.24	0.04±0.04	4.50±0.38	0.24±0.27	2.94±0.74	0.02±0.02	3.81±0.83	0.10±0.11	4.18±0.54
Si	0.02±0.04	12.43±0.6	0.21±0.09	12.59±0.78	0.55±0.65	8.10±0.54	0.04±0.03	11.61±2.07	0.27±0.24	12.16±1.64
P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01±0.03	0.00
S	0.24±0.36	0.15±0.26	0.26±0.45	0.00	0.1±0.17	0.00	0.10±0.18	0.03±0.05	0.02±0.03	0.28±0.49
Cl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K	0.52±0.78	1.11±0.11	0.5±0.87	1.20±0.25	0.18±0.31	0.47±0.12	0.20±0.34	1.32±0.92	0.12±0.12	0.99±0.1
Ca	0.02±0.03	19.18±1.24	0.27±0.1	17.99±2.94	0.34±0.36	10.01±5.1	0.00	20.49±3.19	0.33±0.29	21.90±0.8
Ti	0.00	0.32±0.04	0.00	0.29±0.06	0.00	0.08±0.03	0.00	0.49±0.17	0.00	0.35±0.04
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mn	1.10±1.3	5.16±0.87	1.71±2.47	5.19±1.48	0.95±1.34	2.16±1	0.83±0.95	8.48±3.63	1.08±0.75	6.61±0.91
Fe	77.51±6.95	0.29±0.06	84.87±8.33	0.84±0.77	83.15±3.3	0.19±0.1	80.38±8.74	1.07±0.46	77.58±2.81	0.92±0.36
Ni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cu	0.00	0.41±0.13	0.00	1.25±0.24	0.00	2.22±2.79	0.00	2.12±0.47	0.00	1.29±0.52
Zn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

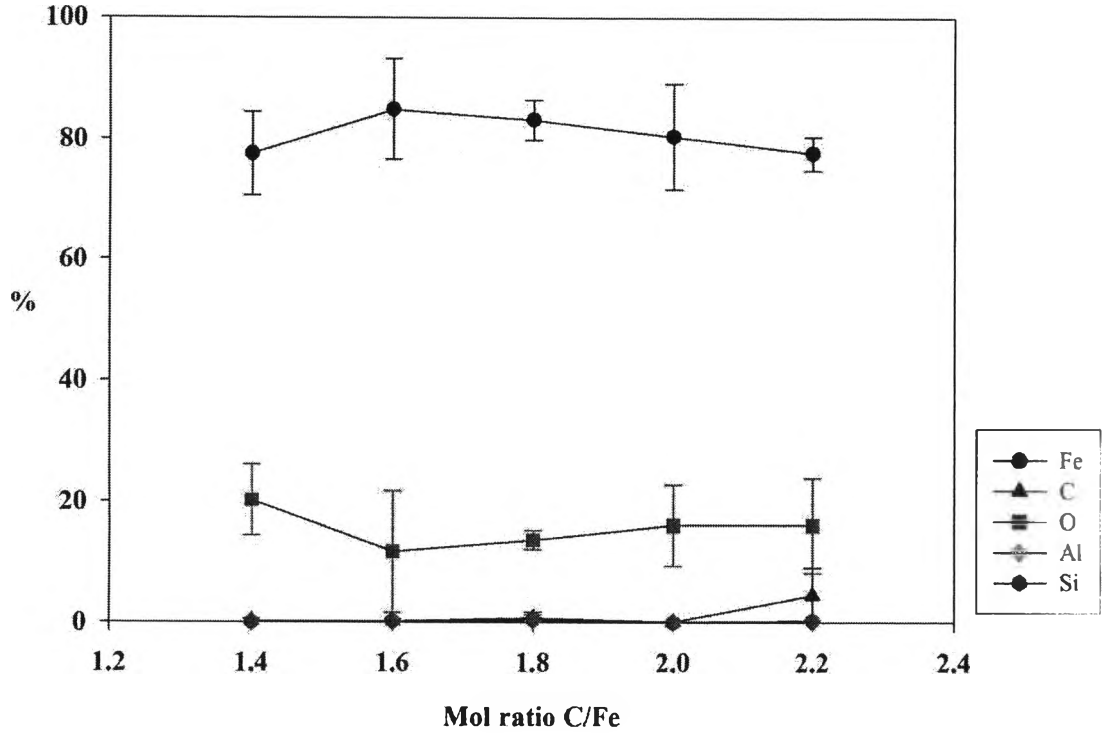


Figure F2 Experiment 4; % Element of iron nugget vs. Molar ratio of C/Fe

Samples No.1 and 2 of experiment 4, it shows an increase of the molar ratio of C/Fe increases the wt % Fe. The molar ratio of C/Fe = 1.4 gives 77.51% Fe and it reaches the maximum point at the molar ratio of C/Fe = 1.6 giving 84.87% Fe. Samples No.3 to 5, an increase in the molar ratio of C/Fe induces the reaction to be a complete separation. Adding the excess moles of FIRST coal decreases the wt % Fe from 84.87% (C/Fe = 1.6) to 77.58% (C/Fe = 2.2), as shown in Figure F2. The best ratio of C/Fe is from the sample No.2 (the best of % Fe and % yield) with the ratio of C/Fe = 1.6. For the wt % of C, an initial state shows a decrease of C because the reaction uses C as the reductant. After the reaction reaches the optimum point at molar ratio C/Fe = 1.6, % C increases.

Table F4 Experiment 4; %Yield of No.1-5 after reduction

No.	%wt Iron ore in mixture	%wt Fe in mixture	Dried weight of pellet (g)	Fe input (g)	%Fe Nugget from EDX	Iron Nugget (g)	Fe Output (g)	%Yield
1	63.30	26.34	162.41	42.78	77.51	47.76	37.02	86.53
2	62.22	25.89	161.08	41.71	84.87	43.03	36.52	87.55
3	61.17	25.46	163.13	41.53	83.15	36.90	29.73	71.59
4	60.16	25.04	162.19	40.61	80.38	39.94	32.10	79.05
5	59.19	24.63	160.33	39.50	77.58	32.85	25.49	64.53

Appendix G Results of Experiment 5

XK-03, Petch Thai Limestone, and Dhebkaset Bentonite were mixed by using the molar ratios as shown in Table G1. The reduction condition and weight of the pellet are shown in Table G2.

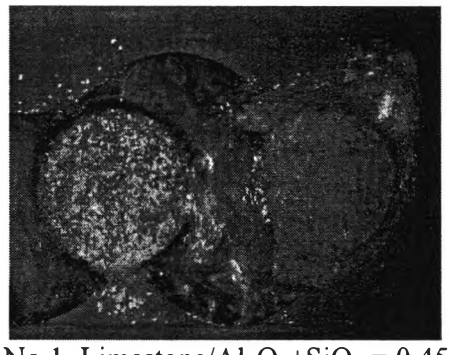
Table G1 Experiment 5; the mole ratio of the mixture

No.	Mol ratio				Weight (g)				
	Fe	C/Fe	Limestone/Al_2O_3+SiO_2	Bentonite/Fe	XK-03	FIRST Coal	Limestone	Bentonite	Water
1	1	1.6	0.45	0.035	200	43.86	43.95	4.34	30.00
2			0.55				53.72		
3			0.65				63.49		
4			0.75				73.26		
5			0.85				83.03		
6			0.95				92.79		
7			1.05				102.56		

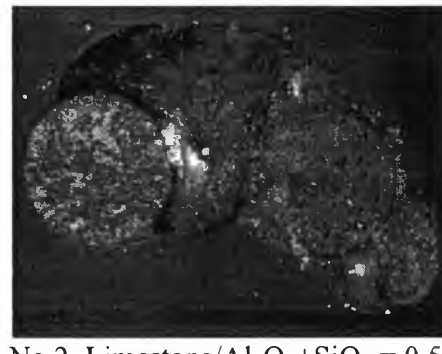
Table G2 Experiment 5; the reduction condition

No.	Mol ratio of Limestone/Al_2O_3 +SiO_2	Reduction Temperature (°C)	Time (min)			Weight of 3 pellets (g)		
			Heating Time (from room temperature)	Soaking Time	Cooling Time (hr)	Before Reduction	After Reduction	
							Iron Nugget	Slag
1	0.45	1300	120	60	20	158.95	58.79	35.54
2	0.55					157.80	53.15	30.39
3	0.65					160.02	46.19	49.12
4	0.75					160.33	46.02	39.94
5	0.85					162.32	38.96	58.49
6	0.95					164.44	41.43	54.69
7	1.05					163.56	39.50	56.67

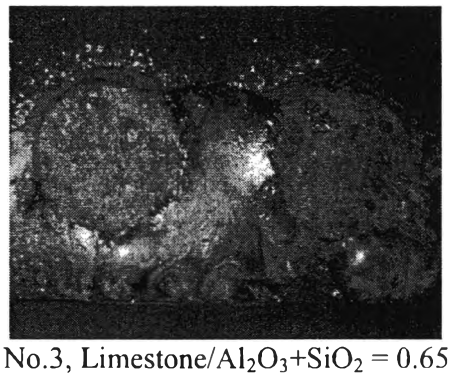
Products from the reduction were characterized for %weight of element by EDX. Table G3 shows the %weight of element of samples No.1-7 in the experiment 5.



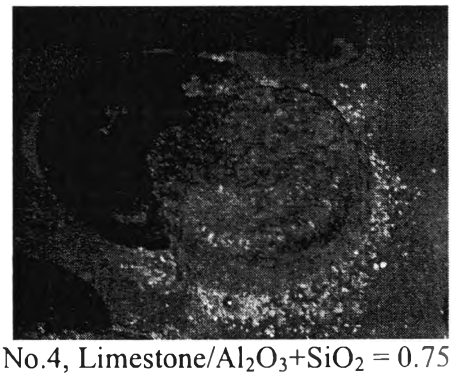
No.1, Limestone/Al_2O_3+SiO_2 = 0.45
Complete Separation



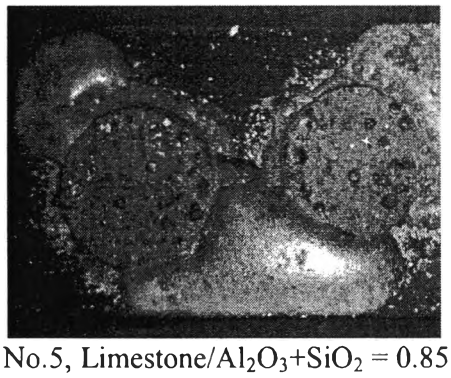
No.2, Limestone/Al_2O_3+SiO_2 = 0.55
Complete Separation



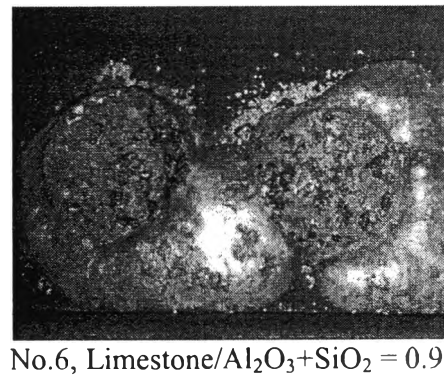
No.3, Limestone/Al_2O_3+SiO_2 = 0.65
Complete Separation



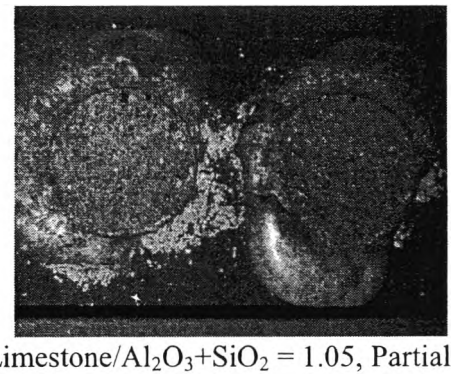
No.4, Limestone/Al_2O_3+SiO_2 = 0.75
Complete Separation



No.5, Limestone/Al_2O_3+SiO_2 = 0.85
Partial Separation



No.6, Limestone/Al_2O_3+SiO_2 = 0.95
Partial Separation



No.7, Limestone/Al_2O_3+SiO_2 = 1.05, Partial Separation

Figure G1 Experiment 5; the pellets after the reduction.

Table G3 Experiment 5; %weight element of No.1-7 after reduction at 1300°C, 60 mins

Element	% wt of element													
	1		2		3		4		5		6		7	
	Iron Nugget	Slag	Iron Nugget	Slag	Iron Nugget	Slag	Iron Nugget	Slag	Iron Nugget	Slag	Iron Nugget	Slag	Iron Nugget	Slag
C	2.64±1.08	14.50±4.01	4.57±2.5	11.43±1.89	2.37±1.61	11.17±0.84	0.25±0.04	8.30±0.73	1.78±0.79	7.41±2.08	4.89±1.2	9.53±0.71	2.01±0.75	8.44±1.14
O	13.89±7.83	39.99±4.5	15.43±5.0	39.32±4.93	12.52±6.43	34.89±6.98	9.33±8.04	41.36±7.17	12.98±3.21	38.00±2.69	13.02±8.18	40.71±3.36	23.34±6.56	38.14±5.6
Na	1.36±0.81	0.00	0.88±1.28	0.00	0.00	0.00	0.49±0.26	0.00	0.02±0.04	0.00	0.37±0.39	0.00	0.00	0.00
Mg	0.00	0.27±0.04	0.00	0.30±0.03	0.00	0.19±0.17	0.00	0.31±0.01	0.00	0.21±0.05	0.00	0.30±0.02	0.00	0.25±0.23
Al	0.09±0.08	4.99±0.75	0.04±0.08	4.99±0.35	0.04±0.04	4.41±0.79	0.12±0.12	5.16±0.23	0.06±0.05	4.16±0.2	0.07±0.08	4.03±0.11	0.08±0.14	3.48±1.33
Si	0.23±0.11	14.53±1.82	0.23±0.16	14.17±0.45	0.20±0.09	13.06±1.84	0.24±0.05	15.09±0.86	0.09±0.01	11.11±1.91	0.19±0.22	0.64±0.33	0.20±0.24	9.00±3.97
P	0.02±0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.08±0.14	0.00	0.28±0.29	0.05±0.09	0.00	0.00	0.20±0.35
S	3.00±1.93	0.14±0.13	0.98±1.52	0.33±0.17	0.06±0.06	0.10±0.09	0.94±0.43	0.22±0.06	0.16±0.11	0.08±0.07	0.55±0.4	0.22±0.03	0.00	0.10±0.13
Cl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K	5.28±4.08	1.52±0.16	1.47±2.33	1.33±0.16	0.03±0.03	1.44±0.27	2.66±1.29	1.29±0.29	0.34±0.25	2.13±0.92	0.75±0.69	0.74±0.06	0.03±0.02	0.80±0.32
Ca	1.79±2.55	13.62±1.41	1.34±2.32	17.58±4.26	0.10±0.09	22.73±3.79	0.62±0.48	19.48±4.45	0.24±0.19	18.34±4.11	0.36±0.44	21.06±2.07	0.33±0.35	18.77±8.63
Ti	0.05±0.04	0.35±0.05	0.03±0.05	0.34±0.09	0.00	0.38±0.07	0.00	0.31±0.06	0.02±0.03	0.40±0.02	0.00	0.21±0.03	0.00	0.22±0.06
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mn	3.40±2.38	6.52±1.24	1.13±1.63	6.38±1.35	0.73±0.49	7.42±2.73	5.12±2.22	5.44±1.21	2.06±1.49	4.44±0.58	0.27±0.11	4.23±0.25	0.37±0.24	3.88±0.35
Fe	68.18±3.55	0.63±0.33	73.88±6.78	0.59±0.4	83.94±6.09	0.27±0.14	80.23±6.88	0.29±0.26	82.19±4.23	9.75±10.34	79.47±5.89	3.33±2.36	73.64±6.73	12.75±19.06
Ni	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02±0.04	0.00	0.00	0.00	0.00	0.00
Cu	0.00	2.07±0.76	0.00	2.15±0.17	0.00	2.85±1.56	0.00	1.28±0.37	0.03±0.06	2.78±0.16	0.00	3.29±0.01	0.00	2.71±0.44
Zn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zr	0.09±0.08	0.87±0.28	0.00	1.05±0.22	0.01±0.01	1.10±0.61	0.00	1.39±0.08	0.00	0.92±0.41	0.00	1.70±0.25	0.01±0.01	1.26±0.19
Cs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

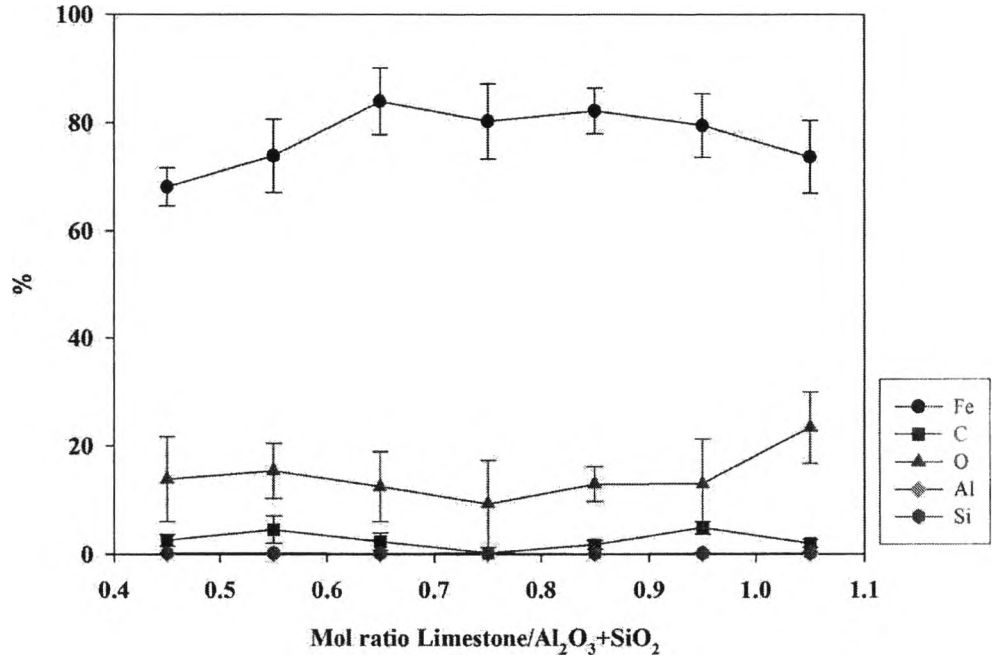


Figure G2 Experiment 5; % Element of iron nugget vs. Molar ratio of Limestone/Al_2O_3+SiO_2.

The Figure G2 shows the increase of wt % Fe in the products occurs when increasing the molar ratio of Limestone/Al_2O_3+SiO_2. Initial states show the increase of % Fe because limestone is combined with impurity in the iron ore and separated in a form of slag, and wt % Fe increases from 68.18% (Limestone/Al_2O_3+SiO_2 = 0.45) to 83.94% (Limestone/Al_2O_3+SiO_2 = 0.65). Further increase in the molar ratio, wt % Fe is still constant. Increase of the moles of limestone decreases the % Fe from 83.94% at optimum point of 73.64% at Limestone/Al_2O_3+SiO_2 = 1.05.

Table G4 Experiment 5; %Yield of No.1-7 after reduction

No.	%wt Iron ore in mixture	%wt Fe in mixture	Dried weight of pellet (g)	Fe input (g)	%Fe Nugget from EDX	Iron Nugget (g)	Fe Output (g)	%Yield
1	68.46	28.49	158.95	45.29	68.18	58.79	40.08	88.51
2	66.24	27.57	157.80	43.51	73.88	53.15	39.27	90.26
3	64.17	26.71	160.02	42.73	83.94	46.19	38.78	90.73
4	62.22	25.89	160.33	41.52	80.23	46.02	36.92	88.92
5	60.38	25.13	162.32	40.79	82.19	38.96	32.02	78.50
6	58.65	24.41	164.44	40.14	79.47	41.43	32.92	82.02
7	57.02	23.73	163.56	38.81	73.64	39.50	29.09	74.94

Appendix H Results of Experiment 6

XK-03, FIRST coal, Petch Thai Limestone, and Dhebkaset Bentonite were mixed by using the molar ratios C/Fe = 1.6, Limestone/Al_2O_3+SiO_2 = 0.65, and Bentonite/Fe = 0.035. The reduction condition is shown in Table H1.

Table H1 Experiment 6; the reduction condition.

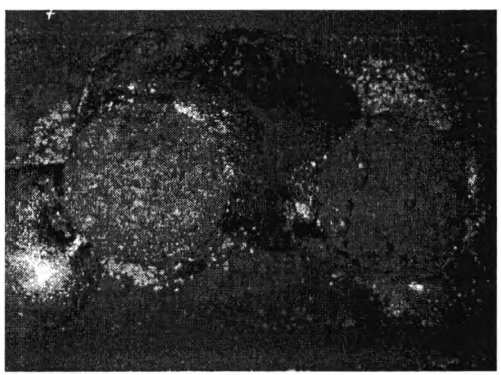
No.	Reduction Temperature (°C)	Soaking Time at Desire Temperature (mins)
1	1300	45
2		75
3		90

The weight of sample after reduction is shown in Table H2.

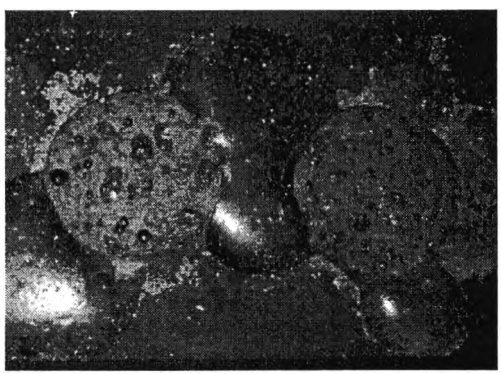
Table H2 Experiment 6; the weight of sample No.1-3 after reduction

No.	Reduction Temperature (°C)	Time (min)			Weight of 3 pellets (g)		
		Heating Time (from room temperature)	Soaking Time	Cooling Time (hr)	Before Reduction	After Reduction	
						Iron Nugget	Slag
1	1300	120	45	24	162.81	49.32	52.42
2			75		161.97	41.42	53.21
3			90		156.40	35.03	54.48

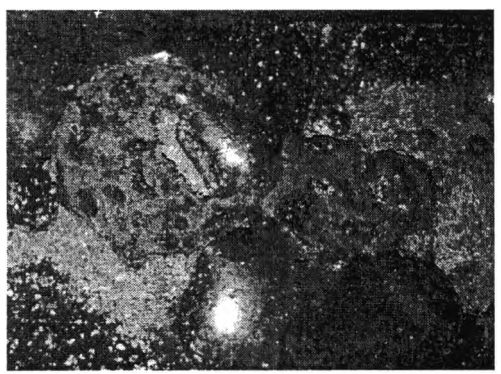
Products from the reduction were characterized %weight of element by EDX (Horiba, model 51-ADD0014); the characterization result is shown in Appendix A2. The appearances of the products are shown in Figure H1. Table H3 shows the %weight of element of samples No.1-3 in the experiment 6. The % yields of No.1-3 are shown in Table H4.



No.1, Reduction Time = 45 min



No.2, Reduction Time = 75 min



No.3, Reduction Time = 90 min

Figure H1 Experiment 6; the pellets after the reduction.

Table H3 Experiment 6; %weight element of No.1-3 after reduction

Element	% wt of element					
	1		2		3	
	Iron Nugget	Slag	Iron Nugget	Slag	Iron Nugget	Slag
C	3.72±4.05	4.15±2.89	0.71±0.47	6.65±3.16	0.76±0.38	4.97±2.53
O	13.23±1.97	36.58±1.65	11.33±4.3	42.34±1.17	5.50±4.45	31.30±1.23
Na	0.27±0.29	0.00	0.00	0.00	0.11±0.19	0.00
Mg	0.04±0.06	0.22±0.07	0.00	0.31±0.01	0.00	0.16±0.05
Al	0.00	4.16±0.41	0.05±0.06	5.22±0.1	0.08±0.04	3.26±0.25
Si	1.13±1.95	9.09±0.96	0.06±0.08	13.31±0.43	0.12±0.04	9.00±0.66
P	0.03±0.06	1.17±0.09	0.01±0.02	0.04±0.06	0.00	0.22±0.27
S	0.42±0.3	0.00	0.07±0.07	0.08±0.03	0.4±0.64	0.14±0.06
Cl	0.00	0.00	0.00	0.00	0.00	0.00
K	0.71±0.52	3.08±0.26	0.15±0.17	2.22±0.48	0.90±1.27	0.93±0.1
Ca	1.22±1.26	15.16±1.2	0.01±0.01	19.40±1.87	0.05±0.05	19.68±1.87
Ti	0.03±0.06	0.41±0.03	0.00	0.38±0.02	0.00	0.33±0.02
Cr	0.00	0.00	0.00	0.00	0.00	0.00
Mn	3.56±2.92	2.78±0.25	0.84±0.9	5.70±0.46	1.41±0.84	5.09±0.44
Fe	75.64±4.77	20.64±1.57	86.60±4.13	1.34±0.32	90.67±3.89	20.15±5.13
Ni	0.00	0.00	0.05±0.08	0.00	0.00	0.00
Cu	0.00	2.35±0.07	0.13±0.17	2.65±0.11	0.00	3.85±0.32
Zn	0.00	0.00	0.00	0.00	0.00	0.00
Zr	0.00	0.21±0.22	0.00	0.38±0.11	0.00	0.91±0.35
Cs	0.00	0.00	0.00	0.00	0.00	0.00

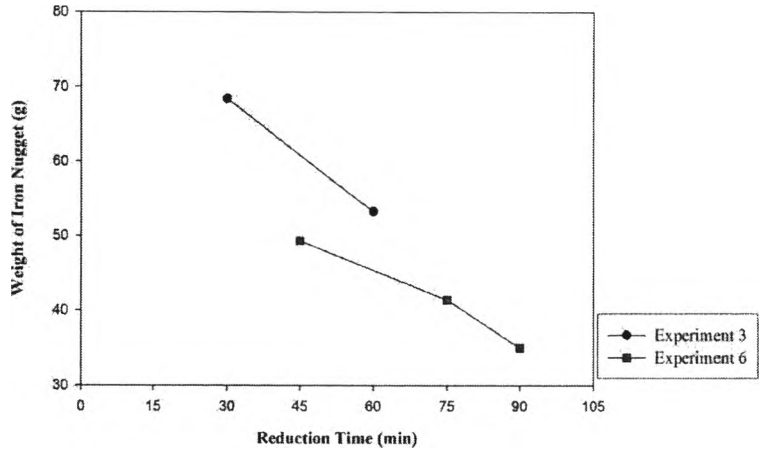


Figure H2 Experiment 3 and 6, Weight of iron nugget vs Reduction Time.

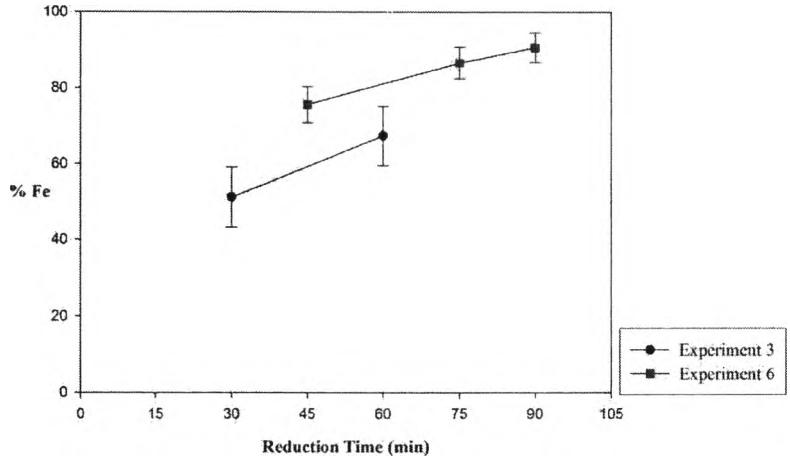


Figure H3 Experiment 3 and 6, % Fe of iron nugget vs Reduction Time.

From Figure H2 and H3, an increase the reduction time increases the wt % of Fe and decreases the weight of iron nuggets. From experiment 3, at the reduction time of 30 minutes, the weight of iron nugget is 68.43 g and contains 51.17% of Fe. When the reduction time increases to 60 minutes. The weight of iron nugget decreases from 68.43 to 53.28 and wt % Fe increases from 51.17% to 67.35%. From experiment 6, at the reduction time of 45 minutes, the weight of iron nugget is 49.32 g and contains 75.64% of Fe. Increasing the reduction time to 90 minutes, the weight decreases to 35.03 g and wt % Fe increases to 90.67%.

Table H4 Experiment 6; % Yield of No.1-3 after reduction

No.	%wt Iron ore in mixture	%wt Fe in mixture	Dried weight of pellet (g)	Fe input (g)	%Fe Nugget from EDX	Iron Nugget (g)	Fe Output (g)	%Yield
1	64.17	26.71	162.81	43.48	75.64	49.32	37.31	85.80
2			161.97	43.26	86.60	41.42	35.87	82.91
3			156.40	41.77	90.67	35.03	31.76	76.04

Appendix I Results of Experiment 7

XK-03, FIRST coal, Petch Thai Limestone, and Dhebkaset Bentonite were mixed by using the molar ratios as shown in Table I1. The pellets were dried at 80 °C, 20 hours. The results are shown in Table I2.

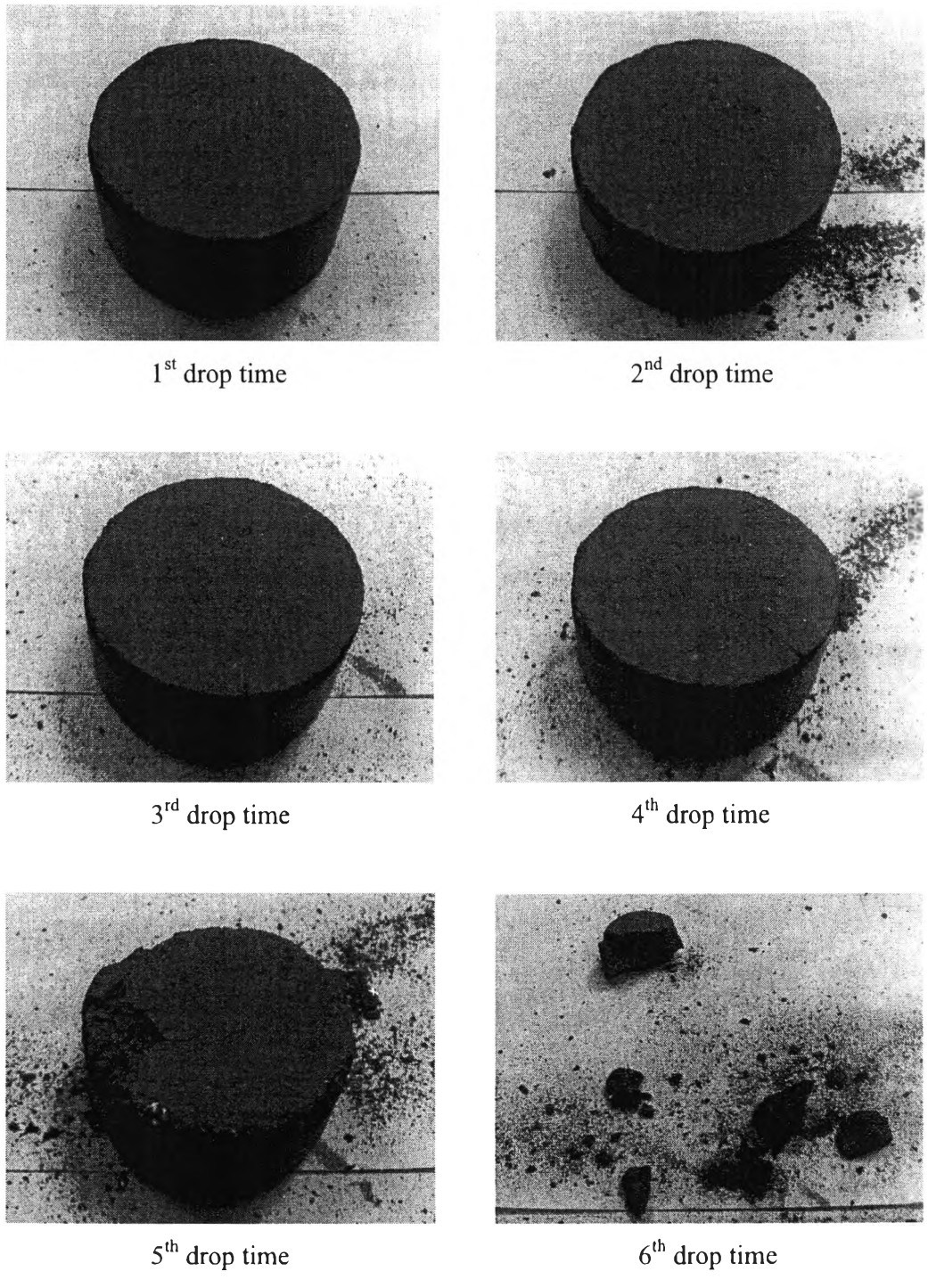
Table I1 Experiment 7; the mole ratio of mixture

No.	Mol ratio				Weight (g)				
	Fe	C/Fe	Limestone/Al_2O_3+SiO_2	Bentonite/Fe	XK-03	FIRST Coal	Limestone	Bentonite	Water
1	1	1.6	0.65	0.025	200	43.86	63.49	3.10	30
2									
3									
4				0.035				4.34	
5									
6									
7				0.045				5.58	
8									
9									

Table I2 Experiment 7; results of drop test at room temperature

Mol ratio Bentonite/Fe	Sample	Drop Time					
		1	2	3	4	5	6
0.025	1	Perfect	Nick	Crack	Break		
	2	Perfect	Nick	Break			
	3	Perfect	Crack	Break			
0.035	4	Perfect	Nick	Nick	Nick	Break	
	5	Perfect	Perfect	Perfect	Crack	Crack	Break
	6	Perfect	Perfect	Nick	Break		
0.045	7	Perfect	Nick	Nick	Break		
	8	Perfect	Nick	Crack	Crack	Break	
	9	Perfect	Perfect	Nick	Nick	Crack	Break

From Experiment 7, with the drying condition at 80 ^{o}C, 20 hrs and one meter height, the pellet was broken within 6 drops. The best result is mol ratio of Bentonite/Fe = 0.035. Figure I1 shows the appearances of the pellets No.5.



1st drop time

2nd drop time

3rd drop time

4th drop time

5th drop time

6th drop time

Figure I1 Appearances of the sample No.5 (the best sample) from drop test.

Appendix J Raw Data

J.1 Energy Dispersive X-Ray Fluorescence Spectrometer (EDXRF)

Samples were characterized for wt % of elements by EDX (Horiba, model 51-ADD0014), an Energy Dispersive X-Ray Fluorescence Spectrometer (Hitachi, model S-4800), connected to a scanning electron microscope. The samples were ground into fine particles (0.043 mm in average diameter as shown in Table A-1). The SEM accelerating voltage and current were 25 kV and 20 μA, respectively. The magnification was 100X. The pellets were stacked onto stubs by using sticker carbon papers. The specimens were coated with platinum using an ion coating machine (Hitachi, model E-1010) for 90 sec, for enhancing the electron conductivity. The specimens were clamped on a holder and placed into a high vacuum SEM chamber for preventing the attenuation of X-ray by the air molecules. 3 measurements were taken from different parts of each sample. The peaks of platinum were subtracted out before calculating the total wt % element and the % atomic of the specimens.

J.1.1 Experiment 3

Table J1 Experiment 3 % wt of element of No.1 (1200°C, 30 min) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	18.81	15.64	18.11	17.52	1.67
O	30.31	33.48	30.70	31.50	1.73
Na	0.13	0.00	0.14	0.09	0.08
Mg	0.00	0.00	0.00	0.00	-
Al	1.53	2.85	2.52	2.30	0.69
Si	4.58	6.29	4.78	5.22	0.93
P	0.81	0.28	0.21	0.43	0.33
S	0.15	0.00	0.00	0.05	0.09
Cl	0.00	0.00	0.00	0.00	-
K	0.34	0.86	0.77	0.66	0.28
Ca	11.41	7.11	5.71	8.08	2.97
Ti	0.13	0.12	0.12	0.12	0.01
Cr	0.00	0.00	0.00	0.00	-
Mn	0.98	3.12	3.32	2.47	1.30
Fe	30.81	30.25	33.63	31.56	1.81
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J2 Experiment 3 % wt of element of No.1 (1200°C, 30 min) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	14.65	15.66	18.14	16.15	1.80
O	34.04	32.53	33.57	33.38	0.77
Na	0.12	0.00	0.17	0.10	0.09
Mg	0.00	0.00	0.00	0.00	-
Al	1.84	1.39	1.67	1.63	0.23
Si	5.53	4.18	4.52	4.74	0.70
P	0.27	0.18	0.24	0.23	0.05
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.71	0.52	0.85	0.69	0.17
Ca	8.43	6.08	7.49	7.33	1.18
Ti	0.16	0.00	0.12	0.09	0.08
Cr	0.00	0.00	0.00	0.00	-
Mn	1.41	1.57	1.65	1.54	0.12
Fe	32.83	37.90	31.58	34.10	3.35
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J3 Experiment 3 % wt of element of No.1 (1200°C, 30 min) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	19.25	22.23	19.60	20.36	1.63
O	31.50	30.66	33.37	31.84	1.39
Na	0.10	0.08	0.08	0.09	0.01
Mg	0.00	0.00	0.00	0.00	-
Al	2.31	1.85	2.44	2.20	0.31
Si	4.88	4.65	5.68	5.07	0.54
P	0.24	0.82	0.37	0.48	0.30
S	0.00	0.15	0.13	0.09	0.08
Cl	0.00	0.00	0.00	0.00	-
K	0.66	0.49	0.50	0.55	0.10
Ca	6.00	11.81	12.58	10.13	3.60
Ti	0.13	0.12	0.21	0.15	0.05
Cr	0.00	0.00	0.00	0.00	-
Mn	3.17	1.58	3.97	2.91	1.22
Fe	31.77	25.54	21.07	26.13	5.37
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J4 Experiment 3 % wt of element of No.2 (1200°C, 60 min) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	20.18	16.45	9.44	15.36	5.45
O	23.99	23.17	24.46	23.87	0.65
Na	0.32	0.82	0.78	0.64	0.28
Mg	0.00	0.00	0.00	0.00	-
Al	0.86	0.71	0.95	0.84	0.12
Si	1.97	1.34	3.30	2.20	1.00
P	0.00	0.00	0.00	0.00	-
S	0.51	1.00	0.95	0.82	0.27
Cl	0.00	0.00	0.00	0.00	-
K	0.98	1.91	1.85	1.58	0.52
Ca	3.37	2.50	4.70	3.52	1.11
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	1.30	0.83	1.45	1.19	0.32
Fe	46.53	51.26	52.12	49.97	3.01
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J5 Experiment 3 % wt of element of No.2 (1200°C, 60 min) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	17.97	16.43	15.46	16.62	1.27
O	34.91	36.75	34.76	35.47	1.11
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	2.42	2.55	2.44	2.47	0.07
Si	6.81	7.52	6.62	6.98	0.47
P	0.00	0.00	0.00	0.00	-
S	0.11	0.00	0.00	0.04	0.06
Cl	0.00	0.00	0.00	0.00	-
K	0.73	0.90	0.77	0.80	0.09
Ca	10.47	10.06	9.30	9.94	0.59
Ti	0.16	0.17	0.14	0.16	0.02
Cr	0.00	0.00	0.00	0.00	-
Mn	2.61	2.08	2.17	2.29	0.28
Fe	23.80	23.56	28.34	25.23	2.69
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J6 Experiment 3 % wt of element of No.2 (1200°C, 60 min) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	21.07	17.11	20.35	19.51	2.11
O	30.16	32.15	29.89	30.73	1.23
Na	0.17	0.00	0.25	0.14	0.13
Mg	0.00	0.00	0.00	0.00	-
Al	1.91	2.07	2.14	2.04	0.12
Si	3.60	3.87	3.87	3.78	0.16
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	1.11	0.93	1.26	1.10	0.17
Ca	3.89	5.55	4.17	4.54	0.89
Ti	0.13	0.19	0.00	0.11	0.10
Cr	0.00	0.00	0.00	0.00	-
Mn	2.01	3.35	2.50	2.62	0.68
Fe	35.96	34.76	35.57	35.43	0.61
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J7 Experiment 3 % wt of element of No.3 iron nugget (1300°C, 30 min) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	13.67	12.40	16.86	14.31	2.30
O	29.12	31.81	29.56	30.16	1.44
Na	1.76	1.33	0.35	1.15	0.72
Mg	0.00	0.00	0.00	0.00	-
Al	0.48	1.83	0.76	1.02	0.71
Si	1.03	2.86	1.30	1.73	0.99
P	0.00	0.00	0.16	0.05	0.09
S	2.33	2.09	0.58	1.67	0.95
Cl	0.00	0.00	0.00	0.00	-
K	3.90	4.05	1.18	3.04	1.62
Ca	1.49	4.39	1.66	2.51	1.63
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	2.02	3.08	1.80	2.30	0.68
Fe	44.19	36.17	45.79	42.05	5.15
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J8 Experiment 3 % wt of element of No.3 iron nugget (1300°C, 30 min) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	17.69	17.11	12.88	15.89	2.63
O	24.72	26.15	25.56	25.48	0.72
Na	0.00	0.00	1.37	0.46	0.79
Mg	0.00	0.00	0.00	0.00	-
Al	0.21	0.17	0.22	0.20	0.03
Si	0.44	0.34	0.25	0.34	0.10
P	0.00	0.00	0.00	0.00	-
S	0.24	0.22	1.35	0.60	0.65
Cl	0.00	0.00	0.00	0.00	-
K	0.45	0.38	1.92	0.92	0.87
Ca	0.54	0.33	0.46	0.44	0.11
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.76	0.59	1.46	0.94	0.46
Fe	54.95	54.70	54.52	54.72	0.22
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J9 Experiment 3 % wt of element of No.3 iron nugget (1300°C, 30 min) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	3.04	3.08	4.94	3.69	1.09
O	31.64	20.25	19.02	23.64	6.96
Na	5.61	2.35	4.87	4.28	1.71
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.29	0.00	0.10	0.17
Si	0.00	0.34	0.32	0.22	0.19
P	0.00	0.00	0.00	0.00	-
S	6.09	3.45	6.00	5.18	1.50
Cl	0.00	0.00	0.00	0.00	-
K	9.49	0.00	0.00	3.16	5.48
Ca	0.00	1.53	1.47	1.00	0.87
Ti	0.00	0.32	0.00	0.11	0.18
Cr	0.00	0.00	0.00	0.00	-
Mn	2.23	2.49	0.96	1.89	0.82
Fe	41.90	65.90	62.44	56.75	12.97
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J10 Experiment 3 % wt of element of No.3 slag (1300°C, 30 min) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	23.64	41.40	34.62	33.22	8.96
O	40.50	33.71	39.31	37.84	3.63
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	4.47	3.31	3.68	3.82	0.59
Si	10.52	7.61	8.46	8.86	1.50
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.98	0.75	0.73	0.82	0.14
Ca	13.73	9.60	9.66	11.00	2.37
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	5.10	3.62	3.55	4.09	0.88
Fe	1.07	0.00	0.00	0.36	0.62
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J11 Experiment 3 % wt of element of No.3 slag (1300°C, 30 min) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	30.01	30.65	21.58	27.41	5.06
O	54.92	43.22	31.28	43.14	11.82
Na	0.48	0.39	0.00	0.29	0.26
Mg	0.74	0.61	0.00	0.45	0.40
Al	2.46	3.17	2.70	2.78	0.36
Si	6.02	8.51	8.18	7.57	1.35
P	0.00	0.00	0.00	0.00	-
S	0.39	0.24	0.45	0.36	0.11
Cl	0.00	0.00	0.00	0.00	-
K	0.22	0.36	0.82	0.47	0.31
Ca	3.94	10.09	20.00	11.34	8.10
Ti	0.00	0.19	0.42	0.20	0.21
Cr	0.00	0.00	0.00	0.00	-
Mn	0.46	1.93	6.42	2.94	3.10
Fe	0.37	0.63	8.14	3.05	4.41
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J12 Experiment 3 % wt of element of No.3 slag (1300°C, 30 min) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	27.19	31.83	27.04	28.69	2.72
O	47.78	41.01	44.49	44.43	3.39
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	3.73	3.72	3.93	3.79	0.12
Si	9.37	9.56	10.24	9.72	0.46
P	0.00	0.00	0.00	0.00	-
S	0.14	0.00	0.12	0.09	0.08
Cl	0.00	0.00	0.00	0.00	-
K	0.66	0.74	0.74	0.71	0.05
Ca	8.62	9.88	10.15	9.55	0.82
Ti	0.00	0.16	0.19	0.12	0.10
Cr	0.00	0.00	0.00	0.00	-
Mn	2.53	3.11	3.10	2.91	0.33
Fe	0.00	0.00	0.00	0.00	-
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J13 Experiment 3 % wt of element of No.4 iron nugget (1300°C, 60 min) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	1.49	0.00	0.00	0.50	0.86
O	20.91	11.81	21.67	18.13	5.49
Na	3.68	1.57	2.33	2.53	1.07
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.00	0.00	1.28	0.43	0.74
P	0.00	0.00	0.00	0.00	-
S	4.69	2.61	3.66	3.65	1.04
Cl	0.00	0.00	0.00	0.00	-
K	7.49	4.17	5.71	5.79	1.66
Ca	0.00	0.76	1.48	0.75	0.74
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	4.42	3.04	3.57	3.68	0.70
Fe	57.32	76.04	60.29	64.55	10.06
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J14 Experiment 3 % wt of element of No.4 iron nugget (1300°C, 60 min) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	1.39	1.39	0.98	1.25	0.24
O	16.34	17.88	19.25	17.82	1.46
Na	1.39	0.00	0.00	0.46	0.80
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.00	0.00	0.00	0.00	-
P	0.00	0.00	0.00	0.00	-
S	2.62	0.19	0.33	1.05	1.36
Cl	0.00	0.00	0.00	0.00	-
K	4.03	0.34	0.45	1.61	2.10
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	2.55	0.80	1.53	1.63	0.88
Fe	71.68	79.39	77.46	76.18	4.01
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J15 Experiment 3 % wt of element of No.4 iron nugget (1300°C, 60 min) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	3.92	5.59	1.26	3.59	2.18
O	23.37	32.60	20.08	25.35	6.49
Na	3.06	1.16	0.94	1.72	1.17
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.00	0.21	0.00	0.07	0.12
P	0.00	0.00	0.00	0.00	-
S	3.44	1.00	0.97	1.80	1.42
Cl	0.00	0.00	0.00	0.00	-
K	4.99	1.65	1.53	2.72	1.96
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	5.31	0.24	4.73	3.43	2.77
Fe	55.91	57.55	70.48	61.31	7.98
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J16 Experiment 3 % wt of element of No.4 slag (1300°C, 60 min) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	20.01	25.77	23.43	23.07	2.90
O	38.70	34.70	35.45	36.28	2.13
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	4.49	4.18	3.98	4.22	0.26
Si	11.96	11.22	10.68	11.29	0.64
P	0.00	0.00	0.00	0.00	-
S	0.14	0.15	0.00	0.10	0.08
Cl	0.00	0.00	0.00	0.00	-
K	1.10	1.06	1.09	1.08	0.02
Ca	17.88	17.51	19.03	18.14	0.79
Ti	0.28	0.32	0.32	0.31	0.02
Cr	0.00	0.00	0.00	0.00	-
Mn	5.13	5.10	6.02	5.42	0.52
Fe	0.31	0.00	0.00	0.10	0.18
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J17 Experiment 3 % wt of element of No.4 slag (1300°C, 60 min) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	19.28	39.16	25.41	27.95	10.18
O	52.04	42.93	50.34	48.44	4.84
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	4.17	2.58	3.73	3.49	0.82
Si	11.00	6.53	8.96	8.83	2.24
P	0.00	0.00	0.00	0.00	-
S	0.27	0.24	0.30	0.27	0.03
Cl	0.00	0.00	0.50	0.17	0.29
K	0.00	0.48	0.50	0.33	0.28
Ca	11.13	6.71	8.52	8.79	2.22
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	2.11	1.36	1.73	1.73	0.38
Fe	0.00	0.00	0.00	0.00	-
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J18 Experiment 3 % wt of element of No.4 slag (1300°C, 60 min) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	15.47	14.14	13.91	14.51	0.84
O	45.42	49.31	46.09	46.94	2.08
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	4.95	5.01	5.06	5.01	0.06
Si	12.84	12.54	13.13	12.84	0.30
P	0.00	0.00	0.00	0.00	-
S	0.19	0.19	0.18	0.19	0.01
Cl	0.00	0.00	0.00	0.00	-
K	1.01	0.90	1.03	0.98	0.07
Ca	16.25	14.45	16.35	15.68	1.07
Ti	0.00	0.00	0.26	0.09	0.15
Cr	0.00	0.00	0.00	0.00	-
Mn	3.86	3.46	4.00	3.77	0.28
Fe	0.00	0.00	0.00	0.00	-
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

J.1.2 Experiment 4

Table J19 Experiment 4 % wt of element of No.1 iron nugget (C/Fe = 1.4) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.84	0.89	0.00	0.58	0.50
O	23.76	3.63	14.26	13.88	10.07
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.00	0.00	0.00	0.00	-
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.00	0.00	-
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.00	0.00	0.00	0.00	-
Fe	75.40	95.48	85.74	85.54	10.04
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J20 Experiment 4 % wt of element of No.1 iron nugget (C/Fe = 1.4) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.00	0.00	0.00	0.00	-
O	29.63	24.11	9.93	21.22	10.16
Na	0.00	1.09	0.60	0.56	0.55
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.11	0.04	0.06
Si	0.00	0.00	0.22	0.07	0.13
P	0.00	0.00	0.00	0.00	-
S	0.23	0.70	1.04	0.66	0.41
Cl	0.00	0.00	0.00	0.00	-
K	0.49	1.13	2.64	1.42	1.10
Ca	0.00	0.00	0.16	0.05	0.09
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.48	1.80	5.32	2.53	2.50
Fe	69.18	71.16	79.98	73.44	5.75
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J21 Experiment 4 % wt of element of No.1 iron nugget (C/Fe = 1.4) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.00	0.00	0.00	0.00	-
O	34.52	22.78	19.09	25.46	8.06
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.00	0.00	0.00	0.00	-
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.20	0.07	0.12
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.40	0.13	0.23
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.36	0.00	1.94	0.77	1.03
Fe	65.11	77.22	78.36	73.56	7.34
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J22 Experiment 4 % wt of element of No.1 slag (C/Fe = 1.4)
1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	20.28	14.81	33.82	22.97	9.79
O	33.43	33.72	29.32	32.16	2.46
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	4.35	5.03	4.84	4.74	0.35
Si	12.59	13.44	9.26	11.76	2.21
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	1.06	1.29	0.77	1.04	0.26
Ca	21.51	23.93	16.28	20.57	3.91
Ti	0.32	0.33	0.26	0.30	0.04
Cr	0.00	0.00	0.00	0.00	-
Mn	5.97	6.58	4.50	5.68	1.07
Fe	0.00	0.33	0.34	0.22	0.19
Ni	0.00	0.00	0.00	0.00	-
Cu	0.48	0.55	0.61	0.55	0.07
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J23 Experiment 4 % wt of element of No.1 slag (C/Fe = 1.4)
2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	17.12	21.40	21.51	20.01	2.50
O	37.78	36.06	37.04	36.96	0.86
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	4.63	4.45	4.26	4.45	0.19
Si	13.21	12.36	12.19	12.59	0.55
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	1.29	1.24	1.16	1.23	0.07
Ca	19.07	17.91	17.61	18.20	0.77
Ti	0.31	0.32	0.26	0.30	0.03
Cr	0.00	0.00	0.00	0.00	-
Mn	5.94	5.60	5.38	5.64	0.28
Fe	0.33	0.37	0.33	0.34	0.02
Ni	0.00	0.00	0.00	0.00	-
Cu	0.32	0.30	0.27	0.30	0.03
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J24 Experiment 4 % wt of element of No.1 slag (C/Fe = 1.4)
3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	15.27	8.14	15.51	12.97	4.19
O	44.11	45.81	43.09	44.34	1.37
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	4.05	4.60	4.17	4.27	0.29
Si	12.27	13.87	12.64	12.93	0.84
P	0.00	0.00	0.00	0.00	-
S	0.53	0.48	0.34	0.45	0.10
Cl	0.00	0.00	0.00	0.00	-
K	0.99	1.11	1.05	1.05	0.06
Ca	17.79	20.34	18.18	18.77	1.37
Ti	0.32	0.45	0.35	0.37	0.07
Cr	0.00	0.00	0.00	0.00	-
Mn	4.03	4.46	3.97	4.15	0.27
Fe	0.28	0.31	0.32	0.30	0.02
Ni	0.00	0.00	0.00	0.00	-
Cu	0.35	0.42	0.36	0.38	0.04
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J25 Experiment 4 % wt of element of No.2 iron nugget (C/Fe = 1.6)
1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.00	0.00	0.00	0.00	-
O	18.74	24.72	26.22	23.23	3.96
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.33	0.00	0.44	0.26	0.23
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.00	0.00	-
Ca	0.25	0.00	0.22	0.16	0.14
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.88	0.36	0.52	0.59	0.27
Fe	79.80	74.92	72.59	75.77	3.68
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J26 Experiment 4 % wt of element of No.2 iron nugget (C/Fe = 1.6) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.17	1.79	0.00	0.65	0.99
O	6.38	2.34	10.91	6.54	4.29
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.11	0.09	0.00	0.07	0.06
Si	0.26	0.50	0.00	0.25	0.25
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.00	0.00	-
Ca	0.20	0.86	0.00	0.35	0.45
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.00	0.00	0.00	0.00	-
Fe	92.87	94.42	89.09	92.13	2.74
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J27 Experiment 4 % wt of element of No.2 iron nugget (C/Fe = 1.6) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.00	0.00	0.00	0.00	-
O	3.26	10.83	1.53	5.21	4.95
Na	0.63	1.48	0.25	0.79	0.63
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.20	0.00	0.07	0.12
Si	0.00	0.32	0.00	0.11	0.18
P	0.00	0.00	0.00	0.00	-
S	0.67	1.33	0.35	0.78	0.50
Cl	0.00	0.00	0.00	0.00	-
K	1.34	1.93	1.23	1.50	0.38
Ca	0.17	0.47	0.30	0.31	0.15
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	3.71	4.90	5.01	4.54	0.72
Fe	90.23	78.54	91.33	86.70	7.09
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J28 Experiment 4 % wt of element of No.2 slag (C/Fe = 1.6)
1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	21.82	29.48	18.11	23.14	5.80
O	33.51	28.66	32.94	31.70	2.65
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	4.19	3.68	4.33	4.07	0.34
Si	12.27	10.31	12.50	11.69	1.20
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	1.41	1.10	1.24	1.25	0.16
Ca	19.22	18.91	21.91	20.01	1.65
Ti	0.34	0.29	0.28	0.30	0.03
Cr	0.00	0.00	0.00	0.00	-
Mn	5.04	5.30	6.02	5.45	0.51
Fe	0.97	0.90	1.10	0.99	0.10
Ni	0.00	0.00	0.00	0.00	-
Cu	1.24	1.37	1.58	1.40	0.17
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J29 Experiment 4 % wt of element of No.2 slag (C/Fe = 1.6)
2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	17.80	11.01	9.50	12.77	4.42
O	38.27	38.85	39.67	38.93	0.70
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	4.44	4.79	4.98	4.74	0.27
Si	12.10	13.03	13.95	13.03	0.93
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	1.43	1.40	1.47	1.43	0.04
Ca	17.82	19.65	20.54	19.34	1.39
Ti	0.32	0.36	0.36	0.35	0.02
Cr	0.00	0.00	0.00	0.00	-
Mn	5.88	6.78	6.90	6.52	0.56
Fe	0.63	2.80	1.12	1.52	1.14
Ni	0.00	0.00	0.00	0.00	-
Cu	1.32	1.32	1.50	1.38	0.10
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J30 Experiment 4 % wt of element of No.2 slag (C/Fe = 1.6)
3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	35.44	28.34	2.61	22.13	17.27
O	34.09	40.02	45.27	39.79	5.59
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	3.60	4.13	6.37	4.70	1.47
Si	10.24	11.24	17.67	13.05	4.03
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.72	0.81	1.26	0.93	0.29
Ca	11.94	11.77	20.13	14.61	4.78
Ti	0.21	0.18	0.28	0.22	0.05
Cr	0.00	0.00	0.00	0.00	-
Mn	2.96	2.70	5.11	3.59	1.32
Fe	0.00	0.00	0.00	0.00	-
Ni	0.00	0.00	0.00	0.00	-
Cu	0.81	0.81	1.31	0.98	0.29
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J31 Experiment 4 % wt of element of No.3 iron nugget (C/Fe = 1.8)
1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.00	0.00	0.00	0.00	-
O	6.81	11.62	25.23	14.55	9.55
Na	0.00	0.00	0.77	0.26	-
Mg	0.00	0.00	0.00	0.00	-
Al	1.61	0.00	0.00	0.54	-
Si	3.27	0.51	0.00	1.26	1.76
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.86	0.29	-
Cl	0.00	0.00	0.00	0.00	-
K	0.30	0.00	1.29	0.53	-
Ca	1.87	0.30	0.00	0.72	1.00
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	5.15	2.00	0.35	2.50	2.44
Fe	81.00	85.57	71.50	79.36	7.18
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J32 Experiment 4 % wt of element of No.3 iron nugget (C/Fe = 1.8) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	1.96	3.49	0.00	1.82	1.75
O	14.19	8.37	12.89	11.82	3.05
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.34	0.18	0.00	0.17	0.17
Si	0.54	0.34	0.28	0.39	0.14
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.00	0.00	-
Ca	0.41	0.23	0.29	0.31	0.09
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.46	0.00	0.00	0.15	0.27
Fe	82.10	87.39	86.54	85.34	2.84
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J33 Experiment 4 % wt of element of No.3 iron nugget (C/Fe = 1.8) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.00	0.00	1.37	0.46	0.79
O	20.37	17.44	5.93	14.58	7.63
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.00	0.00	0.00	0.00	-
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	0.00
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.00	0.00	0.00
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.00	0.00	0.61	0.20	0.35
Fe	79.63	82.56	92.09	84.76	6.51
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J34 Experiment 4 % wt of element of No.3 slag (C/Fe = 1.8)
1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	31.49	29.27	29.56	30.11	1.21
O	32.36	38.46	32.62	34.48	3.45
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	2.35	2.19	1.77	2.10	0.30
Si	7.99	8.10	7.75	7.95	0.18
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.69	0.52	0.51	0.57	0.10
Ca	16.19	14.04	17.09	15.77	1.57
Ti	0.34	0.00	0.00	0.11	0.20
Cr	0.00	0.00	0.00	0.00	-
Mn	3.61	2.46	3.62	3.23	0.67
Fe	0.71	0.00	0.00	0.24	0.41
Ni	0.00	0.00	0.00	0.00	-
Cu	4.28	4.96	7.07	5.44	1.45
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J35 Experiment 4 % wt of element of No.3 slag (C/Fe = 1.8)
2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	37.22	32.77	33.54	34.51	2.38
O	43.90	48.23	46.39	46.17	2.17
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	3.02	3.48	3.15	3.22	0.24
Si	7.47	7.59	7.92	7.66	0.23
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.35	0.32	0.36	0.34	0.02
Ca	6.16	5.75	6.36	6.09	0.31
Ti	0.00	0.00	0.15	0.05	0.09
Cr	0.00	0.00	0.00	0.00	-
Mn	1.24	1.17	1.33	1.25	0.08
Fe	0.00	0.00	0.79	0.26	0.46
Ni	0.00	0.00	0.00	0.00	-
Cu	0.63	0.68	0.00	0.44	0.38
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J36 Experiment 4 % wt of element of No.3 slag (C/Fe = 1.8)
3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	30.57	29.36	32.78	30.90	1.73
O	43.02	46.42	46.55	45.33	2.00
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	3.58	3.74	3.18	3.50	0.29
Si	9.08	9.17	7.84	8.70	0.74
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.57	0.51	0.39	0.49	0.09
Ca	9.42	8.22	6.82	8.15	1.30
Ti	0.20	0.00	0.00	0.07	0.12
Cr	0.00	0.00	0.00	0.00	-
Mn	2.49	1.85	1.65	2.00	0.44
Fe	0.22	0.00	0.00	0.07	0.13
Ni	0.00	0.00	0.00	0.00	-
Cu	0.84	0.72	0.80	0.79	0.06
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J37 Experiment 4 % wt of element of No.4 iron nugget (C/Fe = 2.0)
1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.00	0.00	0.79	0.26	0.46
O	19.90	2.54	4.73	9.06	9.45
Na	0.40	0.00	0.30	0.23	0.21
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.09	0.03	0.05
Si	0.00	0.00	0.20	0.07	0.12
P	0.00	0.00	0.00	0.00	-
S	0.63	0.00	0.29	0.31	0.32
Cl	0.00	0.00	0.00	0.00	-
K	1.09	0.22	0.46	0.59	0.45
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	1.77	1.97	2.06	1.93	0.15
Fe	76.20	95.28	91.08	87.52	10.03
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J38 Experiment 4 % wt of element of No.4 iron nugget (C/Fe = 2.0) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.00	0.00	0.00	0.00	-
O	18.47	19.51	16.61	18.20	1.47
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.00	0.00	0.17	0.06	0.10
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.00	0.00	-
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.41	0.31	0.38	0.37	0.05
Fe	81.12	80.18	82.84	81.38	1.35
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	0.00

Table J39 Experiment 4 % wt of element of No.4 iron nugget (C/Fe = 2.0) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.00	0.00	0.00	0.00	-
O	8.69	23.20	17.92	16.60	7.34
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.10	0.00	0.00	0.03	0.06
Si	0.14	0.00	0.00	0.05	0.08
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.00	0.00	-
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.66	0.33	0.00	0.33	0.33
Fe	90.42	76.46	82.08	82.99	7.02
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J40 Experiment 4 % wt of element of No.4 slag (C/Fe = 2.0)
1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	34.18	13.05	11.22	19.48	12.76
O	23.07	35.04	36.17	31.43	7.26
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	3.07	4.03	4.35	3.82	0.67
Si	9.52	13.66	13.97	12.38	2.48
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	1.36	0.96	0.93	1.08	0.24
Ca	20.14	23.65	23.59	22.46	2.01
Ti	0.00	0.51	0.45	0.32	0.28
Cr	0.00	0.00	0.00	0.00	-
Mn	6.06	5.71	5.80	5.86	0.18
Fe	0.00	1.18	1.27	0.82	0.71
Ni	0.00	0.00	0.00	0.00	-
Cu	2.58	2.20	2.24	2.34	0.21
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J41 Experiment 4 % wt of element of No.4 slag (C/Fe = 2.0)
2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	17.93	10.69	8.91	12.51	4.78
O	33.69	34.69	36.73	35.04	1.55
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	4.38	4.62	4.90	4.63	0.26
Si	12.26	13.43	13.87	13.19	0.83
P	0.00	0.00	0.00	0.00	-
S	0.28	0.00	0.00	0.09	0.16
Cl	0.00	0.00	0.00	0.00	-
K	2.75	2.03	2.24	2.34	0.37
Ca	19.50	24.00	23.13	22.21	2.39
Ti	0.67	0.58	0.70	0.65	0.06
Cr	0.00	0.00	0.00	0.00	-
Mn	6.14	7.59	7.16	6.96	0.74
Fe	0.90	0.67	0.81	0.79	0.12
Ni	0.00	0.00	0.00	0.00	-
Cu	1.50	1.69	1.55	1.58	0.10
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J42 Experiment 4 % wt of element of No.4 slag (C/Fe = 2.0)
3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	21.86	21.04	23.78	22.23	1.41
O	35.55	29.85	27.69	31.03	4.06
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	3.48	3.34	2.08	2.97	0.77
Si	10.47	10.03	7.29	9.26	1.72
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.88	0.53	0.22	0.54	0.33
Ca	15.74	18.98	15.70	16.81	1.88
Ti	0.76	0.45	0.26	0.49	0.25
Cr	0.00	0.00	0.00	0.00	-
Mn	8.40	10.17	19.29	12.62	5.84
Fe	0.82	2.56	1.45	1.61	0.88
Ni	0.00	0.00	0.00	0.00	-
Cu	2.03	3.04	2.23	2.43	0.53
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J43 Experiment 4 % wt of element of No.5 iron nugget (C/Fe = 2.2)
1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	9.13	18.42	0.00	9.18	9.21
O	7.47	6.95	7.70	7.37	0.38
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.15	0.12	0.40	0.22	0.15
Si	0.29	0.23	0.69	0.40	0.25
P	0.00	0.00	0.13	0.04	0.08
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.12	0.11	0.17	0.13	0.03
Ca	0.63	0.20	0.61	0.48	0.24
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	2.11	0.79	1.83	1.58	0.70
Fe	80.09	73.19	88.47	80.58	7.65
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J44 Experiment 4 % wt of element of No.5 iron nugget (C/Fe = 2.2) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.00	0.00	0.00	0.00	-
O	12.57	30.43	24.88	22.63	9.14
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.00	0.00	0.00	0.00	-
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.00	0.00	-
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.00	0.00	0.66	0.22	0.38
Fe	87.43	69.57	74.46	77.15	9.23
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J45 Experiment 4 % wt of element of No.5 iron nugget (C/Fe = 2.2) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.00	0.00	12.59	4.20	7.27
O	35.14	7.03	12.06	18.08	14.99
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.23	0.08	0.13
Si	0.00	0.12	1.12	0.41	0.61
P	0.00	0.00	0.00	0.00	-
S	0.00	0.18	0.00	0.06	0.10
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.54	0.17	0.24	0.28
Ca	0.00	0.00	1.52	0.51	0.88
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.82	1.14	2.34	1.43	0.80
Fe	64.05	91.00	69.96	75.00	14.17
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J46 Experiment 4 % wt of element of No.5 slag (C/Fe = 2.2)
1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	10.83	18.71	15.65	15.06	3.97
O	34.93	33.59	33.38	33.97	0.84
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	5.07	4.50	4.69	4.75	0.29
Si	14.81	13.04	13.63	13.83	0.90
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	1.09	1.02	1.11	1.07	0.05
Ca	24.25	21.20	22.92	22.79	1.53
Ti	0.40	0.33	0.40	0.38	0.04
Cr	0.00	0.00	0.00	0.00	-
Mn	7.06	6.11	6.63	6.60	0.48
Fe	0.48	0.54	0.49	0.50	0.03
Ni	0.00	0.00	0.00	0.00	-
Cu	1.07	0.95	1.11	1.04	0.08
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J47 Experiment 4 % wt of element of No.5 slag (C/Fe = 2.2)
2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	19.97	20.81	27.52	22.77	4.14
O	33.65	36.65	25.50	31.93	5.77
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	3.88	4.16	2.98	3.67	0.62
Si	11.28	11.55	8.81	10.55	1.51
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.86	0.83	0.96	0.88	0.07
Ca	21.50	19.12	23.05	21.22	1.98
Ti	0.30	0.27	0.35	0.31	0.04
Cr	0.00	0.00	0.00	0.00	-
Mn	5.71	4.76	6.66	5.71	0.95
Fe	1.13	0.75	1.31	1.06	0.29
Ni	0.00	0.00	0.00	0.00	-
Cu	1.72	1.11	2.85	1.89	0.88
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J48 Experiment 4 % wt of element of No.5 slag (C/Fe = 2.2)
3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	16.34	10.89	17.09	14.77	3.38
O	34.97	36.94	34.34	35.42	1.36
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	4.14	4.36	3.87	4.12	0.25
Si	12.26	12.70	11.34	12.10	0.69
P	0.00	0.00	0.00	0.00	-
S	0.11	0.97	1.48	0.85	0.69
Cl	0.00	0.00	0.00	0.00	-
K	1.02	1.12	0.93	1.02	0.10
Ca	22.39	22.24	20.43	21.69	1.09
Ti	0.34	0.42	0.36	0.37	0.04
Cr	0.00	0.00	0.00	0.00	-
Mn	5.92	7.92	8.75	7.53	1.45
Fe	1.51	1.47	0.57	1.18	0.53
Ni	0.00	0.00	0.00	0.00	-
Cu	0.99	0.98	0.84	0.94	0.08
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

J.1.3 Experiment 5

Table J49 Experiment 5 % wt of element of No.1 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.45) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	5.18	5.90	0.00	3.69	3.22
O	13.62	11.58	1.35	8.85	6.57
Na	2.22	4.59	0.00	2.27	2.30
Mg	0.00	0.00	0.00	0.00	-
Al	0.47	0.00	0.00	0.16	0.27
Si	0.21	0.00	0.20	0.14	0.12
P	0.00	0.00	0.17	0.06	0.10
S	3.45	8.13	0.64	4.07	3.78
Cl	0.00	0.00	0.00	0.00	-
K	4.56	11.11	1.62	5.76	4.86
Ca	2.79	0.84	10.51	4.71	5.11
Ti	0.20	0.00	0.00	0.07	0.12
Cr	0.00	0.00	0.00	0.00	-
Mn	3.34	5.41	6.26	5.00	1.50
Fe	63.73	52.24	79.26	65.08	13.56
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.24	0.21	0.00	0.15	0.13
Cs	0.00	0.00	0.00	0.00	-

Table J50 Experiment 5 % wt of element of No.1 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.45) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	3.46	4.62	0.00	2.69	2.40
O	1.67	17.47	10.56	9.90	7.92
Na	0.67	2.57	0.00	1.08	1.33
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.00	0.00	1.07	0.36	0.62
P	0.00	0.00	0.00	0.00	-
S	6.70	4.05	1.72	4.16	2.49
Cl	0.00	0.00	0.00	0.00	-
K	12.21	6.46	8.64	9.10	2.90
Ca	1.21	0.55	0.00	0.59	0.61
Ti	0.00	0.21	0.00	0.07	0.12
Cr	0.00	0.00	0.00	0.00	-
Mn	4.38	5.79	3.39	4.52	1.21
Fe	69.55	58.08	74.62	67.42	8.47
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.15	0.20	0.00	0.12	0.10
Cs	0.00	0.00	0.00	0.00	-

Table J51 Experiment 5 % wt of element of No.1 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.45) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	1.94	1.82	0.82	1.53	0.61
O	22.98	22.74	23.02	22.91	0.15
Na	0.74	0.72	0.71	0.72	0.02
Mg	0.00	0.00	0.00	0.00	-
Al	0.17	0.00	0.19	0.12	0.10
Si	0.24	0.23	0.15	0.21	0.05
P	0.00	0.00	0.00	0.00	-
S	0.75	0.76	0.80	0.77	0.03
Cl	0.00	0.00	0.00	0.00	-
K	1.00	0.95	0.98	0.98	0.03
Ca	0.00	0.00	0.17	0.06	0.10
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.65	0.67	0.67	0.66	0.01
Fe	71.52	72.12	72.49	72.04	0.49
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J52 Experiment 5 % wt of element of No.1 slag (Limestone/Al_2O_3+SiO_2 = 0.45) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	15.66	12.35	12.73	13.58	1.81
O	42.63	43.30	45.02	43.65	1.23
Na	0.00	0.00	0.00	0.00	-
Mg	0.30	0.30	0.31	0.30	0.01
Al	5.22	5.49	5.46	5.39	0.15
Si	14.71	15.79	15.36	15.29	0.54
P	0.00	0.00	0.00	0.00	-
S	0.18	0.19	0.16	0.18	0.02
Cl	0.00	0.00	0.00	0.00	-
K	1.26	1.39	1.39	1.35	0.08
Ca	11.68	12.66	11.64	11.99	0.58
Ti	0.27	0.29	0.30	0.29	0.02
Cr	0.00	0.00	0.00	0.00	-
Mn	5.43	5.70	5.21	5.45	0.25
Fe	0.49	0.52	0.45	0.49	0.04
Ni	0.00	0.00	0.00	0.00	-
Cu	1.51	1.46	1.39	1.45	0.06
Zn	0.00	0.00	0.00	0.00	-
Zr	0.66	0.56	0.60	0.61	0.05
Cs	0.00	0.00	0.00	0.00	-

Table J53 Experiment 5 % wt of element of No.1 slag (Limestone/Al_2O_3+SiO_2 = 0.45) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	19.24	17.79	19.66	18.90	0.98
O	34.79	38.75	31.33	34.96	3.71
Na	0.00	0.00	0.00	0.00	-
Mg	0.18	0.27	0.22	0.22	0.05
Al	4.18	4.26	3.95	4.13	0.16
Si	12.43	12.73	12.19	12.45	0.27
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	1.63	1.58	1.78	1.66	0.10
Ca	14.25	12.91	15.76	14.31	1.43
Ti	0.36	0.32	0.48	0.39	0.08
Cr	0.00	0.00	0.00	0.00	-
Mn	7.67	6.86	9.12	7.88	1.15
Fe	1.07	0.80	1.15	1.01	0.18
Ni	0.00	0.00	0.00	0.00	-
Cu	2.92	2.72	3.13	2.92	0.21
Zn	0.00	0.00	0.00	0.00	-
Zr	1.27	1.02	1.22	1.17	0.13
Cs	0.00	0.00	0.00	0.00	-

Table J54 Experiment 5 % wt of element of No.1 slag (Limestone/Al_2O_3+SiO_2 = 0.45) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	10.30	13.50	9.31	11.04	2.19
O	41.02	40.53	42.51	41.35	1.03
Na	0.00	0.00	0.00	0.00	-
Mg	0.29	0.29	0.31	0.30	0.01
Al	5.44	5.30	5.65	5.46	0.18
Si	16.09	15.05	16.38	15.84	0.70
P	0.00	0.00	0.00	0.00	-
S	0.24	0.25	0.24	0.24	0.01
Cl	0.00	0.00	0.00	0.00	-
K	1.58	1.54	1.54	1.55	0.02
Ca	14.98	14.10	14.57	14.55	0.44
Ti	0.38	0.35	0.38	0.37	0.02
Cr	0.00	0.00	0.00	0.00	-
Mn	6.42	6.04	6.25	6.24	0.19
Fe	0.37	0.43	0.37	0.39	0.03
Ni	0.00	0.00	0.00	0.00	-
Cu	1.88	1.91	1.70	1.83	0.11
Zn	0.00	0.00	0.00	0.00	-
Zr	1.02	0.70	0.79	0.84	0.17
Cs	0.00	0.00	0.00	0.00	-

Table J55 Experiment 5 % wt of element of No.2 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.55) 1st specimen

Element	%Weigh				
	1	2	3	Avg	SD
C	1.29	5.10	15.99	7.46	7.63
O	5.66	9.25	14.05	9.65	4.21
Na	0.00	2.44	4.61	2.35	2.31
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	1.25	0.00	0.00	0.42	0.72
P	0.00	0.00	0.00	0.00	-
S	0.14	4.95	3.10	2.73	2.43
Cl	0.00	0.00	0.00	0.00	-
K	0.22	8.56	3.71	4.16	4.19
Ca	11.73	0.35	0.00	4.03	6.67
Ti	0.00	0.26	0.00	0.09	0.15
Cr	0.00	0.00	0.00	0.00	-
Mn	7.18	1.62	0.24	3.01	3.67
Fe	72.53	67.36	58.30	66.06	7.20
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.12	0.00	0.04	0.07
Cs	0.00	0.00	0.00	0.00	-

Table J56 Experiment 5 % wt of element of No.2 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.55) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	3.05	2.95	3.99	3.33	0.57
O	17.64	17.69	18.25	17.86	0.34
Na	0.47	0.40	0.00	0.29	0.25
Mg	0.00	0.00	0.00	0.00	-
Al	0.20	0.00	0.19	0.13	0.11
Si	0.22	0.23	0.00	0.15	0.13
P	0.00	0.00	0.00	0.00	-
S	0.32	0.30	0.00	0.21	0.18
Cl	0.00	0.00	0.00	0.00	-
K	0.35	0.42	0.00	0.26	0.23
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.33	0.42	0.00	0.25	0.22
Fe	77.42	77.59	77.57	77.53	0.09
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J57 Experiment 5 % wt of element of No.2 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.55) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	2.93	3.92	1.87	2.91	1.03
O	18.43	18.94	18.97	18.78	0.30
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.20	0.18	0.00	0.13	0.11
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.00	0.00	-
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.00	0.00	0.39	0.13	0.23
Fe	78.44	76.96	78.77	78.06	0.96
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J58 Experiment 5 % wt of element of No.2 slag (Limestone/Al_2O_3+SiO_2 = 0.55) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	9.61	10.68	10.10	10.13	0.54
O	44.73	44.59	42.50	43.94	1.25
Na	0.00	0.00	0.00	0.00	-
Mg	0.34	0.33	0.30	0.32	0.02
Al	5.29	5.28	5.54	5.37	0.15
Si	14.55	14.03	14.65	14.41	0.33
P	0.00	0.00	0.00	0.00	-
S	0.51	0.54	0.51	0.52	0.02
Cl	0.00	0.00	0.00	0.00	-
K	1.32	1.30	1.43	1.35	0.07
Ca	13.61	13.42	14.57	13.87	0.62
Ti	0.24	0.28	0.30	0.27	0.03
Cr	0.00	0.00	0.00	0.00	-
Mn	5.48	5.33	5.57	5.46	0.12
Fe	0.99	0.84	1.04	0.96	0.10
Ni	0.00	0.00	0.00	0.00	-
Cu	2.09	2.09	2.14	2.11	0.03
Zn	0.00	0.00	0.00	0.00	-
Zr	1.24	1.29	1.34	1.29	0.05
Cs	0.00	0.00	0.00	0.00	-

Table J59 Experiment 5 % wt of element of No.2 slag (Limestone/Al_2O_3+SiO_2 = 0.55) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	10.19	11.30	10.22	10.57	0.63
O	33.23	34.70	34.47	34.13	0.79
Na	0.00	0.00	0.00	0.00	-
Mg	0.24	0.34	0.24	0.27	0.06
Al	4.61	4.74	4.71	4.69	0.07
Si	14.60	14.38	14.37	14.45	0.13
P	0.00	0.00	0.00	0.00	-
S	0.24	0.22	0.24	0.23	0.01
Cl	0.00	0.00	0.00	0.00	-
K	1.66	1.51	1.49	1.55	0.09
Ca	22.90	21.48	22.32	22.23	0.71
Ti	0.46	0.43	0.44	0.44	0.02
Cr	0.00	0.00	0.00	0.00	-
Mn	8.25	7.62	7.90	7.92	0.32
Fe	0.00	0.00	0.47	0.16	0.27
Ni	0.00	0.00	0.00	0.00	-
Cu	2.61	2.17	2.21	2.33	0.24
Zn	0.00	0.00	0.00	0.00	-
Zr	1.01	1.10	0.91	1.01	0.10
Cs	0.00	0.00	0.00	0.00	-

Table J60 Experiment 5 % wt of element of No.2 slag (Limestone/Al_2O_3+SiO_2 = 0.55) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	13.92	14.94	11.95	13.60	1.52
O	39.89	39.97	39.78	39.88	0.10
Na	0.00	0.00	0.00	0.00	-
Mg	0.29	0.25	0.33	0.29	0.04
Al	5.01	4.78	4.91	4.90	0.12
Si	13.84	13.11	14.02	13.66	0.48
P	0.00	0.00	0.00	0.00	-
S	0.20	0.25	0.23	0.23	0.03
Cl	0.00	0.00	0.00	0.00	-
K	1.23	1.17	1.29	1.23	0.06
Ca	16.53	16.05	17.36	16.65	0.66
Ti	0.24	0.28	0.35	0.29	0.06
Cr	0.00	0.00	0.00	0.00	-
Mn	5.65	5.51	6.10	5.75	0.31
Fe	0.54	0.80	0.65	0.66	0.13
Ni	0.00	0.00	0.00	0.00	-
Cu	1.83	2.10	2.07	2.00	0.15
Zn	0.00	0.00	0.00	0.00	-
Zr	0.84	0.80	0.96	0.87	0.08
Cs	0.00	0.00	0.00	0.00	-

Table J61 Experiment 5 % wt of element of No.3 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.65) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	2.50	1.20	0.85	1.52	0.87
O	7.55	5.61	3.84	5.67	1.86
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.19	0.00	0.06	0.11
Si	0.28	0.31	0.32	0.30	0.02
P	0.00	0.00	0.00	0.00	-
S	0.23	0.13	0.00	0.12	0.12
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.00	0.00	-
Ca	0.15	0.17	0.19	0.17	0.02
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	1.40	1.21	1.13	1.25	0.14
Fe	87.89	91.18	93.67	90.91	2.90
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J62 Experiment 5 % wt of element of No.3 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.65) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	2.01	0.12	1.97	1.37	1.08
O	27.30	6.95	21.01	18.42	10.42
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.20	0.00	0.00	0.07	0.12
Si	0.35	0.00	0.00	0.12	0.20
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.14	0.00	0.05	0.08
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.24	0.37	0.24	0.28	0.08
Fe	69.89	92.42	76.78	79.70	11.54
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J63 Experiment 5 % wt of element of No.3 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.65) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	2.27	7.95	2.48	4.23	3.22
O	6.30	3.71	30.44	13.48	14.74
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.41	0.17	0.00	0.19	0.21
P	0.00	0.00	0.00	0.00	-
S	0.00	0.15	0.00	0.05	0.09
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.14	0.00	0.05	0.08
Ca	0.21	0.14	0.00	0.12	0.11
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.59	0.98	0.38	0.65	0.30
Fe	90.21	86.72	66.70	81.21	12.69
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.05	0.00	0.02	0.03
Cs	0.00	0.00	0.00	0.00	-

Table J64 Experiment 5 % wt of element of No.3 slag (Limestone/Al_2O_3+SiO_2 = 0.65) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	10.27	10.49	10.78	10.51	0.26
O	39.85	39.12	40.14	39.70	0.53
Na	0.00	0.00	0.00	0.00	-
Mg	0.27	0.32	0.35	0.31	0.04
Al	4.98	4.90	5.11	5.00	0.11
Si	14.55	14.41	14.73	14.56	0.16
P	0.00	0.00	0.00	0.00	-
S	0.25	0.28	0.00	0.18	0.15
Cl	0.00	0.00	0.00	0.00	-
K	1.21	1.19	1.12	1.17	0.05
Ca	20.52	20.61	19.87	20.33	0.40
Ti	0.41	0.27	0.29	0.32	0.08
Cr	0.00	0.00	0.00	0.00	-
Mn	5.46	5.61	5.42	5.50	0.10
Fe	0.00	0.40	0.00	0.13	0.23
Ni	0.00	0.00	0.00	0.00	-
Cu	1.52	1.71	1.60	1.61	0.10
Zn	0.00	0.00	0.00	0.00	-
Zr	0.72	0.69	0.60	0.67	0.06
Cs	0.00	0.00	0.00	0.00	-

Table J65 Experiment 5 % wt of element of No.3 slag (Limestone/Al_2O_3+SiO_2 = 0.65) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	10.80	11.89	9.92	10.87	0.99
O	38.04	39.13	37.07	38.08	1.03
Na	0.00	0.00	0.00	0.00	-
Mg	0.31	0.23	0.23	0.26	0.05
Al	4.66	4.68	4.84	4.73	0.10
Si	13.62	13.19	14.05	13.62	0.43
P	0.00	0.00	0.00	0.00	-
S	0.17	0.00	0.21	0.13	0.11
Cl	0.00	0.00	0.00	0.00	-
K	1.46	1.35	1.45	1.42	0.06
Ca	20.86	19.62	21.79	20.76	1.09
Ti	0.37	0.32	0.36	0.35	0.03
Cr	0.00	0.00	0.00	0.00	-
Mn	6.20	5.95	6.49	6.21	0.27
Fe	0.36	0.45	0.45	0.42	0.05
Ni	0.00	0.00	0.00	0.00	-
Cu	2.29	2.37	2.35	2.34	0.04
Zn	0.00	0.00	0.00	0.00	-
Zr	0.86	0.84	0.79	0.83	0.04
Cs	0.00	0.00	0.00	0.00	-

Table J66 Experiment 5 % wt of element of No.3 slag (Limestone/Al_2O_3+SiO_2 = 0.65) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	12.29	12.70	11.36	12.12	0.69
O	26.40	27.47	26.78	26.88	0.54
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	3.41	3.55	3.60	3.52	0.10
Si	10.87	10.79	11.36	11.01	0.31
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	1.72	1.65	1.79	1.72	0.07
Ca	27.40	26.22	27.68	27.10	0.77
Ti	0.49	0.44	0.43	0.45	0.03
Cr	0.00	0.00	0.00	0.00	-
Mn	10.81	10.06	10.76	10.54	0.42
Fe	0.00	0.73	0.00	0.24	0.42
Ni	0.00	0.00	0.00	0.00	-
Cu	4.79	4.61	4.41	4.60	0.19
Zn	0.00	0.00	0.00	0.00	-
Zr	1.81	1.76	1.83	1.80	0.04
Cs	0.00	0.00	0.00	0.00	-

Table J67 Experiment 5 % wt of element of No.4 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.75) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.06	0.82	0.00	0.29	0.46
O	10.67	0.00	2.80	4.49	5.53
Na	0.68	0.00	0.13	0.27	0.36
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.20	0.07	0.12
Si	0.27	0.08	0.53	0.29	0.23
P	0.00	0.00	0.00	0.00	-
S	2.27	0.07	0.87	1.07	1.11
Cl	0.00	0.00	0.00	0.00	-
K	5.13	0.69	5.18	3.67	2.58
Ca	0.67	1.91	0.94	1.17	0.65
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	2.06	14.75	1.52	6.11	7.49
Fe	78.20	81.67	87.82	82.56	4.87
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J68 Experiment 5 % wt of element of No.4 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.75) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.04	0.00	0.75	0.26	0.42
O	23.42	16.35	16.07	18.61	4.17
Na	1.11	0.57	0.66	0.78	0.29
Mg	0.00	0.00	0.00	0.00	-
Al	0.15	0.30	0.32	0.26	0.09
Si	0.00	0.19	0.48	0.22	0.24
P	0.00	0.00	0.00	0.00	-
S	0.84	2.00	1.04	1.29	0.62
Cl	0.00	0.00	0.00	0.00	-
K	1.79	5.41	2.11	3.10	2.00
Ca	0.19	0.32	0.69	0.40	0.26
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	2.83	2.60	2.30	2.58	0.27
Fe	69.62	72.25	75.59	72.49	2.99
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J69 Experiment 5 % wt of element of No.4 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.75) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.00	0.00	0.62	0.21	0.36
O	4.90	8.02	1.73	4.88	3.15
Na	0.66	0.45	0.12	0.41	0.27
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.13	0.04	0.08
Si	0.50	0.00	0.08	0.19	0.27
P	0.00	0.00	0.00	0.00	-
S	0.43	0.53	0.45	0.47	0.05
Cl	0.00	0.00	0.00	0.00	-
K	0.80	1.11	1.72	1.21	0.47
Ca	0.68	0.18	0.00	0.29	0.35
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	7.87	6.05	6.07	6.66	1.05
Fe	84.17	83.66	89.08	85.64	2.99
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J70 Experiment 5 % wt of element of No.4 slag (Limestone/Al_2O_3+SiO_2 = 0.75) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	9.65	9.12	8.55	9.11	0.55
O	37.72	39.48	39.86	39.02	1.14
Na	0.00	0.00	0.00	0.00	-
Mg	0.30	0.31	0.30	0.30	0.01
Al	5.30	5.47	5.44	5.40	0.09
Si	15.61	15.93	16.11	15.88	0.25
P	0.00	0.00	0.00	0.00	-
S	0.22	0.22	0.24	0.23	0.01
Cl	0.00	0.00	0.00	0.00	-
K	1.51	1.47	1.50	1.49	0.02
Ca	20.10	19.14	19.16	19.47	0.55
Ti	0.36	0.32	0.32	0.33	0.02
Cr	0.00	0.00	0.00	0.00	-
Mn	6.10	5.61	5.59	5.77	0.29
Fe	0.39	0.34	0.41	0.38	0.04
Ni	0.00	0.00	0.00	0.00	-
Cu	1.36	1.30	1.22	1.29	0.07
Zn	0.00	0.00	0.00	0.00	-
Zr	1.39	1.30	1.29	1.33	0.06
Cs	0.00	0.00	0.00	0.00	-

Table J71 Experiment 5 % wt of element of No.4 slag (Limestone/Al_2O_3+SiO_2 = 0.75) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	8.56	7.85	6.61	7.67	0.99
O	49.55	49.13	49.54	49.41	0.24
Na	0.00	0.00	0.00	0.00	-
Mg	0.32	0.29	0.31	0.31	0.02
Al	4.90	4.90	5.06	4.95	0.09
Si	14.00	13.99	14.54	14.18	0.31
P	0.00	0.75	0.00	0.25	0.43
S	0.14	0.15	0.18	0.16	0.02
Cl	0.00	0.00	0.00	0.00	-
K	0.83	1.11	0.94	0.96	0.14
Ca	14.65	15.03	15.42	15.03	0.39
Ti	0.22	0.23	0.26	0.24	0.02
Cr	0.00	0.00	0.00	0.00	-
Mn	3.89	4.10	4.33	4.11	0.22
Fe	0.60	0.48	0.41	0.50	0.10
Ni	0.00	0.00	0.00	0.00	-
Cu	0.92	0.89	0.89	0.90	0.02
Zn	0.00	0.00	0.00	0.00	-
Zr	1.43	1.10	1.52	1.35	0.22
Cs	0.00	0.00	0.00	0.00	-

Table J72 Experiment 5 % wt of element of No.4 slag (Limestone/Al_2O_3+SiO_2 = 0.75) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	8.82	7.26	8.27	8.12	0.79
O	36.35	36.67	33.97	35.66	1.48
Na	0.00	0.00	0.00	0.00	-
Mg	0.33	0.30	0.32	0.32	0.02
Al	5.13	5.27	4.98	5.13	0.15
Si	14.98	15.82	14.83	15.21	0.53
P	0.00	0.00	0.00	0.00	-
S	0.28	0.28	0.26	0.27	0.01
Cl	0.00	0.00	0.00	0.00	-
K	1.29	1.44	1.54	1.42	0.13
Ca	23.22	23.43	25.17	23.94	1.07
Ti	0.26	0.34	0.44	0.35	0.09
Cr	0.00	0.00	0.00	0.00	-
Mn	6.23	6.20	6.92	6.45	0.41
Fe	0.00	0.00	0.00	0.00	-
Ni	0.00	0.00	0.00	0.00	-
Cu	1.66	1.50	1.77	1.64	0.14
Zn	0.00	0.00	0.00	0.00	-
Zr	1.43	1.48	1.54	1.48	0.06
Cs	0.00	0.00	0.00	0.00	-

Table J73 Experiment 5 % wt of element of No.5 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.85) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	1.21	2.44	1.08	1.58	0.75
O	15.80	12.72	21.42	16.65	4.41
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.19	0.13	0.11	0.10
Si	0.00	0.12	0.14	0.09	0.08
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.14	0.05	0.08
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.26	0.09	0.15
Ca	0.00	1.14	0.23	0.46	0.60
Ti	0.00	0.18	0.00	0.06	0.10
Cr	0.00	0.00	0.00	0.00	-
Mn	1.52	4.99	3.42	3.31	1.74
Fe	81.47	78.22	73.19	77.63	4.17
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J74 Experiment 5 % wt of element of No.5 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.85) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	1.82	0.73	5.40	2.65	2.44
O	16.06	12.06	3.96	10.69	6.16
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.20	0.07	0.12
Si	0.00	0.00	0.28	0.09	0.16
P	0.00	0.00	0.00	0.00	-
S	0.00	0.72	0.09	0.27	0.39
Cl	0.00	0.00	0.00	0.00	-
K	0.00	1.55	0.22	0.59	0.84
Ca	0.31	0.00	0.25	0.19	0.16
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	4.07	2.17	1.18	2.47	1.47
Fe	77.75	82.77	88.39	82.97	5.32
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.03	0.01	0.02
Cs	0.00	0.00	0.00	0.00	-

Table J75 Experiment 5 % wt of element of No.5 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.85) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.30	1.80	1.20	1.10	0.75
O	8.47	23.92	2.37	11.59	11.11
Na	0.21	0.00	0.00	0.07	0.12
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.08	0.00	0.22	0.10	0.11
P	0.00	0.00	0.00	0.00	-
S	0.48	0.00	0.00	0.16	0.28
Cl	0.00	0.00	0.00	0.00	-
K	1.06	0.00	0.00	0.35	0.61
Ca	0.00	0.00	0.24	0.08	0.14
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.43	0.36	0.43	0.41	0.04
Fe	88.97	73.91	95.05	85.98	10.88
Ni	0.00	0.00	0.20	0.07	0.12
Cu	0.00	0.00	0.29	0.10	0.17
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J76 Experiment 5 % wt of element of No.5 slag (Limestone/Al_2O_3+SiO_2 = 0.85) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	9.50	9.82	9.58	9.63	0.17
O	40.37	40.81	40.85	40.68	0.27
Na	0.00	0.00	0.00	0.00	-
Mg	0.19	0.00	0.28	0.16	0.14
Al	3.96	4.04	4.22	4.07	0.13
Si	12.98	12.65	12.84	12.82	0.17
P	0.00	0.00	0.00	0.00	-
S	0.15	0.00	0.22	0.12	0.11
Cl	0.00	0.00	0.00	0.00	-
K	1.25	1.42	1.12	1.26	0.15
Ca	21.77	21.71	21.56	21.68	0.11
Ti	0.36	0.42	0.35	0.38	0.04
Cr	0.00	0.00	0.00	0.00	-
Mn	4.81	5.08	4.57	4.82	0.26
Fe	0.37	0.00	0.39	0.25	0.22
Ni	0.00	0.00	0.00	0.00	-
Cu	2.90	2.71	2.72	2.78	0.11
Zn	0.00	0.00	0.00	0.00	-
Zr	1.40	1.35	1.29	1.35	0.06
Cs	0.00	0.00	0.00	0.00	-

Table J77 Experiment 5 % wt of element of No.5 slag (Limestone/Al_2O_3+SiO_2 = 0.85) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	8.42	9.12	3.75	7.10	2.92
O	40.92	39.70	33.43	38.02	4.02
Na	0.00	0.00	0.00	0.00	-
Mg	0.17	0.22	0.25	0.21	0.04
Al	3.84	3.99	4.25	4.03	0.21
Si	12.95	12.73	8.69	11.46	2.40
P	0.00	0.00	0.82	0.27	0.47
S	0.14	0.17	0.00	0.10	0.09
Cl	0.00	0.00	0.00	0.00	-
K	1.44	1.22	3.39	2.02	1.19
Ca	22.35	22.67	13.79	19.60	5.04
Ti	0.43	0.41	0.39	0.41	0.02
Cr	0.00	0.00	0.00	0.00	-
Mn	5.37	5.11	3.68	4.72	0.91
Fe	0.00	0.00	24.71	8.24	14.27
Ni	0.00	0.00	0.00	0.00	-
Cu	2.71	3.25	2.85	2.94	0.28
Zn	0.00	0.00	0.00	0.00	-
Zr	1.27	1.42	0.00	0.90	0.78
Cs	0.00	0.00	0.00	0.00	-

Table J78 Experiment 5 % wt of element of No.5 slag (Limestone/Al_2O_3+SiO_2 = 0.85) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	3.55	8.78	4.20	5.51	2.85
O	34.10	37.58	34.23	35.30	1.97
Na	0.00	0.00	0.00	0.00	-
Mg	0.18	0.32	0.25	0.25	0.07
Al	4.37	4.26	4.54	4.39	0.14
Si	8.86	8.86	9.41	9.04	0.32
P	0.83	0.00	0.88	0.57	0.49
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	3.28	2.21	3.80	3.10	0.81
Ca	14.62	12.01	14.62	13.75	1.51
Ti	0.46	0.34	0.40	0.40	0.06
Cr	0.00	0.00	0.00	0.00	-
Mn	3.98	3.58	3.74	3.77	0.20
Fe	22.84	18.43	21.03	20.77	2.22
Ni	0.00	0.00	0.00	0.00	-
Cu	2.93	2.06	2.89	2.63	0.49
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	1.58	0.00	0.53	0.91
Cs	0.00	0.00	0.00	0.00	-

Table J79 Experiment 5 % wt of element of No.6 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.95) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	11.67	1.06	3.42	5.38	5.57
O	10.16	1.58	9.72	7.15	4.83
Na	0.00	0.00	1.02	0.34	0.59
Mg	0.00	0.00	0.00	0.00	-
Al	0.49	0.00	0.00	0.16	0.28
Si	1.22	0.12	0.00	0.45	0.67
P	0.49	0.00	0.00	0.16	0.28
S	0.18	0.00	1.03	0.40	0.55
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	1.51	0.50	0.87
Ca	2.34	0.23	0.00	0.86	1.29
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.00	0.46	0.31	0.26	0.23
Fe	73.45	96.54	82.99	84.33	11.60
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J80 Experiment 5 % wt of element of No.6 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.95) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	5.12	8.21	3.94	5.76	2.21
O	5.58	16.28	6.79	9.55	5.86
Na	2.13	0.19	0.00	0.77	1.18
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.19	0.00	0.00	0.06	0.11
P	0.00	0.00	0.00	0.00	-
S	3.01	0.00	0.00	1.00	1.74
Cl	0.00	0.00	0.00	0.00	-
K	4.60	0.00	0.00	1.53	2.66
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.27	0.20	0.00	0.16	0.14
Fe	79.10	75.11	89.28	81.16	7.31
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J81 Experiment 5 % wt of element of No.6 iron nugget (Limestone/Al_2O_3+SiO_2 = 0.95) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	5.37	3.02	2.17	3.52	1.66
O	14.08	24.16	28.84	22.36	7.54
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.17	0.06	0.10
Si	0.00	0.00	0.19	0.06	0.11
P	0.00	0.00	0.00	0.00	-
S	0.00	0.72	0.00	0.24	0.42
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.66	0.00	0.22	0.38
Ca	0.00	0.48	0.23	0.24	0.24
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.50	0.38	0.27	0.38	0.12
Fe	80.06	70.58	68.12	72.92	6.30
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J82 Experiment 5 % wt of element of No.6 slag (Limestone/Al_2O_3+SiO_2 = 0.95) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	8.95	8.92	8.48	8.78	0.26
O	38.07	38.21	38.54	38.27	0.24
Na	0.00	0.00	0.00	0.00	-
Mg	0.28	0.33	0.27	0.29	0.03
Al	4.18	4.02	4.24	4.15	0.11
Si	10.47	10.37	11.46	10.77	0.60
P	0.00	0.00	0.00	0.00	-
S	0.20	0.20	0.20	0.20	-
Cl	0.00	0.00	0.00	0.00	-
K	0.74	0.76	0.89	0.80	0.08
Ca	22.95	22.69	24.09	23.24	0.74
Ti	0.21	0.21	0.31	0.24	0.06
Cr	0.00	0.00	0.00	0.00	-
Mn	4.01	4.08	4.45	4.18	0.24
Fe	5.10	5.73	2.06	4.30	1.96
Ni	0.00	0.00	0.00	0.00	-
Cu	3.38	3.13	3.39	3.30	0.15
Zn	0.00	0.00	0.00	0.00	-
Zr	1.48	1.35	1.61	1.48	0.13
Cs	0.00	0.00	0.00	0.00	-

Table J83 Experiment 5 % wt of element of No.6 slag (Limestone/Al_2O_3+SiO_2 = 0.95) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	9.87	10.62	10.07	10.19	0.39
O	39.92	34.41	43.58	39.30	4.62
Na	0.00	0.00	0.00	0.00	-
Mg	0.24	0.29	0.32	0.28	0.04
Al	4.18	3.74	4.01	3.98	0.22
Si	11.33	8.57	10.90	10.27	1.49
P	0.00	0.00	0.00	0.00	-
S	0.20	0.19	0.26	0.22	0.04
Cl	0.00	0.00	0.00	0.00	-
K	0.87	0.68	0.66	0.74	0.12
Ca	23.31	19.27	19.91	20.83	2.17
Ti	0.20	0.16	0.22	0.19	0.03
Cr	0.00	0.00	0.00	0.00	-
Mn	4.03	3.61	4.36	4.00	0.38
Fe	0.63	13.82	0.74	5.06	7.58
Ni	0.00	0.00	0.00	0.00	-
Cu	3.51	3.13	3.23	3.29	0.20
Zn	0.00	0.00	0.00	0.00	-
Zr	1.70	1.48	1.75	1.64	0.14
Cs	0.00	0.00	0.00	0.00	-

Table J84 Experiment 5 % wt of element of No.6 slag (Limestone/Al_2O_3+SiO_2 = 0.95) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	9.65	10.51	8.74	9.63	0.89
O	42.24	47.43	43.95	44.54	2.64
Na	0.00	0.00	0.00	0.00	-
Mg	0.30	0.35	0.30	0.32	0.03
Al	3.99	3.98	3.89	3.95	0.06
Si	10.86	10.74	11.10	10.90	0.18
P	0.00	0.00	0.00	0.00	-
S	0.28	0.23	0.25	0.25	0.03
Cl	0.00	0.00	0.00	0.00	-
K	0.73	0.54	0.79	0.69	0.13
Ca	20.52	16.60	20.22	19.11	2.18
Ti	0.23	0.15	0.23	0.20	0.05
Cr	0.00	0.00	0.00	0.00	-
Mn	5.20	3.59	4.70	4.50	0.82
Fe	1.07	0.39	0.47	0.64	0.37
Ni	0.00	0.00	0.00	0.00	-
Cu	2.98	3.37	3.50	3.28	0.27
Zn	0.00	0.00	0.00	0.00	-
Zr	1.94	2.11	1.85	1.97	0.13
Cs	0.00	0.00	0.00	0.00	-

Table J85 Experiment 5 % wt of element of No.7 iron nugget (Limestone/Al_2O_3+SiO_2 = 1.05) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	3.54	1.26	0.85	1.88	1.45
O	9.59	22.30	17.29	16.39	6.40
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.23	0.00	0.00	0.08	0.13
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.09	0.00	0.00	0.03	0.05
Ca	0.35	0.00	0.00	0.12	0.20
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.33	0.23	0.00	0.19	0.17
Fe	85.82	76.21	81.86	81.30	4.83
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.06	0.00	0.00	0.02	0.03
Cs	0.00	0.00	0.00	0.00	-

Table J86 Experiment 5 % wt of element of No.7 iron nugget (Limestone/Al_2O_3+SiO_2 = 1.05) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	4.25	2.65	1.55	2.82	1.36
O	20.23	25.18	27.13	24.18	3.56
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.55	0.00	0.19	0.25	0.28
Si	0.92	0.00	0.49	0.47	0.46
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.00	0.00	-
Ca	1.39	0.00	0.80	0.73	0.70
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.62	0.78	0.51	0.64	0.14
Fe	72.04	71.39	69.32	70.92	1.42
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J87 Experiment 5 % wt of element of No.7 iron nugget (Limestone/Al_2O_3+SiO_2 = 1.05) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	1.31	2.08	0.63	1.34	0.73
O	25.91	26.63	35.78	29.44	5.50
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.00	0.15	0.00	0.05	0.09
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.14	0.05	0.08
Ca	0.00	0.40	0.00	0.13	0.23
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.26	0.40	0.22	0.29	0.09
Fe	72.52	70.34	63.23	68.70	4.86
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J88 Experiment 5 % wt of element of No.7 slag (Limestone/Al_2O_3+SiO_2 = 1.05) 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	7.58	6.67	7.12	7.12	0.46
O	40.85	41.02	40.65	40.84	0.19
Na	0.00	0.00	0.00	0.00	-
Mg	0.29	0.30	0.28	0.29	0.01
Al	4.03	4.05	4.09	4.06	0.03
Si	11.53	11.83	11.80	11.72	0.17
P	0.00	0.00	0.00	0.00	-
S	0.23	0.25	0.24	0.24	0.01
Cl	0.00	0.00	0.00	0.00	-
K	0.73	0.72	0.69	0.71	0.02
Ca	24.23	24.36	24.35	24.31	0.07
Ti	0.24	0.30	0.28	0.27	0.03
Cr	0.00	0.00	0.00	0.00	-
Mn	4.15	4.07	4.10	4.11	0.04
Fe	1.69	1.75	1.80	1.75	0.06
Ni	0.00	0.00	0.00	0.00	-
Cu	3.05	3.34	3.21	3.20	0.15
Zn	0.00	0.00	0.00	0.00	-
Zr	1.39	1.34	1.38	1.37	0.03
Cs	0.00	0.00	0.00	0.00	-

Table J89 Experiment 5 % wt of element of No.7 slag (Limestone/Al_2O_3+SiO_2 = 1.05) 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	9.61	10.56	7.28	9.15	1.69
O	42.11	40.39	43.14	41.88	1.39
Na	0.00	0.00	0.00	0.00	-
Mg	0.43	0.42	0.49	0.45	0.04
Al	4.26	4.33	4.67	4.42	0.22
Si	10.71	10.62	11.16	10.83	0.29
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.51	0.61	0.50	0.54	0.06
Ca	22.87	23.29	23.37	23.18	0.27
Ti	0.17	0.14	0.14	0.15	0.02
Cr	0.00	0.00	0.00	0.00	-
Mn	4.07	4.05	4.04	4.05	0.02
Fe	1.64	1.79	1.82	1.75	0.10
Ni	0.00	0.00	0.00	0.00	-
Cu	2.57	2.74	2.40	2.57	0.17
Zn	0.00	0.00	0.00	0.00	-
Zr	1.04	1.07	1.01	1.04	0.03
Cs	0.00	0.00	0.00	0.00	-

Table J90 Experiment 5 % wt of element of No.7 slag (Limestone/Al_2O_3+SiO_2 = 1.05) 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	9.47	9.53	8.10	9.03	0.81
O	32.26	31.85	31.00	31.70	0.64
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	2.00	2.11	1.74	1.95	0.19
Si	4.85	4.82	3.65	4.44	0.68
P	0.72	0.62	0.48	0.61	0.12
S	0.00	0.17	0.00	0.06	0.10
Cl	0.00	0.00	0.00	0.00	-
K	0.90	1.32	1.26	1.16	0.23
Ca	10.71	9.00	6.77	8.83	1.98
Ti	0.24	0.26	0.24	0.25	0.01
Cr	0.00	0.00	0.00	0.00	-
Mn	3.86	3.79	2.76	3.47	0.62
Fe	31.18	32.80	40.32	34.77	4.88
Ni	0.00	0.00	0.00	0.00	-
Cu	2.36	2.47	2.24	2.36	0.12
Zn	0.00	0.00	0.00	0.00	-
Zr	1.45	1.25	1.43	1.38	0.11
Cs	0.00	0.00	0.00	0.00	-

J.1.4 Experiment 6

Table J91 Experiment 6 % wt of element of No.1 iron nugget 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	1.85	0.89	4.23	2.32	1.72
O	22.24	13.22	4.50	13.32	8.87
Na	0.00	0.37	0.33	0.23	0.20
Mg	0.33	0.00	0.00	0.11	0.19
Al	0.00	0.00	0.00	0.00	-
Si	9.44	0.00	0.70	3.38	5.26
P	0.31	0.00	0.00	0.10	0.18
S	0.00	0.36	1.29	0.55	0.67
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.64	2.50	1.05	1.30
Ca	6.37	0.00	1.18	2.52	3.39
Ti	0.00	0.00	0.31	0.10	0.18
Cr	0.00	0.00	0.00	0.00	-
Mn	4.92	3.61	8.58	5.70	2.58
Fe	54.54	80.92	76.37	70.61	14.10
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.02	0.01	0.01
Cs	0.00	0.00	0.00	0.00	-

Table J92 Experiment 6 % wt of element of No.1 iron nugget 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	21.47	1.78	1.59	8.28	11.42
O	4.27	20.34	9.02	11.21	8.26
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.00	0.00	0.00	0.00	-
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.25	0.08	0.14
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.33	0.11	0.19
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.00	0.00	0.68	0.23	0.39
Fe	74.25	77.88	88.14	80.09	7.20
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J93 Experiment 6 % wt of element of No.1 iron nugget 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.17	1.49	0.00	0.55	0.82
O	17.11	1.41	26.92	15.15	12.87
Na	1.64	0.08	0.00	0.57	0.92
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.03	0.00	0.01	0.02
Si	0.00	0.00	0.00	0.00	-
P	0.00	0.00	0.00	0.00	-
S	1.37	0.08	0.44	0.63	0.67
Cl	0.00	0.00	0.00	0.00	-
K	1.83	0.16	0.90	0.96	0.84
Ca	0.24	3.22	0.00	1.15	1.79
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	2.80	11.03	0.39	4.74	5.58
Fe	74.83	82.49	71.35	76.22	5.70
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.01	0.00	0.00	0.01
Cs	0.00	0.00	0.00	0.00	-

Table J93 Experiment 6 % wt of element of No.1 slag 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.81	2.44	0.05	1.10	1.22
O	37.04	37.86	39.80	38.23	1.42
Na	0.00	0.00	0.00	0.00	-
Mg	0.31	0.28	0.33	0.31	0.03
Al	4.44	4.52	4.66	4.54	0.11
Si	9.68	10.41	10.16	10.08	0.37
P	1.13	0.94	1.29	1.12	0.18
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	3.11	2.69	3.39	3.06	0.35
Ca	15.98	17.23	16.28	16.50	0.65
Ti	0.36	0.38	0.49	0.41	0.07
Cr	0.00	0.00	0.00	0.00	-
Mn	3.04	3.35	2.75	3.05	0.30
Fe	21.68	17.40	18.46	19.18	2.23
Ni	0.00	0.00	0.00	0.00	-
Cu	2.44	2.50	2.34	2.43	0.08
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J94 Experiment 6 % wt of element of No.1 slag 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	1.65	9.31	2.56	4.51	4.18
O	37.96	35.24	36.55	36.58	1.36
Na	0.00	0.00	0.00	0.00	-
Mg	0.32	0.19	0.00	0.17	0.16
Al	4.74	3.54	4.33	4.20	0.61
Si	10.85	7.51	8.73	9.03	1.69
P	1.13	1.15	1.55	1.28	0.24
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	2.71	3.04	4.28	3.34	0.83
Ca	18.20	13.24	13.00	14.81	2.94
Ti	0.47	0.33	0.49	0.43	0.09
Cr	0.00	0.00	0.00	0.00	-
Mn	3.33	2.44	2.45	2.74	0.51
Fe	16.17	21.47	23.64	20.43	3.84
Ni	0.00	0.00	0.00	0.00	-
Cu	2.48	1.97	2.42	2.29	0.28
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.55	0.00	0.18	0.32
Cs	0.00	0.00	0.00	0.00	-

Table J95 Experiment 6 % wt of element of No.1 slag 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	9.65	9.86	1.05	6.85	5.03
O	33.89	33.75	37.14	34.93	1.92
Na	0.00	0.00	0.00	0.00	-
Mg	0.18	0.17	0.24	0.20	0.04
Al	3.63	3.22	4.35	3.73	0.57
Si	7.66	7.18	9.66	8.17	1.32
P	1.07	1.09	1.20	1.12	0.07
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	3.05	2.43	2.98	2.82	0.34
Ca	13.34	13.37	15.82	14.18	1.42
Ti	0.40	0.32	0.41	0.38	0.05
Cr	0.00	0.00	0.00	0.00	-
Mn	2.41	2.31	2.93	2.55	0.33
Fe	21.73	23.47	21.70	22.30	1.01
Ni	0.00	0.00	0.00	0.00	-
Cu	2.34	2.14	2.52	2.33	0.19
Zn	0.00	0.00	0.00	0.00	-
Zr	0.66	0.68	0.00	0.45	0.39
Cs	0.00	0.00	0.00	0.00	-

Table J96 Experiment 6 % wt of element of No.2 iron nugget 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	1.43	1.11	1.02	1.19	0.22
O	14.36	4.92	1.28	6.85	6.75
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.09	0.18	0.09	0.12	0.05
Si	0.16	0.17	0.13	0.15	0.02
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.00	0.00	-
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.00	0.00	-
Ca	0.00	0.00	0.07	0.02	0.04
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.38	0.33	0.00	0.24	0.21
Fe	83.57	93.29	96.82	91.23	6.86
Ni	0.00	0.00	0.41	0.14	0.24
Cu	0.00	0.00	0.19	0.06	0.11
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J97 Experiment 6 % wt of element of No.2 iron nugget 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.75	0.00	0.00	0.25	0.43
O	6.76	9.59	18.84	11.73	6.32
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.09	0.00	0.03	0.05
Si	0.00	0.09	0.00	0.03	0.05
P	0.10	0.00	0.00	0.03	0.06
S	0.00	0.41	0.00	0.14	0.24
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.99	0.00	0.33	0.57
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.47	4.74	0.40	1.87	2.49
Fe	91.92	83.16	80.76	85.28	5.87
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.94	0.00	0.31	0.54
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J98 Experiment 6 % wt of element of No.2 iron nugget 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	2.11	0.00	0.00	0.70	1.22
O	15.26	13.20	17.79	15.42	2.30
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.00	0.00	0.00	-
Si	0.00	0.00	0.00	0.00	-
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.20	0.07	0.12
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.00	0.36	0.12	0.21
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.40	0.00	0.81	0.40	0.41
Fe	82.23	86.80	80.84	83.29	3.12
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J99 Experiment 6 % wt of element of No.2 slag 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	1.20	5.92	7.64	4.92	3.33
O	44.44	45.30	38.71	42.82	3.58
Na	0.00	0.00	0.00	0.00	-
Mg	0.33	0.34	0.27	0.31	0.04
Al	5.65	5.19	5.15	5.33	0.28
Si	14.57	13.36	13.25	13.73	0.73
P	0.00	0.00	0.00	0.00	-
S	0.00	0.00	0.13	0.04	0.08
Cl	0.00	0.00	0.00	0.00	-
K	2.22	1.37	2.54	2.04	0.60
Ca	20.91	18.56	21.41	20.29	1.52
Ti	0.40	0.41	0.40	0.40	0.01
Cr	0.00	0.00	0.00	0.00	-
Mn	6.03	5.55	6.29	5.96	0.38
Fe	1.50	1.08	0.66	1.08	0.42
Ni	0.00	0.00	0.00	0.00	-
Cu	2.75	2.13	2.83	2.57	0.38
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.78	0.70	0.49	0.43
Cs	0.00	0.00	0.00	0.00	-

Table J100 Experiment 6 % wt of element of No.2 slag 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.01	7.28	6.87	4.72	4.08
O	35.72	46.65	47.18	43.18	6.47
Na	0.00	0.00	0.00	0.00	-
Mg	0.32	0.32	0.32	0.32	-
Al	5.03	5.18	5.21	5.14	0.10
Si	13.71	13.07	13.20	13.33	0.34
P	0.00	0.00	0.00	0.00	-
S	0.24	0.00	0.00	0.08	0.14
Cl	0.00	0.00	0.00	0.00	-
K	2.61	1.57	1.37	1.85	0.67
Ca	28.45	16.74	16.80	20.66	6.74
Ti	0.51	0.29	0.30	0.37	0.12
Cr	0.00	0.00	0.00	0.00	-
Mn	8.59	4.64	4.67	5.97	2.27
Fe	0.78	1.67	1.26	1.24	0.45
Ni	0.00	0.00	0.00	0.00	-
Cu	4.02	2.10	2.19	2.77	1.08
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.50	0.60	0.37	0.32
Cs	0.00	0.00	0.00	0.00	-

Table J101 Experiment 6 % wt of element of No.2 slag 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	9.54	5.68	15.67	10.30	5.04
O	43.24	40.14	39.64	41.01	1.95
Na	0.00	0.00	0.00	0.00	-
Mg	0.33	0.29	0.26	0.29	0.04
Al	5.41	5.18	4.96	5.18	0.23
Si	13.30	13.71	11.58	12.86	1.13
P	0.00	0.00	0.32	0.11	0.18
S	0.14	0.00	0.18	0.11	0.09
Cl	0.00	0.00	0.00	0.00	-
K	2.72	1.89	3.69	2.77	0.90
Ca	16.48	21.24	14.03	17.25	3.67
Ti	0.34	0.38	0.39	0.37	0.03
Cr	0.00	0.00	0.00	0.00	-
Mn	4.80	6.23	4.48	5.17	0.93
Fe	1.33	1.65	2.13	1.70	0.40
Ni	0.00	0.00	0.00	0.00	-
Cu	2.35	2.80	2.66	2.60	0.23
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.82	0.00	0.27	0.47
Cs	0.00	0.00	0.00	0.00	-

Table J102 Experiment 6 % wt of element of No.3 iron nugget 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	1.41	1.02	0.73	1.05	0.34
O	17.34	3.63	10.73	10.57	6.86
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.00	0.09	0.12	0.07	0.06
Si	0.00	0.19	0.22	0.14	0.12
P	0.00	0.00	0.00	0.00	-
S	0.00	0.07	0.00	0.02	0.04
Cl	0.00	0.00	0.00	0.00	-
K	0.00	0.20	0.20	0.13	0.12
Ca	0.00	0.00	0.00	0.00	-
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	0.00	0.99	0.37	0.45	0.50
Fe	81.25	93.80	87.64	87.56	6.28
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J103 Experiment 6 % wt of element of No.3 iron nugget 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.98	0.00	0.00	0.33	0.57
O	4.65	0.76	1.31	2.24	2.11
Na	0.00	0.00	0.00	0.00	-
Mg	0.00	0.00	0.00	0.00	-
Al	0.11	0.00	0.00	0.04	0.06
Si	0.14	0.05	0.06	0.08	0.05
P	0.00	0.00	0.00	0.00	-
S	0.00	0.03	0.06	0.03	0.03
Cl	0.00	0.00	0.00	0.00	-
K	0.13	0.11	0.36	0.20	0.14
Ca	0.00	0.08	0.12	0.07	0.06
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	1.10	1.76	3.10	1.99	1.02
Fe	92.88	97.21	95.00	95.03	2.17
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J104 Experiment 6 % wt of element of No.3 iron nugget 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.52	0.00	2.17	0.90	1.13
O	0.42	6.59	4.07	3.69	3.10
Na	0.00	0.32	0.66	0.33	0.33
Mg	0.00	0.00	0.00	0.00	-
Al	0.05	0.12	0.19	0.12	0.07
Si	0.11	0.00	0.35	0.15	0.18
P	0.00	0.00	0.00	0.00	-
S	0.00	0.54	2.89	1.14	1.54
Cl	0.00	0.00	0.00	0.00	-
K	0.00	1.06	6.04	2.37	3.23
Ca	0.00	0.26	0.00	0.09	0.15
Ti	0.00	0.00	0.00	0.00	-
Cr	0.00	0.00	0.00	0.00	-
Mn	1.07	3.31	1.02	1.80	1.31
Fe	97.83	87.80	82.62	89.42	7.73
Ni	0.00	0.00	0.00	0.00	-
Cu	0.00	0.00	0.00	0.00	-
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.00	0.00	0.00	-
Cs	0.00	0.00	0.00	0.00	-

Table J105 Experiment 6 % wt of element of No.3 slag 1st specimen

Element	%Weight				
	1	2	3	Avg	SD
C	7.28	8.16	6.61	7.35	0.78
O	30.76	30.24	32.75	31.25	1.32
Na	0.00	0.00	0.00	0.00	-
Mg	0.17	0.20	0.20	0.19	0.02
Al	3.15	3.41	3.69	3.42	0.27
Si	8.56	9.64	10.76	9.65	1.10
P	0.00	0.00	0.00	0.00	-
S	0.20	0.00	0.00	0.07	0.12
Cl	0.00	0.00	0.00	0.00	-
K	0.92	0.82	0.77	0.84	0.08
Ca	19.09	23.96	21.96	21.67	2.45
Ti	0.35	0.35	0.36	0.35	0.01
Cr	0.00	0.00	0.00	0.00	-
Mn	5.01	6.18	5.28	5.49	0.61
Fe	19.40	10.75	12.66	14.27	4.54
Ni	0.00	0.00	0.00	0.00	-
Cu	3.79	4.97	3.73	4.16	0.70
Zn	0.00	0.00	0.00	0.00	-
Zr	1.31	1.33	1.23	1.29	0.05
Cs	0.00	0.00	0.00	0.00	-

Table J106 Experiment 6 % wt of element of No.3 slag 2nd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	1.61	7.05	7.09	5.25	3.15
O	31.38	28.38	30.52	30.09	1.54
Na	0.00	0.00	0.00	0.00	-
Mg	0.15	0.00	0.17	0.11	0.09
Al	3.37	2.33	3.24	2.98	0.57
Si	9.07	6.37	9.57	8.34	1.72
P	0.41	0.00	0.00	0.14	0.24
S	0.18	0.19	0.14	0.17	0.03
Cl	0.00	0.00	0.00	0.00	-
K	0.96	0.94	0.87	0.92	0.05
Ca	19.80	15.14	23.35	19.43	4.12
Ti	0.33	0.28	0.36	0.32	0.04
Cr	0.00	0.00	0.00	0.00	-
Mn	5.13	4.34	6.03	5.17	0.85
Fe	23.70	30.34	13.20	22.41	8.64
Ni	0.00	0.00	0.00	0.00	-
Cu	3.91	3.47	4.20	3.86	0.37
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	1.16	1.28	0.81	0.71
Cs	0.00	0.00	0.00	0.00	-

Table J107 Experiment 6 % wt of element of No.3 slag 3rd specimen

Element	%Weight				
	1	2	3	Avg	SD
C	0.40	0.39	6.14	2.31	3.32
O	34.08	32.16	31.43	32.56	1.37
Na	0.00	0.00	0.00	0.00	-
Mg	0.23	0.19	0.16	0.19	0.04
Al	3.89	3.36	2.94	3.40	0.48
Si	10.99	8.36	7.68	9.01	1.75
P	0.64	0.54	0.40	0.53	0.12
S	0.16	0.19	0.19	0.18	0.02
Cl	0.00	0.00	0.00	0.00	-
K	0.95	1.10	1.04	1.03	0.08
Ca	20.23	17.00	16.63	17.95	1.98
Ti	0.33	0.33	0.29	0.32	0.02
Cr	0.00	0.00	0.00	0.00	-
Mn	4.84	4.47	4.53	4.61	0.20
Fe	19.74	27.31	24.23	23.76	3.81
Ni	0.00	0.00	0.00	0.00	-
Cu	3.51	3.66	3.43	3.53	0.12
Zn	0.00	0.00	0.00	0.00	-
Zr	0.00	0.93	0.92	0.62	0.53
Cs	0.00	0.00	0.00	0.00	-

J.2 X-Ray Fluorescence (XRF)

Samples were characterized for wt % of elements by XRF (PANalytical, model AXIOS PW4400). The samples were mixed with boric acid in the pan and compressed at 6,000 psi for 2 minutes. The specimens were clamped on a holder and placed into a chamber. The XRF spectrometer measures the individual component wavelengths of the fluorescent emission produced by a sample when irradiated with X-rays.

J.2.1 Experiment 3

Table J108 Experiment 3 XRF characterization of product No.1

4/3/2012 5:07:29 PM

PANalytical

Quantification of sample Exp 3-1

R.M.S.:	0.000
Sum before normalization:	12.1 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Sr	0.2390
2	Si	1.442
3	S	0.5027
4	P	0.6327
5	O	30.80
6	Na	0.4659
7	Mn	2.625
8	K	0.6193
9	Fe	58.95
10	Cu	1.742
11	Ca	1.724
12	Ba	0.2551

Table J109 Experiment 3 XRF characterization of product No.2

4/3/2012 5:08:18 PM

PANalytical

Quantification of sample Exp 3-2

R.M.S.:	0.000
Sum before normalization:	11.8 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Zn	0.07737
2	Ti	0.1926
3	Si	3.840
4	S	0.3972
5	P	0.8552
6	O	32.12
7	Na	0.2450
8	Mn	3.057
9	Mg	0.2672
10	K	0.6771
11	Fe	51.26
12	Cu	1.540
13	Cr	0.1613
14	Ca	5.310

Table J110 Experiment 3 XRF characterization of product No.3

4/3/2012 5:09:26 PM

PANalytical

Quantification of sample Exp 3-3

R.M.S.:	0.000
Sum before normalization:	12.8 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Zr	0.02874
2	Ti	0.2898
3	Si	6.282
4	S	3.408
5	P	0.7782
6	O	34.76
7	Ni	0.1310
8	Na	1.148
9	Mn	4.330
10	Mg	0.2288
11	K	3.444
12	Fe	30.41
13	Cu	1.246
14	Cr	0.1908
15	Ca	13.18
16	Ba	0.1448

Table J111 Experiment 3 XRF characterization of product No.4

4/3/2012 5:10:01 PM

PANalytical

Quantification of sample Exp 3-4

R.M.S.:	0.000
Sum before normalization:	15.3 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Zn	0.07054
2	Si	1.773
3	S	1.851
4	P	0.5949
5	O	31.94
6	Na	0.8887
7	Mn	2.520
8	Mg	0.2252
9	K	1.728
10	Fe	55.07
11	Cu	1.293
12	Cr	0.1136
13	Ca	1.937

J.2.2 Experiment 4

Table J112 Experiment 4 XRF characterization of product No.1

3/15/2012 12:40:53 PM

PANalytical

Quantification of sample 4-1M

R.M.S.:	0.000
Sum before normalization:	11.3 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Si	3.147
2	P	1.042
3	O	31.39
4	Na	0.8114
5	Mn	3.127
6	Mg	0.3494
7	K	1.423
8	Fe	51.44
9	Cu	1.792
10	Ca	5.477

Table J113 Experiment 4 XRF characterization of product No.2

3/15/2012 6:51:50 PM

PANalytical

Quantification of sample 4-2M

R.M.S.:	0.000
Sum before normalization:	6.9 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Ti	0.3777
2	P	1.502
3	O	29.45
4	Na	4.358
5	Mn	7.716
6	Fe	44.08
7	Cu	3.103
8	Cr	0.2529
9	Ca	9.160

Table J114 Experiment 4 XRF characterization of product No.3

3/15/2012 6:52:58 PM

PANalytical

Quantification of sample 4-3M

R.M.S.:	0.000
Sum before normalization:	14.1 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Ti	0.2403
2	Sr	0.04250
3	Si	3.582
4	S	4.311
5	P	0.968
6	O	34.22
7	Na	3.656
8	Mn	3.730
9	Mg	0.2825
10	K	4.003
11	Fe	36.37
12	Cu	1.156
13	Cr	0.2050
14	Ca	7.234

Table J115 Experiment 4 XRF characterization of product No.4

3/15/2012 6:53:50 PM

PANalytical

Quantification of sample 4-4M

R.M.S.:	0.000
Sum before normalization:	10.6 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Ti	0.1666
2	Si	5.367
3	S	2.271
4	P	1.111
5	O	34.31
6	Na	1.359
7	Mn	2.950
8	Mg	0.3026
9	K	1.568
10	Fe	48.65
11	Cu	1.645
12	Cs	0.1380
13	Cr	0.1553

Table J116 Experiment 4 XRF characterization of product No.5

3/15/2012 6:54:57 PM

PANalytical

Quantification of sample 4-5M

R.M.S.:	0.000
Sum before normalization:	17.1 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Ti	0.5765
2	Si	18.08
3	S	0.6027
4	P	0.5554
5	O	38.37
6	Na	0.1867
7	Mn	6.484
8	Mg	0.2397
9	K	1.527
10	Fe	2.834
11	Cu	0.5748
12	Cr	0.2232
13	Ca	29.76

J.2.3 Experiment 5

Table J117 Experiment 5 XRF characterization of product No.1

3/15/2012 6:55:38 PM

PANalytical

Quantification of sample 5-1M

R.M.S.:	0.000
Sum before normalization:	12.8 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Si	5.162
2	S	2.033
3	P	0.9011
4	O	33.54
5	Na	0.9122
6	Mn	3.187
7	Mg	0.3043
8	K	3.121
9	Fe	41.59
10	Cu	1.411
11	Cr	0.1657
12	Ca	7.671

Table J118 Experiment 5 XRF characterization of product No.2

3/15/2012 6:56:35 PM

PANalytical

Quantification of sample 5-2M

R.M.S.:	0.000
Sum before normalization:	14.3 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Si	1.072
2	S	1.581
3	P	0.5951
4	O	31.53
5	Na	1.083
6	Mn	2.119
7	Mg	0.3373
8	K	1.324
9	Fe	58.09
10	Cu	1.275
11	Ca	0.996

Table J119 Experiment 5 XRF characterization of product No.3

3/15/2012 6:57:19 PM

PANalytical

Quantification of sample 5-3M

R.M.S.:	0.000
Sum before normalization:	13.1 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Ti	0.1221
2	S	2.098
3	P	0.7652
4	O	31.20
5	Na	2.060
6	Mn	3.381
7	Mg	0.3479
8	K	1.736
9	Fe	54.39
10	Cu	1.560
11	Cr	0.1184
12	Ca	2.216

Table J120 Experiment 5 XRF characterization of product No.4

3/15/2012 6:57:58 PM

PANalytical

Quantification of sample 5-4M

R.M.S.:	0.000
Sum before normalization:	13.1 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Ti	0.1051
2	Si	1.695
3	S	2.028
4	P	0.6636
5	O	31.83
6	Na	1.304
7	Mn	3.317
8	Mg	0.3018
9	K	2.718
10	Fe	52.15
11	Cu	1.441
12	Cr	0.1561
13	Ca	2.287

Table J121 Experiment 5 XRF characterization of product No.5

3/15/2012 6:58:37 PM

PANalytical

Quantification of sample 5-5M

R.M.S.:	0.000
Sum before normalization:	17.3 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Si	3.537
2	S	0.1532
3	P	0.6014
4	O	30.24
5	Mn	18.67
6	Mg	0.2466
7	K	0.5707
8	Fe	42.87
9	Cu	1.198
10	Ca	1.918

Table J122 Experiment 5 XRF characterization of product No.6

3/15/2012 6:59:28 PM

PANalytical

Quantification of sample 5-6M

R.M.S.:	0.000
Sum before normalization:	17.3 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Si	1.225
2	P	0.7105
3	O	28.69
4	Mn	23.14
5	Mg	0.2362
6	K	0.2211
7	Fe	44.03
8	Cu	1.243
9	Cr	0.1108
10	Ca	0.3889

Table J123 Experiment 5 XRF characterization of product No.7

3/15/2012 7:00:00 PM

PANalytical

Quantification of sample 5-7M

R.M.S.:	0.000
Sum before normalization:	14.8 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Si	5.339
2	P	1.359
3	O	32.99
4	Mn	1.845
5	Mg	0.2775
6	K	0.2658
7	Fe	46.84
8	Cu	1.232
9	Cr	0.1477
10	Ca	9.700

J.2.4 Experiment 6

Table J124 Experiment 6 XRF characterization of product No.1

4/3/2012 5:10:33 PM

PANalytical

Quantification of sample Exp 6-1

R.M.S.:	0.000
Sum before normalization:	13.7 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Zn	0.06775
2	Ti	0.1714
3	Si	2.198
4	S	0.8575
5	P	0.7320
6	O	31.20
7	Na	0.6409
8	Mn	5.094
9	K	1.306
10	Fe	51.04
11	Cu	1.601
12	Cr	0.1155
13	Cl	0.02547
14	Ca	4.946

Table J125 Experiment 6 XRF characterization of product No.2

4/3/2012 5:11:31 PM

PANalytical

Quantification of sample Exp 6-2

R.M.S.:	0.000
Sum before normalization:	14.5 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	V	0.02771
2	Ti	0.1543
3	Si	3.906
4	P	0.6639
5	O	29.09
6	Mn	31.71
7	Mg	0.1842
8	K	0.4842
9	Fe	29.51
10	Cu	1.341
11	Cr	0.1632
12	Ca	2.761

Table J126 Experiment 6 XRF characterization of product No.3

4/3/2012 5:12:05 PM

PANalytical

Quantification of sample Exp 6-3

R.M.S.:	0.000
Sum before normalization:	15.1 %
Normalised to:	100.0 %
Sample type:	Solid
Correction applied for medium:	No
Correction applied for film:	None
Used Compound list:	OXIDES
Results database:	routine
Results database in:	c:\program files\panalytical\superq\userdata

	Element	Conc. (%)
1	Zn	0.06907
2	Ti	0.1208
3	Si	3.432
4	S	0.8245
5	P	0.6347
6	O	32.08
7	Na	0.4417
8	Mn	2.642
9	K	1.090
10	Fe	53.09
11	Cu	1.214
12	Cr	0.1480
13	Ca	4.212

From the XRF results, the results contain an error because the sample for XRF must be a smooth surface. The iron nuggets contain a rough surface that effects to the reflection of fluorescence.

J.3 Particle Size Analyzer (PSA)

Samples were characterized for size of diameter sizes by PSA (Malvern, Mastersizer X). The Mastersizer X used lenses of 300 mm. The samples were placed in the Sample Presentation Unit (SPU) and dispersed in water. The water was used as a medium containing particles visible to the cell window.

J.3.1 XK-03

Result: Analysis Report

Sample Details

Sample ID: XK-03
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 1
Record Number: 1

Measured: Tue Jul 12 2011 10:35AM
Analysed: Tue Jul 12 2011 10:35AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 15.8 %
Residual: 2.875 %

Result Statistics

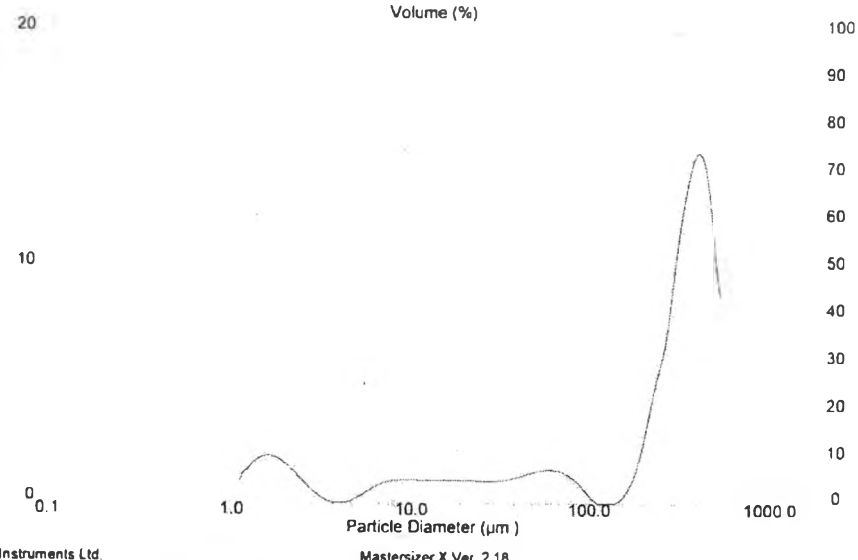
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 276.87 um

Concentration = 0.0305 %Vol
D (v, 0.1) = 5.68 um
D [3, 2] = 14.10 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 319.86 um
Span = 1.549E+00

Specific S.A. = 0.4256 sq. m / g
D (v, 0.9) = 501.08 um
Uniformity = 4.868E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.99	1.32	1.00	25.46	1.22	31.01	20.25
1.32	2.15	1.60	3.14	31.01	1.28	37.79	21.53
1.60	2.60	1.95	5.74	37.79	1.47	46.03	23.00
1.95	2.20	2.38	7.94	46.03	1.73	56.09	24.73
2.38	1.34	2.90	9.27	56.09	1.88	68.33	26.60
2.90	0.50	3.53	9.77	68.33	1.69	83.26	28.30
3.53	0.04	4.30	9.81	83.26	1.03	101.44	29.32
4.30	0.06	5.24	9.87	101.44	0.10	123.59	29.43
5.24	0.48	6.39	10.35	123.59	0.00	150.57	29.43
6.39	1.00	7.78	11.34	150.57	0.73	183.44	30.16
7.78	1.25	9.48	12.60	183.44	3.20	223.51	33.37
9.48	1.30	11.55	13.90	223.51	7.05	272.31	40.44
11.55	1.28	14.08	15.18	272.31	12.39	331.77	52.80
14.08	1.29	17.15	16.46	331.77	17.79	404.21	70.59
17.15	1.30	20.90	17.76	404.21	18.17	492.47	88.71
20.90	1.26	25.46	19.02	492.47	11.25	600.00	100.00



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Mastersizer X Ver. 2.18
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p. 1
12 Jul 11 11:51

Figure J1 PSA reference of XK-03, run number 1.

Result: Analysis Report

Sample Details

Sample ID: XK-03
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 2
Record Number: 2

Measured: Tue Jul 12 2011 10:36AM
Analysed: Tue Jul 12 2011 10:36AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 16.1 %
Residual: 2.296 %

Result Statistics

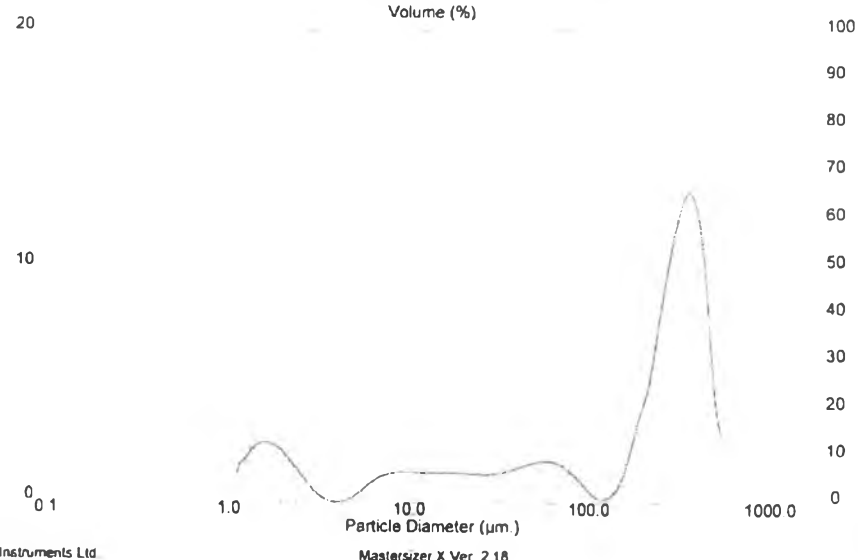
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 224.10 um

Concentration = 0.0250 %Vol
D (v, 0.1) = 2.41 um
D [3, 2] = 11.37 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 257.80 um
Span = 1.681E+00

Specific S.A. = 0.5277 sq. m / g
D (v, 0.9) = 435.89 um
Uniformity = 5.776E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	1.23	1.32	1.23	25.46	1.51	31.01	25.31
1.32	2.67	1.60	3.90	31.01	1.61	37.79	26.92
1.60	3.23	1.95	7.13	37.79	1.86	46.03	28.78
1.95	2.75	2.38	9.88	46.03	2.14	56.09	30.92
2.38	1.67	2.90	11.54	56.09	2.23	68.33	33.15
2.90	0.63	3.53	12.17	68.33	1.91	83.26	35.06
3.53	0.05	4.30	12.23	83.26	1.12	101.44	36.18
4.30	0.08	5.24	12.31	101.44	0.31	123.59	36.49
5.24	0.61	6.39	12.92	123.59	0.37	150.57	36.87
6.39	1.26	7.78	14.18	150.57	1.96	183.44	38.83
7.78	1.59	9.48	15.77	183.44	5.01	223.51	43.85
9.48	1.65	11.55	17.42	223.51	9.33	272.31	53.17
11.55	1.62	14.08	19.04	272.31	14.31	331.77	67.47
14.08	1.61	17.15	20.65	331.77	16.80	404.21	84.25
17.15	1.60	20.90	22.25	404.21	12.01	492.47	96.21
20.90	1.55	25.46	23.80	492.47	3.73	600.00	100.00



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12 Jul 11 11:51 p. 2

Figure J2 PSA reference of XK-03, run number 2.

Result: Analysis Report

Sample Details

Sample ID: XK-03
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 3
Record Number: 3

Measured: Tue Jul 12 2011 10:38AM
Analysed: Tue Jul 12 2011 10:38AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000): Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 17.6 %
Residual: 2.565 %

Result Statistics

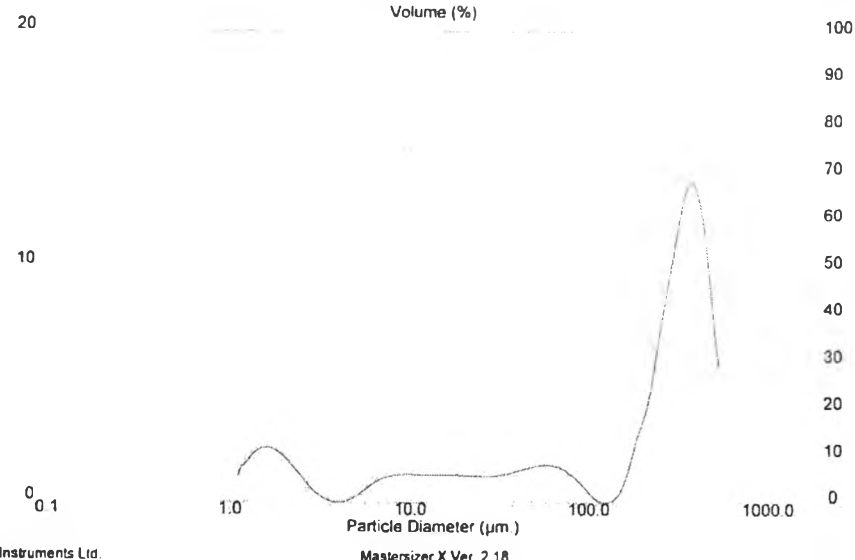
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 248.51 um

Concentration = 0.0300 %Vol
D (v, 0.1) = 2.64 um
D [3, 2] = 12.36 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 285.88 um
Span = 1.643E+00

Specific S.A. = 0.4856 sq. m / g
D (v, 0.9) = 472.27 um
Uniformity = 5.427E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	1.13	1.32	1.13	25.46	1.41	31.01	23.35
1.32	2.45	1.60	3.58	31.01	1.49	37.79	24.85
1.60	2.96	1.95	6.54	37.79	1.70	46.03	26.55
1.95	2.52	2.38	9.06	46.03	1.94	56.09	28.49
2.38	1.53	2.90	10.59	56.09	2.03	68.33	30.52
2.90	0.58	3.53	11.18	68.33	1.77	83.26	32.29
3.53	0.06	4.30	11.24	83.26	1.06	101.44	33.35
4.30	0.08	5.24	11.32	101.44	0.22	123.59	33.57
5.24	0.57	6.39	11.89	123.59	0.08	150.57	33.66
6.39	1.17	7.78	13.06	150.57	1.37	183.44	35.03
7.78	1.46	9.48	14.52	183.44	4.09	223.51	39.14
9.48	1.52	11.55	16.03	223.51	8.09	272.31	47.23
11.55	1.49	14.08	17.53	272.31	13.16	331.77	60.37
14.08	1.48	17.15	19.01	331.77	17.21	404.21	77.57
17.15	1.48	20.90	20.49	404.21	15.04	492.47	92.58
20.90	1.45	25.46	21.94	492.47	7.38	600.00	100.00



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p. 3
12 Jul 11 11:52

Figure J3 PSA reference of XK-03, run number 3.

Result: Analysis Report

Sample Details

Sample ID: XK-03
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes

Run Number: 4
Record Number 4

Measured: Tue Jul 12 2011 10:39AM
Analysed: Tue Jul 12 2011 10:39AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration 17.8 %
Residual 2.668 %

Result Statistics

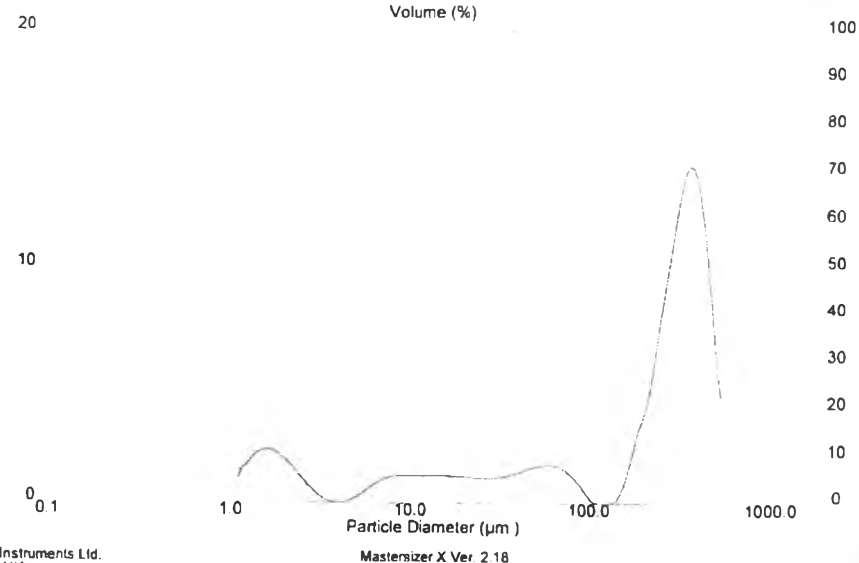
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 246.23 um

Concentration = 0.0311 %Vol
D (v, 0.1) = 2.73 um
D [3, 2] = 12.63 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 284.90 um
Span = 1.600E+00

Specific S.A. = 0.4752 sq. m / g
D (v, 0.9) = 458.49 um
Uniformity = 5.239E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	1.10	1.32	1.10	25.46	1.34	31.01	22.83
1.32	2.39	1.60	3.49	31.01	1.41	37.79	24.24
1.60	2.89	1.95	6.38	37.79	1.64	46.03	25.88
1.95	2.47	2.38	8.85	46.03	1.92	56.09	27.80
2.38	1.50	2.90	10.35	56.09	2.06	68.33	29.85
2.90	0.57	3.53	10.92	68.33	1.78	83.26	31.63
3.53	0.06	4.30	10.99	83.26	0.99	101.44	32.62
4.30	0.08	5.24	11.07	101.44	0.03	123.59	32.65
5.24	0.56	6.39	11.63	123.59	0.00	150.57	32.67
6.39	1.14	7.78	12.77	150.57	1.41	183.44	34.07
7.78	1.43	9.48	14.20	183.44	4.39	223.51	38.48
9.48	1.49	11.55	15.69	223.51	8.74	272.31	47.21
11.55	1.48	14.08	17.17	272.31	14.28	331.77	61.47
14.08	1.47	17.15	18.64	331.77	18.26	404.21	79.71
17.15	1.46	20.90	20.10	404.21	14.61	492.47	94.29
20.90	1.39	25.46	21.49	492.47	5.66	600.00	100.00



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p. 4
12 Jul 11 11:53

Figure J4 PSA reference of XK-03, run number 4.

Result: Analysis Report

Sample Details

Sample ID: XK-03
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 5
Record Number: 5

Measured: Tue Jul 12 2011 10:39AM
Analysed: Tue Jul 12 2011 10:39AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
(Particle R.I. = (1.5295, 0.1000)

Sampler: MS17
Dispersant R.I. = 1.3300]

Obscuration: 17.5 %
Residual: 2.792 %

Result Statistics

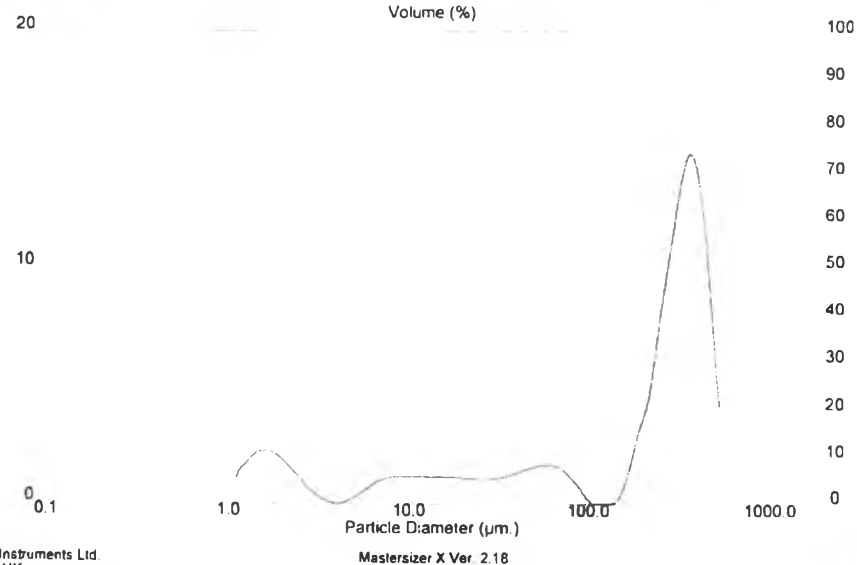
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 246.34 um

Concentration = 0.0310 %Vol
D (v, 0.1) = 2.80 um
D [3, 2] = 12.81 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 286.89 um
Span = 1.570E+00

Specific S.A. = 0.4686 sq. m / g
D (v, 0.9) = 453.29 um
Uniformity = 5.112E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	1.08	1.32	1.09	25.46	1.32	31.01	22.48
1.32	2.36	1.60	3.44	31.01	1.41	37.79	23.89
1.60	2.85	1.95	6.29	37.79	1.66	46.03	25.55
1.95	2.43	2.38	8.71	46.03	1.96	56.09	27.51
2.38	1.48	2.90	10.19	56.09	2.09	68.33	29.61
2.90	0.57	3.53	10.76	68.33	1.76	83.26	31.37
3.53	0.06	4.30	10.83	83.26	0.87	101.44	32.23
4.30	0.08	5.24	10.91	101.44	0.00	123.59	32.24
5.24	0.55	6.39	11.46	123.59	0.00	150.57	32.26
6.39	1.12	7.78	12.58	150.57	1.22	183.44	33.47
7.78	1.42	9.48	14.00	183.44	4.30	223.51	37.79
9.48	1.48	11.55	15.48	223.51	8.88	272.31	46.67
11.55	1.46	14.08	16.93	272.31	14.82	331.77	61.47
14.08	1.44	17.15	18.38	331.77	18.99	404.21	80.43
17.15	1.42	20.90	19.80	404.21	14.59	492.47	94.99
20.90	1.36	25.46	21.16	492.47	4.96	600.00	100.00



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p. 5
12 Jul 11 11:54

Figure J5 PSA reference of XK-03, run number 5.

Result: Analysis Report

Sample Details

Sample ID: XK-03
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 6
Record Number: 6

Measured: Tue Jul 12 2011 10:40AM
Analysed: Tue Jul 12 2011 10:40AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 17.0 %
Residual: 2.530 %

Result Statistics

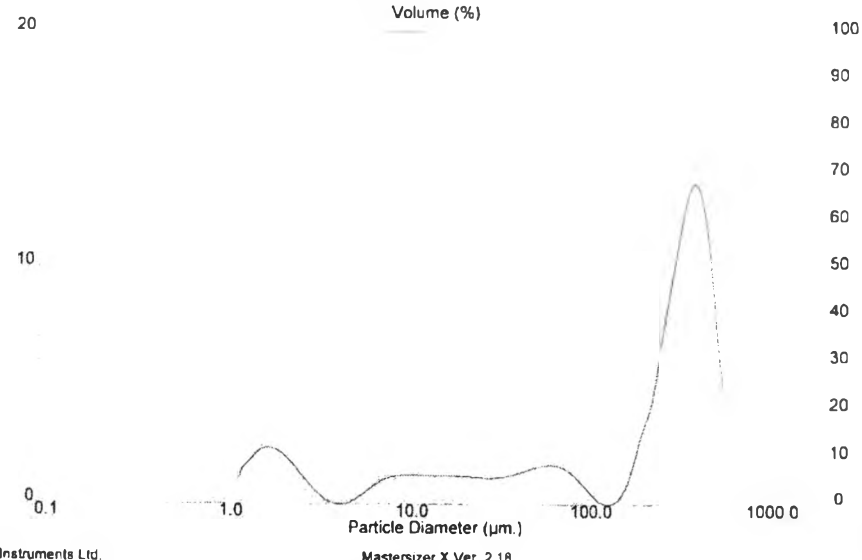
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 241.37 um

Concentration = 0.0282 %Vol
D (v, 0.1) = 2.56 um
D [3, 2] = 12.03 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 278.43 um
Span = 1.647E+00

Specific S.A. = 0.4987 sq. m / g
D (v, 0.9) = 461.19 um
Uniformity = 5.521E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	1.15	1.32	1.16	25.46	1.42	31.01	24.05
1.32	2.51	1.60	3.66	31.01	1.49	37.79	25.54
1.60	3.04	1.95	6.70	37.79	1.72	46.03	27.26
1.95	2.59	2.38	9.29	46.03	1.99	56.09	29.24
2.38	1.58	2.90	10.87	56.09	2.10	68.33	31.34
2.90	0.61	3.53	11.48	68.33	1.84	83.26	33.18
3.53	0.07	4.30	11.56	83.26	1.09	101.44	34.28
4.30	0.09	5.24	11.65	101.44	0.21	123.59	34.49
5.24	0.59	6.39	12.24	123.59	0.08	150.57	34.57
6.39	1.20	7.78	13.44	150.57	1.45	183.44	36.01
7.78	1.52	9.48	14.96	183.44	4.27	223.51	40.30
9.48	1.58	11.55	16.54	223.51	8.42	272.31	48.72
11.55	1.56	14.08	18.10	272.31	13.60	331.77	62.31
14.08	1.54	17.15	19.64	331.77	17.31	404.21	79.60
17.15	1.53	20.90	21.17	404.21	14.30	492.47	93.86
20.90	1.46	25.46	22.63	492.47	6.09	600.00	100.00



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Mastersizer X Ver. 2.18
Serial Number: MAL300122

p. 6
12 Jul 11 11:54

Figure J6 PSA reference of XK-03, run number 6.

Result: Analysis Report

Sample Details

Sample ID: XK-03
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 7
Record Number: 7

Measured: Tue Jul 12 2011 10:40AM
Analysed: Tue Jul 12 2011 10:40AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
(Particle R.I. = (1.5295, 0.1000);

Sampler: MS17
Dispersant R.I. = 1.3300]

Obscuration: 17.0 %
Residual: 2.390 %

Result Statistics

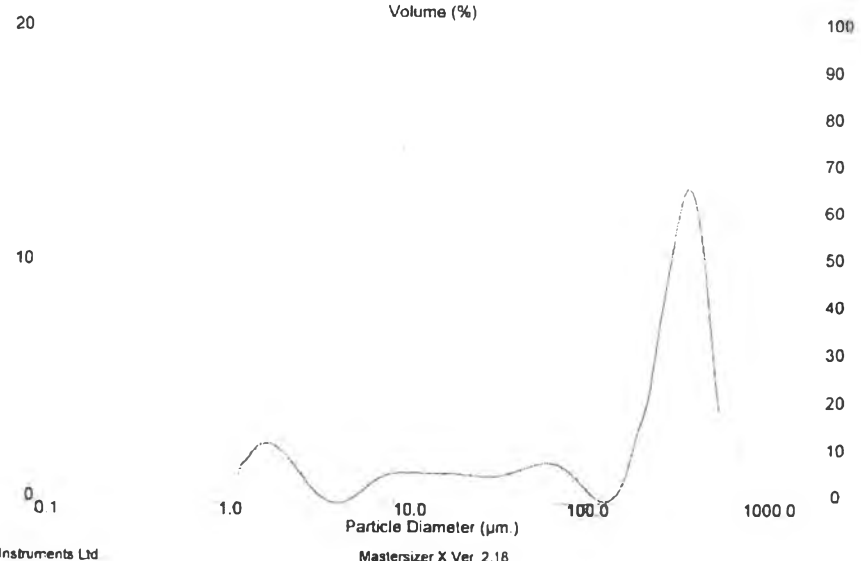
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 231.11 um

Concentration = 0.0267 %Vol
D (v, 0.1) = 2.42 um
D [3, 2] = 11.39 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 266.94 um
Span = 1.678E+00

Specific S.A. = 0.5267 sq. m / g
D (v, 0.9) = 450.34 um
Uniformity = 5.763E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	1.22	1.32	1.22	25.46	1.46	31.01	25.40
1.32	2.66	1.60	3.88	31.01	1.52	37.79	26.92
1.60	3.22	1.95	7.09	37.79	1.76	46.03	28.68
1.95	2.74	2.38	9.83	46.03	2.05	56.09	30.72
2.38	1.68	2.90	11.51	56.09	2.19	68.33	32.92
2.90	0.64	3.53	12.15	68.33	1.95	83.26	34.87
3.53	0.07	4.30	12.23	83.26	1.23	101.44	36.10
4.30	0.10	5.24	12.33	101.44	0.35	123.59	36.45
5.24	0.63	6.39	12.96	123.59	0.21	150.57	36.66
6.39	1.28	7.78	14.23	150.57	1.56	183.44	38.23
7.78	1.61	9.48	15.84	183.44	4.38	223.51	42.63
9.48	1.68	11.55	17.52	223.51	8.49	272.31	51.12
11.55	1.65	14.08	19.17	272.31	13.59	331.77	64.69
14.08	1.63	17.15	20.80	331.77	17.05	404.21	81.72
17.15	1.61	20.90	22.41	404.21	13.36	492.47	95.05
20.90	1.53	25.46	23.94	492.47	4.90	600.00	100.00



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12 Jul 11 11:55

Figure J7 PSA reference of XK-03, run number 7.

Result: Analysis Report

Sample Details

Sample ID: XK-03
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 8
Record Number: 8

Measured: Tue Jul 12 2011 10:41AM
Analysed: Tue Jul 12 2011 10:41AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 17.1 %
Residual: 3.128 %

Result Statistics

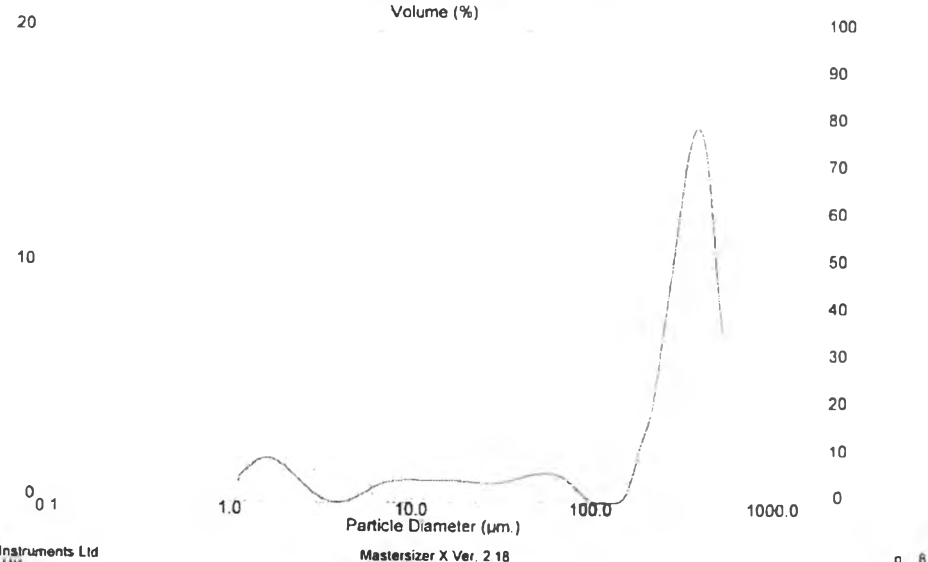
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 280.81 um

Concentration = 0.0362 %Vol
D (v, 0.1) = 7.19 um
D [3, 2] = 15.39 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 321.35 um
Span = 1.497E+00

Specific S.A. = 0.3898 sq. m / g
D (v, 0.9) = 488.11 um
Uniformity = 4.520E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.89	1.32	0.89	25.46	1.09	31.01	18.69
1.32	1.94	1.60	2.84	31.01	1.15	37.79	19.84
1.60	2.35	1.95	5.19	37.79	1.34	46.03	21.19
1.95	2.01	2.38	7.20	46.03	1.57	56.09	22.75
2.38	1.23	2.90	8.43	56.09	1.62	68.33	24.37
2.90	0.47	3.53	8.90	68.33	1.30	83.26	25.67
3.53	0.06	4.30	8.96	83.26	0.53	101.44	26.20
4.30	0.07	5.24	9.03	101.44	0.00	123.59	26.21
5.24	0.46	6.39	9.49	123.59	0.00	150.57	26.21
6.39	0.93	7.78	10.42	150.57	0.84	183.44	27.05
7.78	1.18	9.48	11.59	183.44	3.67	223.51	30.73
9.48	1.24	11.55	12.83	223.51	7.99	272.31	38.72
11.55	1.23	14.08	14.05	272.31	14.00	331.77	52.70
14.08	1.22	17.15	15.27	331.77	19.70	404.21	72.40
17.15	1.20	20.90	16.47	404.21	18.28	492.47	90.64
20.90	1.13	25.46	17.60	492.47	9.31	600.00	100.00



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p. 8
12 Jul 11 11:56

Figure J8 PSA reference of XK-03, run number 8.

Result: Analysis Report

Sample Details

Sample ID: XK-03
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 9
Record Number: 9

Measured: Tue Jul 12 2011 10:41AM
Analysed: Tue Jul 12 2011 10:41AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000): Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 17.2 %
Residual: 2.536 %

Result Statistics

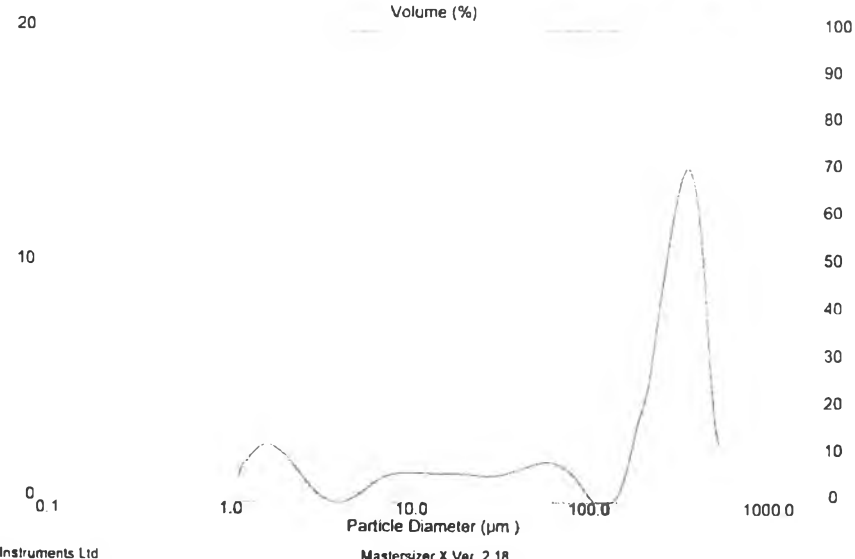
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 228.86 um

Concentration = 0.0277 %Vol
D (v, 0.1) = 2.49 um
D [3, 2] = 11.72 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 267.14 um
Span = 1.613E+00

Specific S.A. = 0.5119 sq. m / g
D (v, 0.9) = 433.42 um
Uniformity = 5.486E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	1.18	1.32	1.19	25.46	1.43	31.01	24.68
1.32	2.58	1.60	3.76	31.01	1.51	37.79	26.18
1.60	3.12	1.95	6.88	37.79	1.75	46.03	27.93
1.95	2.66	2.38	9.54	46.03	2.05	56.09	29.98
2.38	1.63	2.90	11.16	56.09	2.17	68.33	32.15
2.90	0.63	3.53	11.79	68.33	1.87	83.26	34.02
3.53	0.07	4.30	11.87	83.26	1.02	101.44	35.04
4.30	0.10	5.24	11.97	101.44	0.05	123.59	35.09
5.24	0.61	6.39	12.58	123.59	0.03	150.57	35.13
6.39	1.24	7.78	13.82	150.57	1.71	183.44	36.84
7.78	1.56	9.48	15.37	183.44	4.89	223.51	41.75
9.48	1.62	11.55	17.00	223.51	9.46	272.31	51.20
11.55	1.60	14.08	18.60	272.31	15.06	331.77	66.24
14.08	1.59	17.15	20.19	331.77	18.09	404.21	84.31
17.15	1.57	20.90	21.75	404.21	12.47	492.47	96.72
20.90	1.49	25.46	23.24	492.47	3.21	600.00	100.00



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p. 9
12 Jul 11 11:57

Figure J9 PSA reference of XK-03, run number 9.

Result: Analysis Report

Sample Details

Sample ID: XK-03
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes

Run Number: 10
Record Number 10

Measured: Tue Jul 12 2011 10:42AM
Analysed: Tue Jul 12 2011 10:42AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 17.5 %
Residual: 2.119 %

Result Statistics

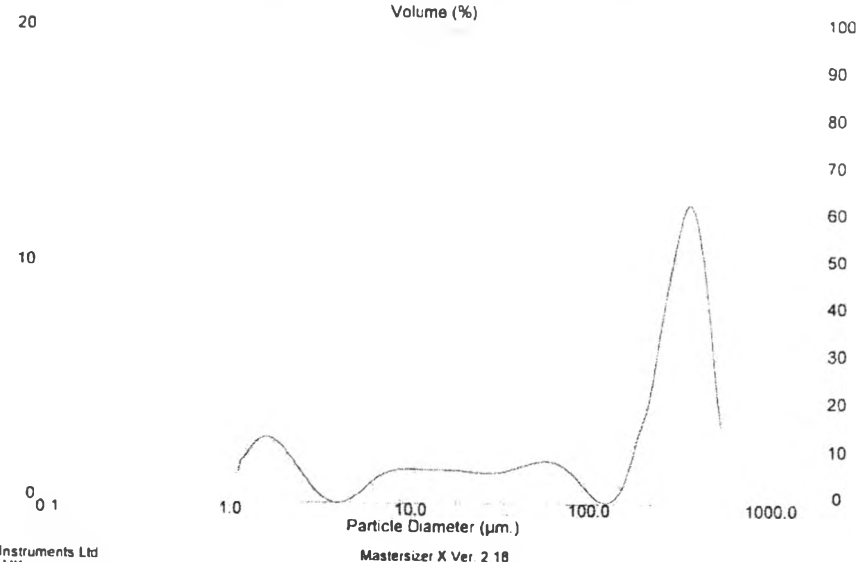
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 216.45 um

Concentration = 0.0248 %Vol
D (v, 0.1) = 2.22 um
D [3, 2] = 10.27 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 249.32 um
Span = 1.757E+00

Specific S.A. = 0.5843 sq. m / g
D (v, 0.9) = 440.32 um
Uniformity = 6.245E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	1.35	1.32	1.36	25.46	1.67	31.01	28.41
1.32	2.95	1.60	4.31	31.01	1.74	37.79	30.15
1.60	3.58	1.95	7.88	37.79	1.97	46.03	32.11
1.95	3.05	2.38	10.93	46.03	2.23	56.09	34.34
2.38	1.87	2.90	12.80	56.09	2.31	68.33	36.65
2.90	0.72	3.53	13.53	68.33	1.98	83.26	38.63
3.53	0.09	4.30	13.62	83.26	1.19	101.44	39.82
4.30	0.12	5.24	13.74	101.44	0.30	123.59	40.12
5.24	0.70	6.39	14.44	123.59	0.16	150.57	40.28
6.39	1.42	7.78	15.87	150.57	1.50	183.44	41.78
7.78	1.79	9.48	17.65	183.44	4.28	223.51	46.07
9.48	1.87	11.55	19.52	223.51	8.37	272.31	54.44
11.55	1.84	14.08	21.36	272.31	13.28	331.77	67.70
14.08	1.83	17.15	23.19	331.77	16.18	404.21	83.87
17.15	1.81	20.90	25.00	404.21	12.05	492.47	95.89
20.90	1.73	25.46	26.74	492.47	4.07	600.00	100.00



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p. 10
12 Jul 11 11:58

Figure J10 PSA reference of XK-03, run number 10.

J.3.2 FIRST Coal

Result: Analysis Report

Sample Details

Sample ID: FIRST Coal
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 1
Record Number: 11

Measured: Tue Jul 12 2011 10:49AM
Analysed: Tue Jul 12 2011 10:49AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 17.0 %
Residual: 5.361 %

Result Statistics

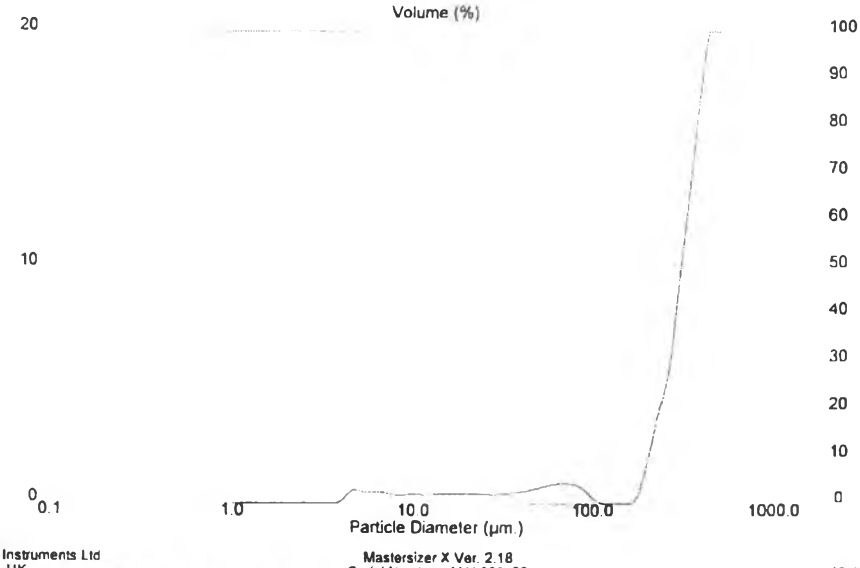
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 383.41 um

Concentration = 0.2785 %Vol
D (v, 0.1) = 88.92 um
D [3, 2] = 112.16 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 413.71 um
Span = 1.134E+00

Specific S.A. = 0.0535 sq. m / g
D (v, 0.9) = 558.01 um
Uniformity = 2.840E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.51	31.01	5.53
1.32	0.00	1.60	0.00	31.01	0.54	37.79	6.06
1.60	0.00	1.95	0.00	37.79	0.65	46.03	6.71
1.95	0.00	2.38	0.00	46.03	0.84	56.09	7.55
2.38	0.00	2.90	0.00	56.09	1.04	68.33	8.59
2.90	0.00	3.53	0.00	68.33	1.09	83.26	9.67
3.53	0.00	4.30	0.01	83.26	0.79	101.44	10.46
4.30	0.62	5.24	0.61	101.44	0.10	123.59	10.57
5.24	0.63	6.39	1.25	123.59	0.00	150.57	10.57
6.39	0.62	7.78	1.87	150.57	0.00	183.44	10.57
7.78	0.48	9.48	2.35	183.44	1.86	223.51	12.44
9.48	0.52	11.55	2.87	223.51	5.39	272.31	17.85
11.55	0.50	14.08	3.37	272.31	10.90	331.77	28.73
14.08	0.54	17.15	3.91	331.77	18.55	404.21	47.30
17.15	0.56	20.90	4.47	404.21	25.55	492.47	72.82
20.90	0.54	25.46	5.01	492.47	27.18	600.00	100.00



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p. 11
12 Jul 11 11:56

Figure J11 PSA reference of FIRST coal, run number 1.

Result: Analysis Report

Sample Details

Sample ID: FIRST Coal
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 2
Record Number: 12

Measured: Tue Jul 12 2011 10:55AM
Analysed: Tue Jul 12 2011 10:55AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 18.9 %
Residual: 4.610 %

Result Statistics

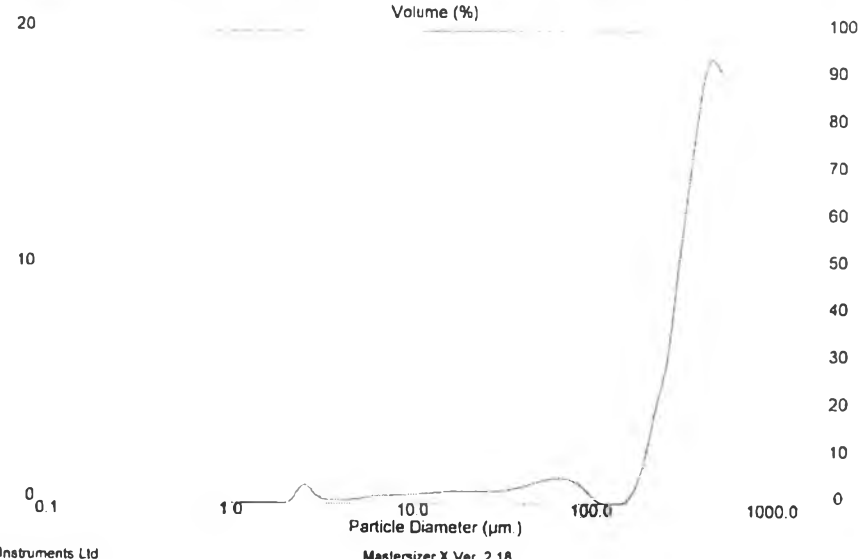
Distribution Type: Volume
Mean Diameters
D [4, 3] = 363.50 um

Concentration = 0.2069 %Vol
D (v, 0.1) = 60.29 um
D [3, 2] = 76.76 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 394.44 um
Span = 1.244E+00

Specific S.A. = 0.0782 sq. m / g
D (v, 0.9) = 551.07 um
Uniformity = 3.187E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.68	31.01	6.72
1.32	0.00	1.60	0.00	31.01	0.73	37.79	7.45
1.60	0.00	1.95	0.00	37.79	0.91	46.03	8.36
1.95	0.00	2.38	0.01	46.03	1.16	56.09	9.52
2.38	0.88	2.90	0.87	56.09	1.36	68.33	10.88
2.90	0.42	3.53	1.29	68.33	1.35	83.26	12.22
3.53	0.22	4.30	1.51	83.26	0.92	101.44	13.15
4.30	0.22	5.24	1.73	101.44	0.15	123.59	13.30
5.24	0.32	6.39	2.05	123.59	0.00	150.57	13.29
6.39	0.42	7.78	2.46	150.57	0.31	183.44	13.60
7.78	0.46	9.48	2.92	183.44	2.46	223.51	16.08
9.48	0.51	11.55	3.44	223.51	6.18	272.31	22.27
11.55	0.57	14.08	4.01	272.31	11.72	331.77	33.97
14.08	0.65	17.15	4.66	331.77	18.88	404.21	52.67
17.15	0.69	20.90	5.35	404.21	23.85	492.47	76.49
20.90	0.69	25.46	6.04	492.47	23.51	600.00	100.00



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p. 12
12 Jul 11 11:59

Figure J12 PSA reference of FIRST coal, run number 2.

Result: Analysis Report

Sample Details

Sample ID: FIRST Coal
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 3
Record Number 13

Measured: Tue Jul 12 2011 10:56AM
Analysed: Tue Jul 12 2011 10:56AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 18.7 %

Residual: 5.425 %

Result Statistics

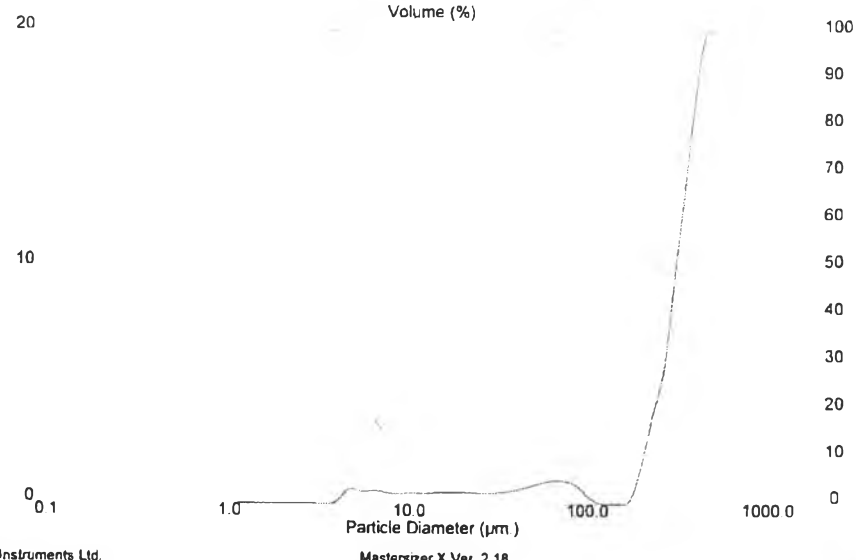
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 376.53 um

Concentration = 0.2880 %Vol
D (v, 0.1) = 71.68 um
D [3, 2] = 104.04 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 408.70 um
Span = 1.187E+00

Specific S.A. = 0.0577 sq. m / g
D (v, 0.9) = 556.70 um
Uniformity = 2.984E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.58	31.01	6.14
1.32	0.00	1.60	0.00	31.01	0.62	37.79	6.76
1.60	0.00	1.95	0.00	37.79	0.76	46.03	7.53
1.95	0.00	2.38	0.00	46.03	0.98	56.09	8.51
2.38	0.00	2.90	0.00	56.09	1.19	68.33	9.70
2.90	0.00	3.53	0.00	68.33	1.23	83.26	10.92
3.53	0.00	4.30	0.01	83.26	0.90	101.44	11.83
4.30	0.65	5.24	0.65	101.44	0.18	123.59	12.01
5.24	0.69	6.39	1.34	123.59	0.00	150.57	12.01
6.39	0.69	7.78	2.03	150.57	0.00	183.44	12.02
7.78	0.54	9.48	2.57	183.44	1.95	223.51	13.97
9.48	0.58	11.55	3.15	223.51	5.48	272.31	19.47
11.55	0.57	14.08	3.71	272.31	10.94	331.77	30.38
14.08	0.61	17.15	4.32	331.77	18.34	404.21	48.74
17.15	0.62	20.90	4.95	404.21	24.94	492.47	73.65
20.90	0.61	25.46	5.56	492.47	26.35	600.00	100.00



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p. 13
12 Jul 11 12:00

Figure J13 PSA reference of FIRST coal, run number 3.

Result: Analysis Report

Sample Details

Sample ID: FIRST Coal
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 4
Record Number: 14

Measured: Tue Jul 12 2011 10:57AM
Analysed: Tue Jul 12 2011 10:57AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 18.9 %
Residual: 4.549 %

Result Statistics

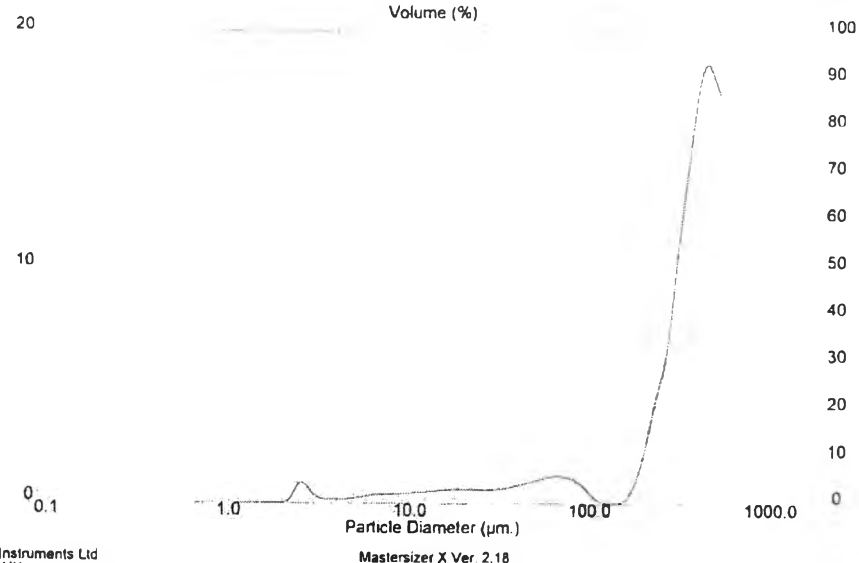
Distribution Type: Volume
Mean Diameters
D [4, 3] = 358.16 um

Concentration = 0.1988 %Vol
D (v, 0.1) = 56.05 um
D [3, 2] = 73.50 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 389.81 um
Span = 1.262E+00

Specific S.A. = 0.0816 sq. m / g
D (v, 0.9) = 548.11 um
Uniformity = 3.260E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.71	31.01	7.08
1.32	0.00	1.60	0.00	31.01	0.77	37.79	7.85
1.60	0.00	1.95	0.00	37.79	0.95	46.03	8.80
1.95	0.00	2.38	0.01	46.03	1.21	56.09	10.00
2.38	0.92	2.90	0.92	56.09	1.43	68.33	11.44
2.90	0.44	3.53	1.36	68.33	1.44	83.26	12.88
3.53	0.23	4.30	1.59	83.26	1.03	101.44	13.91
4.30	0.23	5.24	1.82	101.44	0.24	123.59	14.16
5.24	0.33	6.39	2.15	123.59	0.00	150.57	14.16
6.39	0.44	7.78	2.59	150.57	0.37	183.44	14.53
7.78	0.48	9.48	3.08	183.44	2.56	223.51	17.10
9.48	0.54	11.55	3.62	223.51	6.27	272.31	23.38
11.55	0.60	14.08	4.23	272.31	11.78	331.77	35.14
14.08	0.68	17.15	4.91	331.77	18.79	404.21	53.95
17.15	0.73	20.90	5.63	404.21	23.75	492.47	77.67
20.90	0.73	25.46	6.36	492.47	22.32	600.00	100.00



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p. 14
12 Jul 11 12:01

Figure J14 PSA reference of FIRST coal, run number 4.

Result: Analysis Report

Sample Details

Sample ID: FIRST Coal
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 5
Record Number: 15

Measured: Tue Jul 12 2011 10:57AM
Analysed: Tue Jul 12 2011 10:58AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000). Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 10.2 %
Residual: 4.696 %

Result Statistics

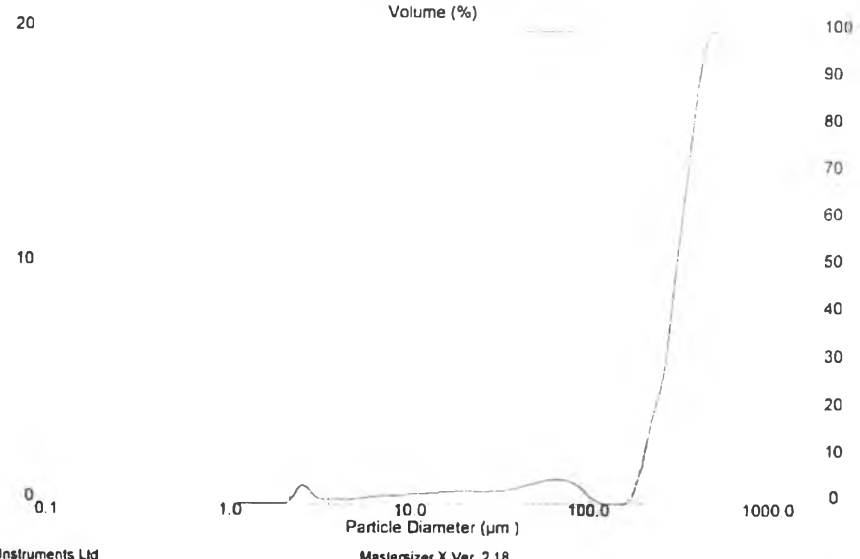
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 371.13 um

Concentration = 0.2129 %Vol
D (v, 0.1) = 61.27 um
D [3, 2] = 77.65 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 405.34 um
Span = 1.222E+00

Specific S.A. = 0.0773 sq. m / g
D (v, 0.9) = 556.50 um
Uniformity = 3.113E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.69	31.01	6.69
1.32	0.00	1.60	0.00	31.01	0.74	37.79	7.42
1.60	0.00	1.95	0.00	37.79	0.89	46.03	8.31
1.95	0.00	2.38	0.01	46.03	1.12	56.09	9.43
2.38	0.87	2.90	0.86	56.09	1.31	68.33	10.74
2.90	0.41	3.53	1.28	68.33	1.32	83.26	12.06
3.53	0.22	4.30	1.50	83.26	0.96	101.44	13.01
4.30	0.21	5.24	1.71	101.44	0.23	123.59	13.24
5.24	0.31	6.39	2.02	123.59	0.00	150.57	13.25
6.39	0.42	7.78	2.44	150.57	0.10	183.44	13.34
7.78	0.46	9.48	2.89	183.44	2.02	223.51	15.37
9.48	0.51	11.55	3.40	223.51	5.53	272.31	20.91
11.55	0.57	14.08	3.97	272.31	10.87	331.77	31.76
14.08	0.64	17.15	4.61	331.77	17.91	404.21	49.69
17.15	0.69	20.90	5.31	404.21	24.23	492.47	73.90
20.90	0.69	25.46	6.00	492.47	28.11	600.00	100.00



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p. 6
12 Jul 11 12:08

Figure J15 PSA reference of FIRST coal, run number 5.

Result: Analysis Report

Sample Details

Sample ID: FIRST Coal
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 6
Record Number: 16

Measured: Tue Jul 12 2011 10:58AM
Analysed: Tue Jul 12 2011 10:58AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000), Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 19.2 %
Residual: 4.913 %

Result Statistics

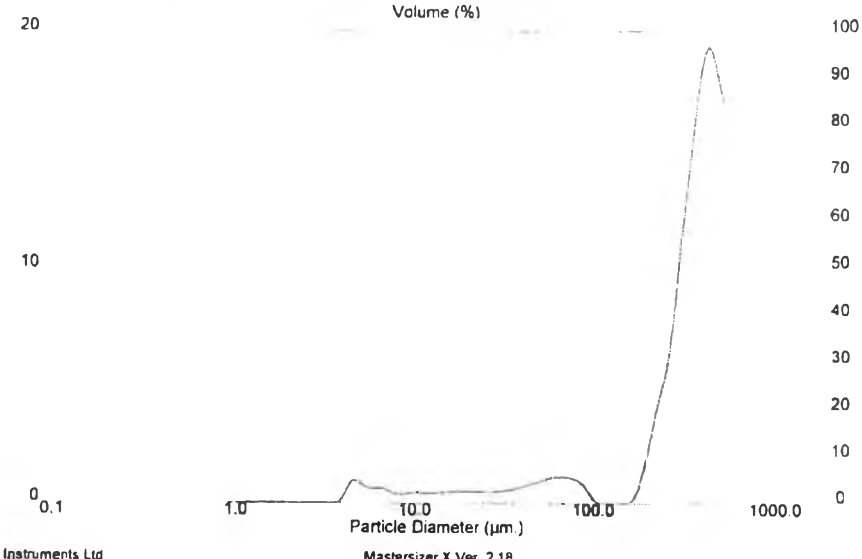
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 361.46 um

Concentration = 0.2556 %Vol
D (v, 0.1) = 59.49 um
D [3, 2] = 90.03 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 392.09 um
Span = 1.241E+00

Specific S.A. = 0.0666 sq. m / g
D (v, 0.9) = 546.15 um
Uniformity = 3.147E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.63	31.01	6.89
1.32	0.00	1.60	0.00	31.01	0.69	37.79	7.58
1.60	0.00	1.95	0.00	37.79	0.88	46.03	8.46
1.95	0.00	2.38	0.00	46.03	1.15	56.09	9.60
2.38	0.00	2.90	0.00	56.09	1.39	68.33	10.99
2.90	0.00	3.53	0.00	68.33	1.40	83.26	12.39
3.53	0.00	4.30	0.01	83.26	0.92	101.44	13.30
4.30	1.06	5.24	1.05	101.44	0.00	123.59	13.31
5.24	0.90	6.39	1.96	123.59	0.00	150.57	13.32
6.39	0.80	7.78	2.76	150.57	0.11	183.44	13.43
7.78	0.50	9.48	3.26	183.44	2.35	223.51	15.79
9.48	0.57	11.55	3.83	223.51	6.13	272.31	21.93
11.55	0.54	14.08	4.37	272.31	11.94	331.77	33.85
14.08	0.61	17.15	4.98	331.77	19.63	404.21	53.50
17.15	0.64	20.90	5.61	404.21	24.74	492.47	78.19
20.90	0.64	25.46	6.25	492.47	21.79	600.00	100.00



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p. 7
12 Jul 11 12:09

Figure J16 PSA reference of FIRST coal, run number 6.

Result: Analysis Report

Sample Details

Sample ID: FIRST Coal
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 7
Record Number: 17

Measured: Tue Jul 12 2011 10:58AM
Analysed: Tue Jul 12 2011 10:58AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
{Particle R.I. = (1.5295, 0.1000): Dispersant R.I. = 1.3300}

Sampler: MS17

Obscuration: 19.3 %
Residual: 4.562 %

Result Statistics

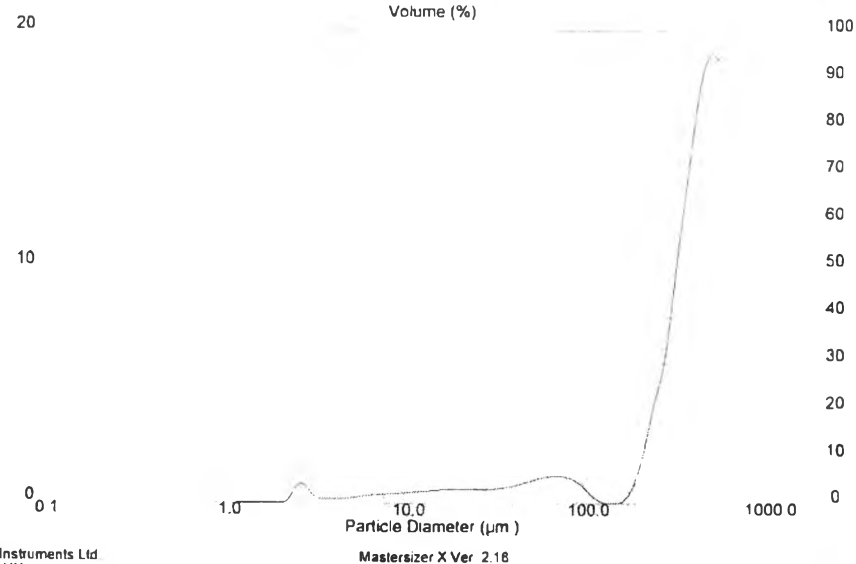
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 362.82 um

Concentration = 0.2039 %Vol
D (v, 0.1) = 55.95 um
D [3, 2] = 73.77 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 396.17 um
Span = 1.254E+00

Specific S.A. = 0.0813 sq. m / g
D (v, 0.9) = 552.65 um
Uniformity = 3.238E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.72	31.01	7.09
1.32	0.00	1.60	0.00	31.01	0.78	37.79	7.87
1.60	0.00	1.95	0.00	37.79	0.95	46.03	8.82
1.95	0.00	2.38	0.01	46.03	1.19	56.09	10.02
2.38	0.92	2.90	0.91	56.09	1.40	68.33	11.42
2.90	0.43	3.53	1.35	68.33	1.40	83.26	12.82
3.53	0.23	4.30	1.58	83.26	1.01	101.44	13.83
4.30	0.23	5.24	1.81	101.44	0.26	123.59	14.09
5.24	0.34	6.39	2.14	123.59	0.00	150.57	14.09
6.39	0.44	7.78	2.59	150.57	0.28	183.44	14.38
7.78	0.49	9.48	3.08	183.44	2.33	223.51	16.72
9.48	0.55	11.55	3.63	223.51	5.94	272.31	22.68
11.55	0.61	14.08	4.24	272.31	11.31	331.77	33.97
14.08	0.68	17.15	4.92	331.77	18.17	404.21	52.16
17.15	0.73	20.90	5.65	404.21	23.70	492.47	75.83
20.90	0.73	25.46	6.37	492.47	24.17	600.00	100.00



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p. 8
12 Jul 11 12:10

Figure J17 PSA reference of FIRST coal, run number 7.

Result: Analysis Report

Sample Details

Sample ID: FIRST Coal
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 8
Record Number: 18

Measured: Tue Jul 12 2011 10:59AM
Analysed: Tue Jul 12 2011 10:59AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000), Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 19.3 %
Residual: 4.748 %

Result Statistics

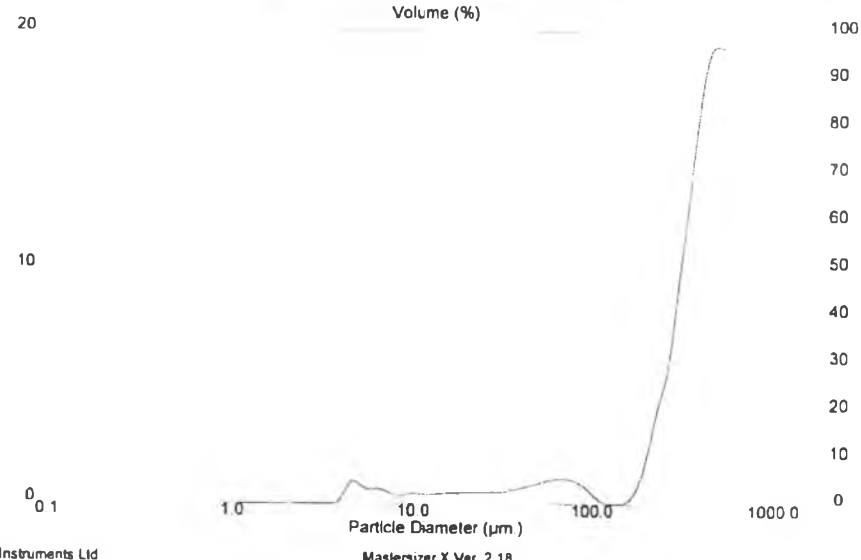
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 366.64 um

Concentration = 0.2572 %Vol
D (v, 0.1) = 60.01 um
D [3, 2] = 90.53 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 400.16 um
Span = 1.235E+00

Specific S.A. = 0.0663 sq. m / g
D (v, 0.9) = 554.04 um
Uniformity = 3.173E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.64	31.01	6.86
1.32	0.00	1.60	0.00	31.01	0.71	37.79	7.56
1.60	0.00	1.95	0.00	37.79	0.88	46.03	8.44
1.95	0.00	2.38	0.00	46.03	1.12	56.09	9.56
2.38	0.00	2.90	0.00	56.09	1.34	68.33	10.90
2.90	0.00	3.53	0.00	68.33	1.36	83.26	12.26
3.53	0.00	4.30	0.01	83.26	1.01	101.44	13.27
4.30	1.05	5.24	1.04	101.44	0.27	123.59	13.54
5.24	0.90	6.39	1.94	123.59	0.00	150.57	13.54
6.39	0.80	7.78	2.74	150.57	0.26	183.44	13.80
7.78	0.50	9.48	3.24	183.44	2.27	223.51	16.09
9.48	0.56	11.55	3.81	223.51	5.78	272.31	21.89
11.55	0.53	14.08	4.34	272.31	11.10	331.77	32.96
14.08	0.60	17.15	4.94	331.77	18.14	404.21	51.12
17.15	0.63	20.90	5.57	404.21	24.04	492.47	75.13
20.90	0.64	25.46	6.22	492.47	24.86	600.00	100.00



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p. 9
12 Jul 11 12:11

Figure J18 PSA reference of FIRST coal, run number 8.

Result: Analysis Report

Sample Details

Sample ID: FIRST Coal
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 10
Record Number: 20

Measured: Tue Jul 12 2011 10:59AM
Analysed: Tue Jul 12 2011 10:59AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
(Particle R.I. = (1.5295, 0.1000), Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 19.1 %
Residual: 4.841 %

Result Statistics

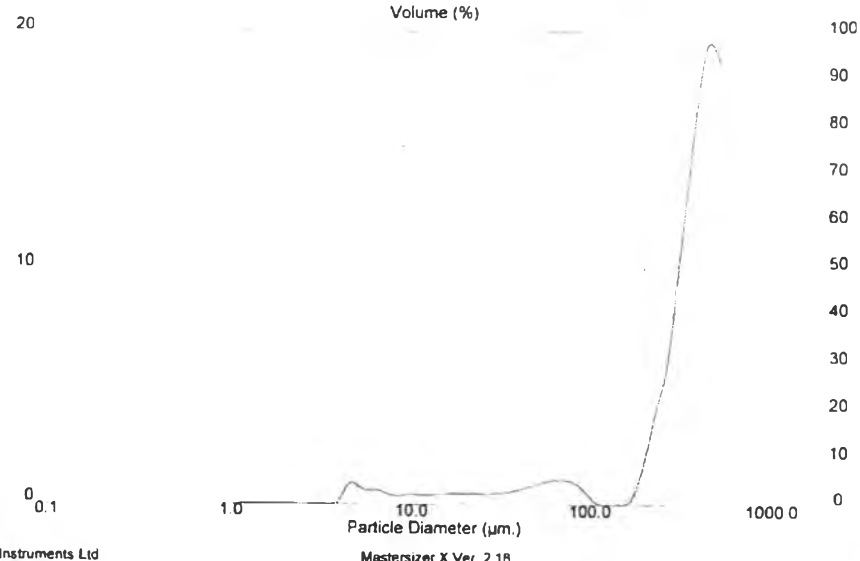
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 368.75 um

Concentration = 0.2678 %Vol
D (v, 0.1) = 66.34 um
D [3, 2] = 95.17 um

Density = 1.000 g / cub cm
D (v, 0.5) = 399.88 um
Span = 1.214E+00

Specific S.A. = 0.0630 sq m / g
D (v, 0.9) = 551.63 um
Uniformity = 3.074E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.59	31.01	6.41
1.32	0.00	1.60	0.00	31.01	0.64	37.79	7.05
1.60	0.00	1.95	0.00	37.79	0.81	46.03	7.86
1.95	0.00	2.38	0.00	46.03	1.06	56.09	8.91
2.38	0.00	2.90	0.00	56.09	1.29	68.33	10.20
2.90	0.00	3.53	0.00	68.33	1.32	83.26	11.52
3.53	0.00	4.30	0.01	83.26	0.93	101.44	12.45
4.30	0.98	5.24	0.98	101.44	0.11	123.59	12.57
5.24	0.84	6.39	1.82	123.59	0.00	150.57	12.57
6.39	0.75	7.78	2.57	150.57	0.13	183.44	12.70
7.78	0.47	9.48	3.04	183.44	2.24	223.51	14.95
9.48	0.53	11.55	3.57	223.51	5.86	272.31	20.82
11.55	0.50	14.08	4.07	272.31	11.45	331.77	32.24
14.08	0.57	17.15	4.64	331.77	19.00	404.21	51.26
17.15	0.59	20.90	5.23	404.21	24.83	492.47	76.05
20.90	0.59	25.46	5.82	492.47	23.94	600.00	100.00



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p. 11
12 Jul 11 12:12

Figure J19 PSA reference of FIRST coal, run number 9.

Result: Analysis Report

Sample Details

Sample ID: FIRST Coal
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 10
Record Number: 20

Measured: Tue Jul 12 2011 10:59AM
Analysed: Tue Jul 12 2011 10:59AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 19.1 %
Residual: 4.841 %

Result Statistics

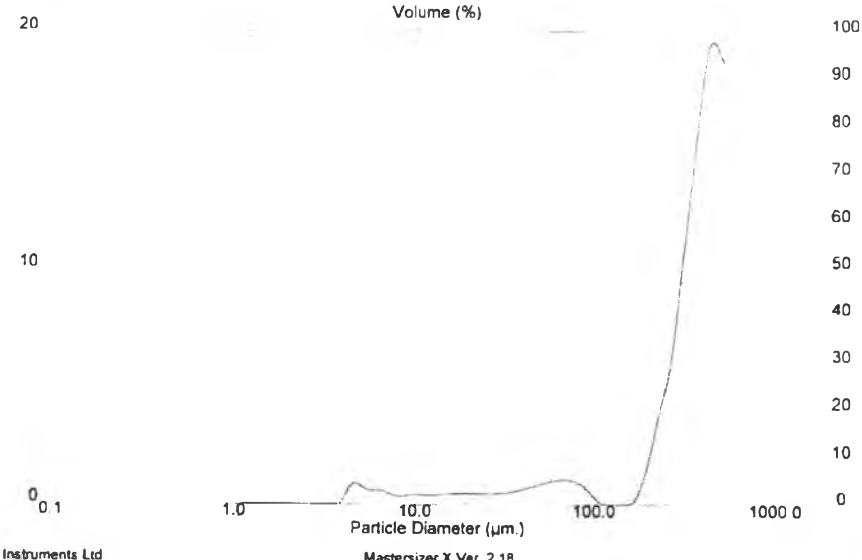
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 368.75 um

Concentration = 0.2678 %Vol
D (v, 0.1) = 68.34 um
D [3, 2] = 95.17 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 399.88 um
Span = 1.214E+00

Specific S.A. = 0.0630 sq. m / g
D (v, 0.9) = 551.63 um
Uniformity = 3.074E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.59	31.01	6.41
1.32	0.00	1.60	0.00	31.01	0.64	37.79	7.05
1.60	0.00	1.95	0.00	37.79	0.81	46.03	7.86
1.95	0.00	2.38	0.00	46.03	1.06	56.09	8.91
2.38	0.00	2.90	0.00	56.09	1.29	68.33	10.20
2.90	0.00	3.53	0.00	68.33	1.32	83.26	11.52
3.53	0.00	4.30	0.01	83.26	0.93	101.44	12.45
4.30	0.98	5.24	0.88	101.44	0.11	123.59	12.57
5.24	0.84	6.39	1.82	123.59	0.00	150.57	12.57
6.39	0.75	7.78	2.57	150.57	0.13	183.44	12.70
7.78	0.47	9.48	3.04	183.44	2.24	223.51	14.95
9.48	0.53	11.55	3.57	223.51	5.86	272.31	20.82
11.55	0.50	14.08	4.07	272.31	11.45	331.77	32.24
14.08	0.57	17.15	4.64	331.77	19.00	404.21	51.26
17.15	0.59	20.90	5.23	404.21	24.83	492.47	76.05
20.90	0.59	25.46	5.82	492.47	23.94	600.00	100.00



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p. 11
12 Jul 11 12:12

Figure J20 PSA reference of FIRST coal, run number 10.

J.3.3 Dhebkaset Bentonite

Result: Analysis Report

Sample Details

Sample ID: Bentonite
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 1
Record Number: 21

Measured: Tue Jul 12 2011 11:04AM
Analysed: Tue Jul 12 2011 11:04AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 16.7 %
Residual: 0.732 %

Result Statistics

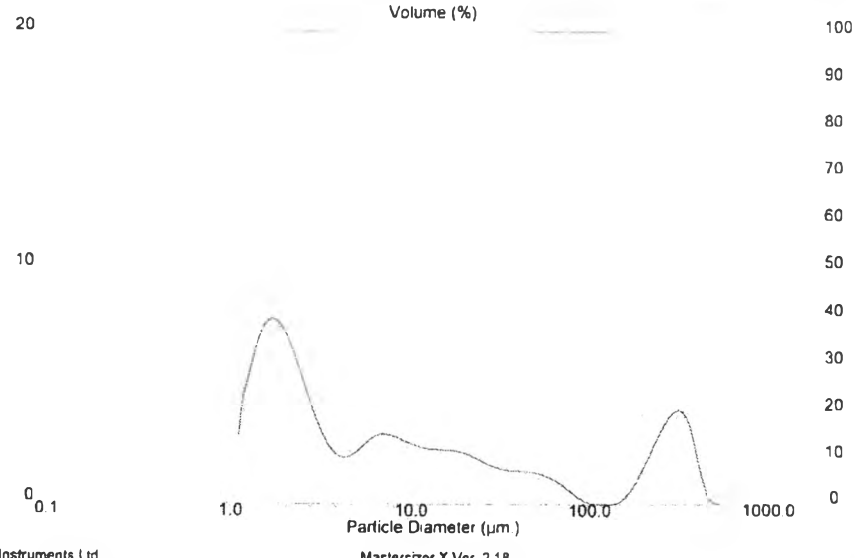
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 58.35 um

Concentration = 0.0082 %Vol
D (v, 0.1) = 1.58 um
D [3, 2] = 3.64 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 6.07 um
Span = 4.529E+01

Specific S.A. = 1.6472 sq. m / g
D (v, 0.9) = 276.41 um
Uniformity = 9.210E+00

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	3.03	1.32	3.05	25.46	2.19	31.01	75.38
1.32	7.64	1.60	10.69	31.01	1.90	37.79	77.29
1.60	9.99	1.95	20.66	37.79	1.80	46.03	79.09
1.95	9.55	2.38	30.21	46.03	1.72	56.09	80.80
2.38	7.27	2.90	37.47	56.09	1.45	68.33	82.25
2.90	4.69	3.53	42.16	68.33	0.93	83.26	83.18
3.53	2.99	4.30	45.15	83.26	0.30	101.44	83.48
4.30	2.59	5.24	47.74	101.44	0.00	123.59	83.49
5.24	3.15	6.39	50.89	123.59	0.00	150.57	83.49
6.39	3.75	7.78	54.64	150.57	0.53	183.44	84.02
7.78	3.69	9.48	58.33	183.44	1.94	223.51	85.96
9.48	3.34	11.55	61.67	223.51	3.69	272.31	89.66
11.55	3.06	14.08	64.72	272.31	4.99	331.77	94.65
14.08	2.97	17.15	67.69	331.77	4.32	404.21	98.95
17.15	2.90	20.90	70.59	404.21	1.04	492.47	100.00
20.90	2.61	25.46	73.19	492.47	0.00	600.00	100.00



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p. 12
12 Jul 11 12:13

Figure J21 PSA reference of Dhebkaset Bentonite, run number 1.

Result: Analysis Report

Sample Details

Sample ID: Bentonite
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVATI
Sample Notes:

Run Number: 2
Record Number 22

Measured: Tue Jul 12 2011 11:05AM
Analysed: Tue Jul 12 2011 11:05AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000). Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 16.1 %
Residual: 0.816 %

Result Statistics

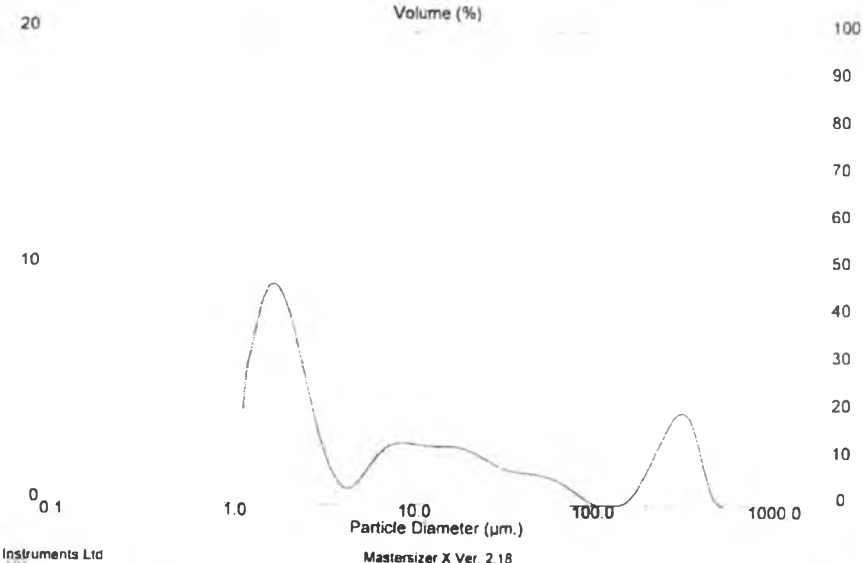
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 57.41 um

Concentration = 0.0072 %Vol
D (v, 0.1) = 1.49 um
D [3, 2] = 3.28 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 5.42 um
Span = 5.049E+01

Specific S.A. = 1.8268 sq. m / g
D (v, 0.9) = 275.08 um
Uniformity = 1.021E+01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	4.16	1.32	4.18	25.46	2.32	31.01	75.72
1.32	9.68	1.60	13.85	31.01	1.94	37.79	77.66
1.60	11.95	1.95	25.79	37.79	1.77	46.03	79.44
1.95	10.63	2.38	36.41	46.03	1.67	56.09	81.11
2.38	7.21	2.90	43.62	56.09	1.44	68.33	82.54
2.90	3.73	3.53	47.36	68.33	0.98	83.26	83.53
3.53	1.51	4.30	48.87	83.26	0.38	101.44	83.91
4.30	0.90	5.24	49.78	101.44	0.00	123.59	83.91
5.24	1.79	6.39	51.57	123.59	0.00	150.57	83.91
6.39	2.86	7.78	54.43	150.57	0.45	183.44	84.36
7.78	3.32	9.48	57.75	183.44	1.82	223.51	86.18
9.48	3.31	11.55	61.06	223.51	3.59	272.31	89.77
11.55	3.22	14.08	64.28	272.31	4.91	331.77	94.68
14.08	3.20	17.15	67.47	331.77	4.22	404.21	98.88
17.15	3.13	20.90	70.60	404.21	1.10	492.47	100.00
20.90	2.80	25.46	73.40	492.47	0.00	600.00	100.00



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p. 13
12 Jul 11 12:14

Figure J22 PSA reference of Dhebkaset Bentonite, run number 2.

Result: Analysis Report

Sample Details

Sample ID: Bentonite
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 3
Record Number: 23

Measured: Tue Jul 12 2011 11:05AM
Analysed: Tue Jul 12 2011 11:05AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 16.0 %
Residual: 0.829 %

Result Statistics

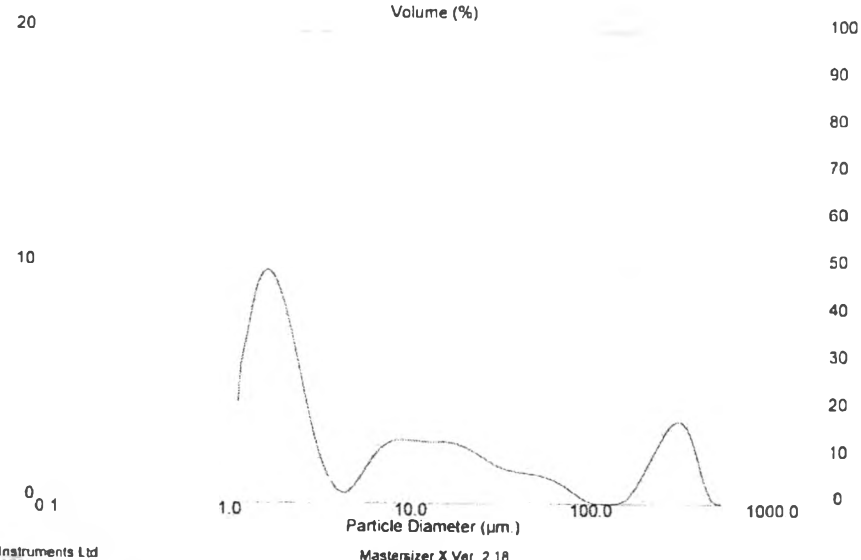
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 51.19 um

Concentration = 0.0068 %Vol
D (v, 0.1) = 1.48 um
D [3, 2] = 3.15 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 3.71 um
Span = 6.860E+01

Specific S.A. = 1.9064 sq. m / g
D (v, 0.9) = 255.87 um
Uniformity = 1.328E+01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	4.47	1.32	4.49	25.46	2.36	31.01	77.92
1.32	10.28	1.60	14.76	31.01	1.94	37.79	79.85
1.60	12.62	1.95	27.37	37.79	1.73	46.03	81.58
1.95	11.12	2.38	38.47	46.03	1.60	56.09	83.17
2.38	7.40	2.90	45.87	56.09	1.35	68.33	84.53
2.90	3.64	3.53	49.53	68.33	0.90	83.26	85.43
3.53	1.27	4.30	50.80	83.26	0.32	101.44	85.75
4.30	0.63	5.24	51.44	101.44	0.00	123.59	85.76
5.24	1.57	6.39	53.00	123.59	0.00	150.57	85.76
6.39	2.83	7.78	55.83	150.57	0.42	183.44	86.18
7.78	3.41	9.48	59.24	183.44	1.71	223.51	87.89
9.48	3.45	11.55	62.69	223.51	3.32	272.31	91.21
11.55	3.37	14.08	66.06	272.31	4.41	331.77	95.61
14.08	3.35	17.15	69.40	331.77	3.58	404.21	99.18
17.15	3.26	20.90	72.66	404.21	0.80	492.47	100.00
20.90	2.90	25.46	75.55	492.47	0.00	600.00	100.00



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12 Jul 11 12.22 p. 3

Figure J23 PSA reference of Dhebkaset Bentonite, run number 3.

Result: Analysis Report

Sample Details

Sample ID: Bentonite
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 4
Record Number: 24

Measured: Tue Jul 12 2011 11:06AM
Analysed: Tue Jul 12 2011 11:06AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000)

Sampler: MS17
Dispersant R.I. = 1.3300]

Obscuration: 15.9 %
Residual: 0.888 %

Result Statistics

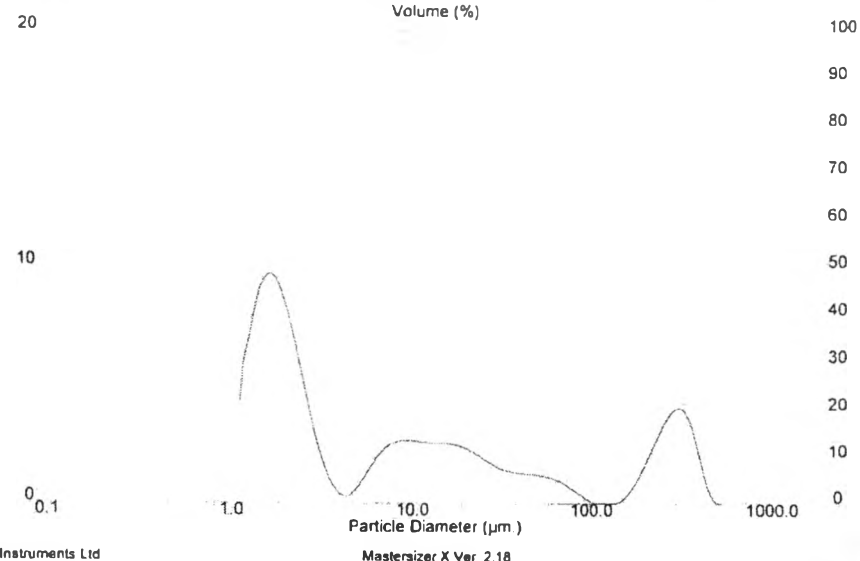
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 58.96 um

Concentration = 0.0069 %Vol
D (v, 0.1) = 1.48 um
D [3, 2] = 3.22 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 5.35 um
Span = 5.143E+01

Specific S.A. = 1.8656 sq. m / g
D (v, 0.9) = 276.52 um
Uniformity = 1.065E+01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	4.46	1.32	4.49	25.46	2.22	31.01	75.32
1.32	10.18	1.60	14.66	31.01	1.81	37.79	77.13
1.60	12.44	1.95	27.08	37.79	1.63	46.03	78.76
1.95	10.88	2.38	37.95	46.03	1.55	56.09	80.31
2.38	7.14	2.90	45.09	56.09	1.38	68.33	81.68
2.90	3.38	3.53	48.49	68.33	0.98	83.26	82.65
3.53	1.02	4.30	49.51	83.26	0.40	101.44	83.05
4.30	0.41	5.24	49.92	101.44	0.00	123.59	83.06
5.24	1.34	6.39	51.26	123.59	0.00	150.57	83.07
6.39	2.66	7.78	53.92	150.57	0.61	183.44	83.67
7.78	3.31	9.48	57.23	183.44	2.07	223.51	85.74
9.48	3.39	11.55	60.62	223.51	3.89	272.31	89.63
11.55	3.31	14.08	63.92	272.31	5.14	331.77	94.76
14.08	3.26	17.15	67.18	331.77	4.22	404.21	98.97
17.15	3.15	20.90	70.33	404.21	1.02	492.47	100.00
20.90	2.76	25.46	73.09	492.47	0.00	600.00	100.00



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12 Jul 11 12:20

Figure J24 PSA reference of Dhebkaset Bentonite, run number 4.

Result: Analysis Report

Sample Details

Sample ID: Bentonite
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 5
Record Number: 25

Measured: Tue Jul 12 2011 11:06AM
Analysed: Tue Jul 12 2011 11:06AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
(Particle R.I. = (1.5295, 0.1000) Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 15.9 %
Residual: 0.896 %

Result Statistics

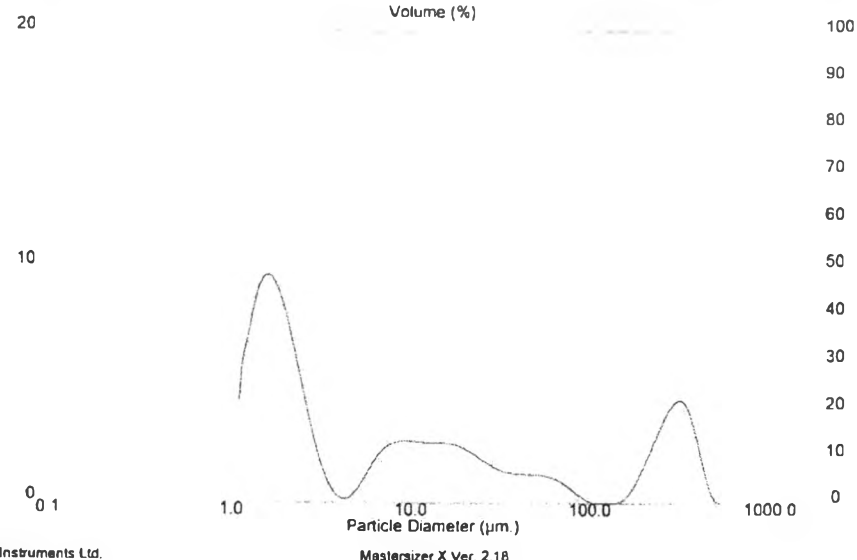
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 64.05 um

Concentration = 0.0070 %Vol
D (v, 0.1) = 1.48 um
D [3, 2] = 3.25 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 6.21 um
Span = 4.714E+01

Specific S.A. = 1.8461 sq. m / g
D (v, 0.9) = 293.99 um
Uniformity = 9.994E+00

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	4.48	1.32	4.50	25.46	2.21	31.01	74.22
1.32	10.16	1.60	14.65	31.01	1.78	37.79	76.00
1.60	12.36	1.95	27.00	37.79	1.61	46.03	77.61
1.95	10.76	2.38	37.75	46.03	1.58	56.09	79.18
2.38	6.98	2.90	44.72	56.09	1.44	68.33	80.62
2.90	3.21	3.53	47.95	68.33	1.02	83.26	81.63
3.53	0.86	4.30	48.81	83.26	0.37	101.44	82.00
4.30	0.26	5.24	49.07	101.44	0.00	123.59	82.01
5.24	1.20	6.39	50.26	123.59	0.00	150.57	82.01
6.39	2.56	7.78	52.83	150.57	0.40	183.44	82.41
7.78	3.26	9.48	56.09	183.44	1.86	223.51	84.27
9.48	3.38	11.55	59.47	223.51	3.77	272.31	88.05
11.55	3.31	14.08	62.78	272.31	5.36	331.77	93.40
14.08	3.28	17.15	66.06	331.77	4.96	404.21	98.34
17.15	3.17	20.90	69.23	404.21	1.64	492.47	99.99
20.90	2.78	25.46	72.01	492.47	0.00	600.00	100.00



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p. 4
12 Jul 11 12:22

Figure J25 PSA reference of Dhebkaset Bentonite, run number 5.

Result: Analysis Report

Sample Details

Sample ID: Bentonite
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 6
Record Number: 26

Measured: Tue Jul 12 2011 11:06AM
Analysed: Tue Jul 12 2011 11:06AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 15.9 %
Residual: 0.982 %

Result Statistics

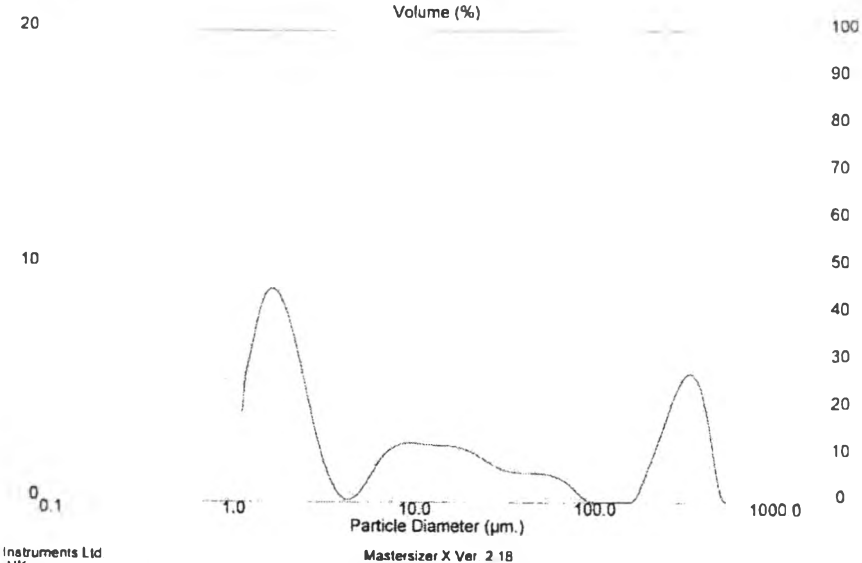
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 81.45 um

Concentration = 0.0075 %Vol
D (v, 0.1) = 1.51 um
D [3, 2] = 3.48 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 7.88 um
Span = 4.230E+01

Specific S.A. = 1.7266 sq. m / g
D (v, 0.9) = 334.66 um
Uniformity = 1.005E+01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	3.98	1.32	4.01	25.46	2.10	31.01	70.08
1.32	9.27	1.60	13.26	31.01	1.72	37.79	71.79
1.60	11.61	1.95	24.86	37.79	1.59	46.03	73.39
1.95	10.40	2.38	35.25	46.03	1.57	56.09	74.96
2.38	6.93	2.90	42.17	56.09	1.40	68.33	76.37
2.90	3.22	3.53	45.41	68.33	0.91	83.26	77.27
3.53	0.79	4.30	46.20	83.26	0.16	101.44	77.44
4.30	0.17	5.24	46.37	101.44	0.00	123.59	77.44
5.24	1.05	6.39	47.42	123.59	0.00	150.57	77.44
6.39	2.40	7.78	49.82	150.57	0.11	183.44	77.55
7.78	3.10	9.48	52.92	183.44	1.78	223.51	79.33
9.48	3.22	11.55	56.14	223.51	4.05	272.31	83.39
11.55	3.15	14.08	59.30	272.31	6.31	331.77	89.69
14.08	3.09	17.15	62.39	331.77	6.82	404.21	96.49
17.15	2.98	20.90	65.37	404.21	3.50	492.47	99.97
20.90	2.61	25.46	67.98	492.47	0.00	600.00	100.00



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12 Jul 11 12:23 p. 5

Figure J26 PSA reference of Dhebkaset Bentonite, run number 6.

Result: Analysis Report

Sample Details

Sample ID: Bentonite
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVATI
Sample Notes

Run Number: 7
Record Number: 27

Measured: Tue Jul 12 2011 11:07AM
Analysed: Tue Jul 12 2011 11:07AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000): Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 15.8 %
Residual: 0.894 %

Result Statistics

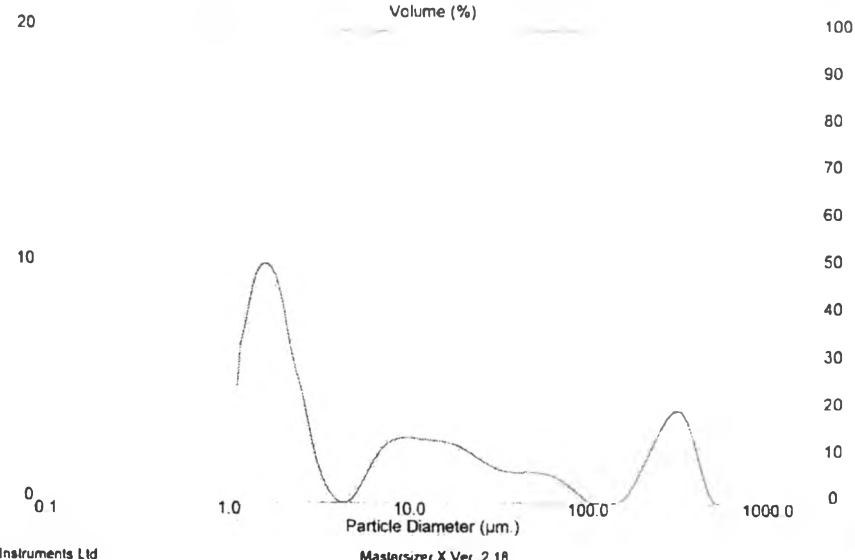
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 59.27 um

Concentration = 0.0067 %Vol
D (v, 0.1) = 1.45 um
D [3, 2] = 3.12 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 5.68 um
Span = 4.923E+01

Specific S.A. = 1.9226 sq. m / g
D (v, 0.9) = 281.33 um
Uniformity = 1.009E+01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	5.08	1.32	5.10	25.46	2.16	31.01	75.24
1.32	11.03	1.60	16.12	31.01	1.76	37.79	77.00
1.60	12.92	1.95	29.03	37.79	1.66	46.03	78.66
1.95	10.77	2.38	39.78	46.03	1.69	56.09	80.35
2.38	6.62	2.90	46.40	56.09	1.58	68.33	81.93
2.90	2.78	3.53	49.20	68.33	1.16	83.26	83.09
3.53	0.54	4.30	49.74	83.26	0.51	101.44	83.60
4.30	0.02	5.24	49.77	101.44	0.00	123.59	83.60
5.24	1.02	6.39	50.78	123.59	0.00	150.57	83.60
6.39	2.55	7.78	53.34	150.57	0.36	183.44	83.96
7.78	3.39	9.48	56.72	183.44	1.73	223.51	85.69
9.48	3.56	11.55	60.28	223.51	3.56	272.31	89.25
11.55	3.48	14.08	63.76	272.31	4.95	331.77	94.19
14.08	3.39	17.15	67.15	331.77	4.40	404.21	98.58
17.15	3.19	20.90	70.34	404.21	1.41	492.47	99.99
20.90	2.74	25.46	73.08	492.47	0.00	600.00	100.00



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p. 6
12 Jul 11 12:24

Figure J27 PSA reference of Dhebkaset Bentonite, run number 7.

Result: Analysis Report

Sample Details

Sample ID: Bentonite
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 8
Record Number: 28

Measured: Tue Jul 12 2011 11:07AM
Analysed: Tue Jul 12 2011 11:07AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration 15.8 %
Residual 1.016 %

Result Statistics

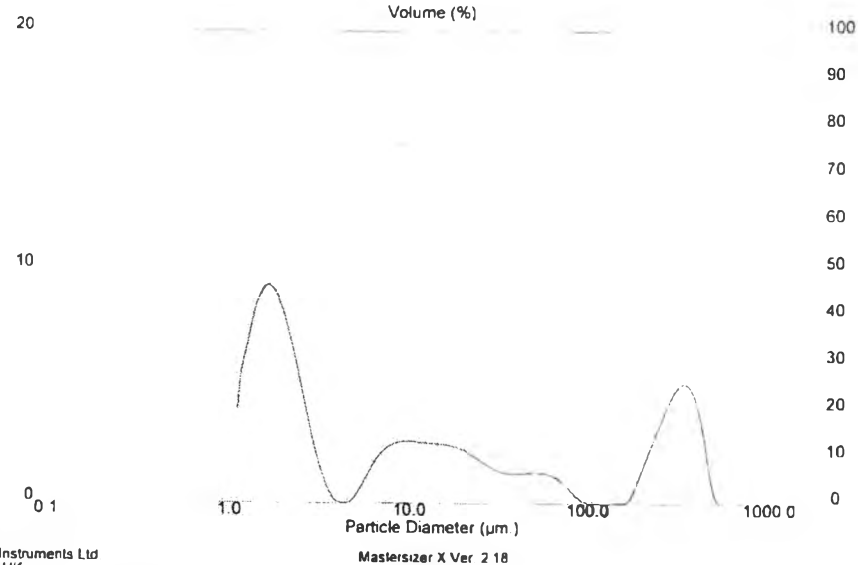
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 77.71 um

Concentration = 0.0073 %Vol
D (v, 0.1) = 1.50 um
D [3, 2] = 3.41 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 7.77 um
Span = 4.214E+01

Specific S.A. = 1.7589 sq. m / g
D (v, 0.9) = 328.80 um
Uniformity = 9.714E+00

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	4.16	1.32	4.18	25.46	2.10	31.01	70.83
1.32	9.57	1.60	13.74	31.01	1.70	37.79	72.53
1.60	11.93	1.95	25.66	37.79	1.60	46.03	74.12
1.95	10.59	2.38	36.24	46.03	1.65	56.09	75.77
2.38	6.92	2.90	43.16	56.09	1.57	68.33	77.34
2.90	3.05	3.53	46.22	68.33	1.09	83.26	78.43
3.53	0.54	4.30	46.77	83.26	0.27	101.44	78.70
4.30	0.00	5.24	46.78	101.44	0.00	123.59	78.71
5.24	0.89	6.39	47.66	123.59	0.00	150.57	78.72
6.39	2.37	7.78	50.02	150.57	0.08	183.44	78.79
7.78	3.18	9.48	53.20	183.44	1.74	223.51	80.54
9.48	3.35	11.55	56.55	223.51	3.89	272.31	84.43
11.55	3.28	14.08	59.83	272.31	5.87	331.77	90.29
14.08	3.21	17.15	63.04	331.77	6.37	404.21	96.65
17.15	3.05	20.90	66.09	404.21	3.34	492.47	99.97
20.90	2.64	25.46	68.73	492.47	0.00	600.00	100.00



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12 Jul 11 12:24 P. 7

Figure J28 PSA reference of Dhebkaset Bentonite, run number 8.

Result: Analysis Report

Sample Details

Sample ID: Bentonite
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes

Run Number: 9
Record Number: 29

Measured: Tue Jul 12 2011 11:07AM
Analysed: Tue Jul 12 2011 11:07AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 15.8 %
Residual: 1.074 %

Result Statistics

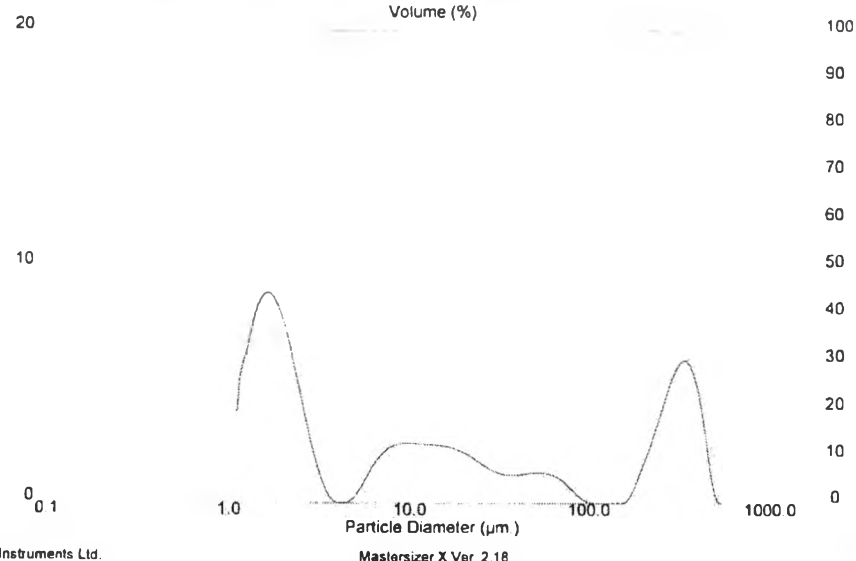
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 88.32 um

Concentration = 0.0076 %Vol
D (v, 0.1) = 1.51 um
D [3, 2] = 3.57 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 9.12 um
Span = 3.745E+01

Specific S.A. = 1.6828 sq. m / g
D (v, 0.9) = 342.88 um
Uniformity = 9.409E+00

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	4.01	1.32	4.03	25.46	1.97	31.01	67.65
1.32	9.19	1.60	13.21	31.01	1.59	37.79	69.24
1.60	11.42	1.95	24.61	37.79	1.52	46.03	70.76
1.95	10.10	2.38	34.70	46.03	1.61	56.09	72.38
2.38	6.55	2.90	41.24	56.09	1.57	68.33	73.95
2.90	2.83	3.53	44.09	68.33	1.13	83.26	75.07
3.53	0.43	4.30	44.52	83.26	0.33	101.44	75.41
4.30	0.00	5.24	44.53	101.44	0.00	123.59	75.41
5.24	0.80	6.39	45.32	123.59	0.00	150.57	75.42
6.39	2.25	7.78	47.57	150.57	0.17	183.44	75.58
7.78	3.07	9.48	50.64	183.44	1.90	223.51	77.49
9.48	3.26	11.55	53.89	223.51	4.35	272.31	81.84
11.55	3.21	14.08	57.10	272.31	6.87	331.77	88.70
14.08	3.12	17.15	60.22	331.77	7.50	404.21	96.19
17.15	2.95	20.90	63.17	404.21	3.80	492.47	99.97
20.90	2.52	25.46	65.68	492.47	0.00	600.00	100.00



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p. 8
12 Jul 11 12:25

Figure J29 PSA reference of Dhebkaset Bentonite, run number 9.

Result: Analysis Report

Sample Details

Sample ID: Bentonite
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 10
Record Number: 30

Measured: Tue Jul 12 2011 11:07AM
Analysed: Tue Jul 12 2011 11:07AM
Result Source: Analysed

System Details

Range Lens.: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
{Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300}

Sampler: MS17

Obscuration: 15.8 %
Residual: 0.964 %

Result Statistics

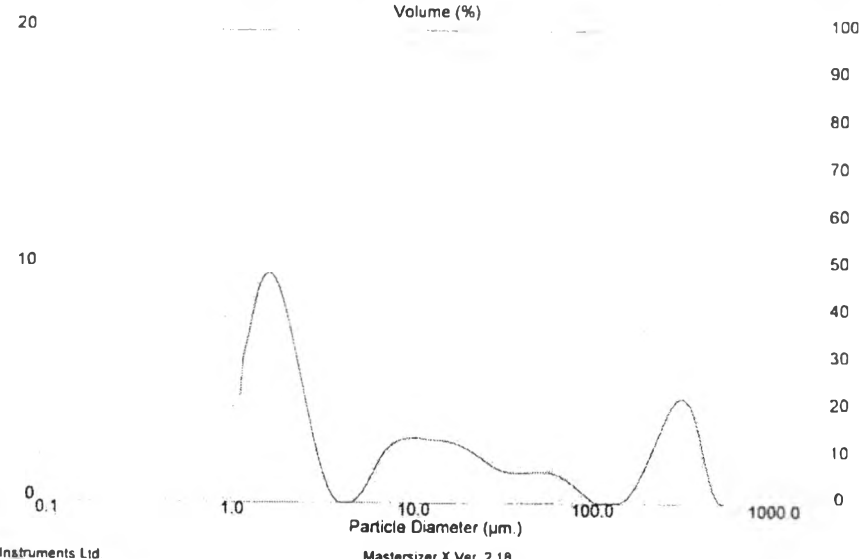
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 65.13 um

Concentration = 0.0069 %Vol
D (v, 0.1) = 1.47 um
D [3, 2] = 3.25 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 7.15 um
Span = 4.056E+01

Specific S.A. = 1.8442 sq. m / g
D (v, 0.9) = 291.43 um
Uniformity = 8.818E+00

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	4.70	1.32	4.73	25.46	2.14	31.01	72.98
1.32	10.41	1.60	15.12	31.01	1.74	37.79	74.72
1.60	12.50	1.95	27.61	37.79	1.64	46.03	76.37
1.95	10.65	2.38	38.24	46.03	1.70	56.09	78.07
2.38	6.63	2.90	44.87	56.09	1.63	68.33	79.70
2.90	2.72	3.53	47.60	68.33	1.23	83.26	80.93
3.53	0.35	4.30	47.96	83.26	0.54	101.44	81.47
4.30	0.00	5.24	47.96	101.44	0.00	123.59	81.47
5.24	0.83	6.39	48.78	123.59	0.00	150.57	81.48
6.39	2.43	7.78	51.22	150.57	0.54	183.44	82.01
7.76	3.33	9.48	54.55	183.44	2.08	223.51	84.09
9.48	3.55	11.55	58.09	223.51	4.09	272.31	88.18
11.55	3.48	14.08	61.58	272.31	5.58	331.77	93.75
14.08	3.38	17.15	64.95	331.77	4.84	404.21	98.58
17.15	3.18	20.90	68.13	404.21	1.41	492.47	99.99
20.90	2.72	25.46	70.84	492.47	0.00	600.00	100.00



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p. 9
12 Jul 11 12:26

Figure J30 PSA reference of Dhebkaset Bentonite, run number 10.

E.2.4 Petch Thai Limestone

Result: Analysis Report

Sample Details

Sample ID: Limestone (PT)
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 1
Record Number: 41

Measured: Tue Jul 12 2011 11:21AM
Analysed: Tue Jul 12 2011 11:21AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 16.4 %
Residual: 1.428 %

Result Statistics

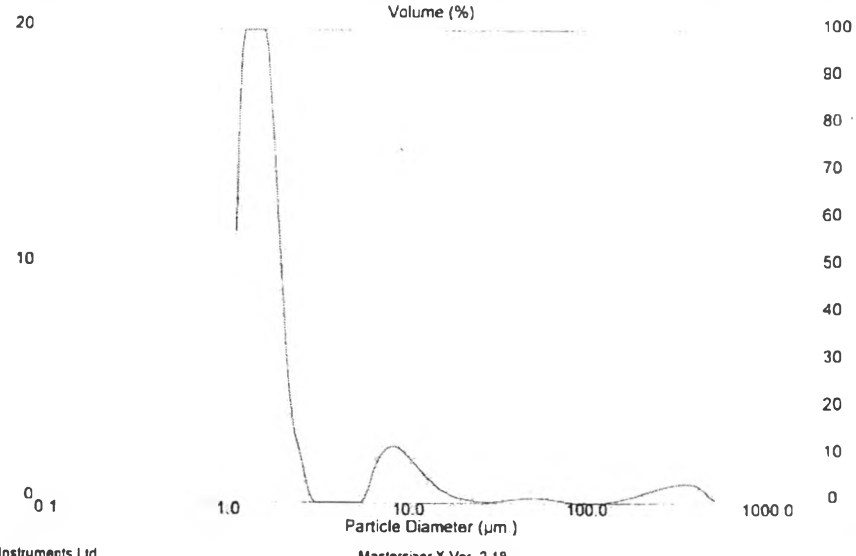
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 16.90 um

Concentration = 0.0039 %Vol
D (v, 0.1) = 1.30 um
D [3, 2] = 1.72 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 1.70 um
Span = 5.258E+00

Specific S.A. = 3.4811 sq. m / g
D (v, 0.9) = 10.26 um
Uniformity = 9.126E+00

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	12.00	1.32	12.07	25.46	0.05	31.01	94.72
1.32	28.49	1.60	40.47	31.01	0.09	37.79	94.82
1.60	26.68	1.95	67.13	37.79	0.20	46.03	95.02
1.95	13.04	2.38	80.17	46.03	0.28	56.09	95.30
2.38	3.29	2.90	83.48	56.09	0.23	68.33	95.53
2.90	0.25	3.53	83.75	68.33	0.10	83.26	95.63
3.53	0.00	4.30	83.75	83.26	0.00	101.44	95.63
4.30	0.00	5.24	83.75	101.44	0.00	123.59	95.63
5.24	0.00	6.39	83.75	123.59	0.05	150.57	95.68
6.39	2.03	7.78	85.78	150.57	0.23	183.44	95.91
7.78	3.06	9.48	88.84	183.44	0.48	223.51	96.39
9.49	2.66	11.55	91.50	223.51	0.74	272.31	97.13
11.55	1.71	14.08	93.21	272.31	0.98	331.77	98.10
14.08	0.89	17.15	94.11	331.77	1.06	404.21	99.16
17.15	0.41	20.90	94.51	404.21	0.73	492.47	99.89
20.90	0.16	25.46	94.67	492.47	0.11	600.00	100.00



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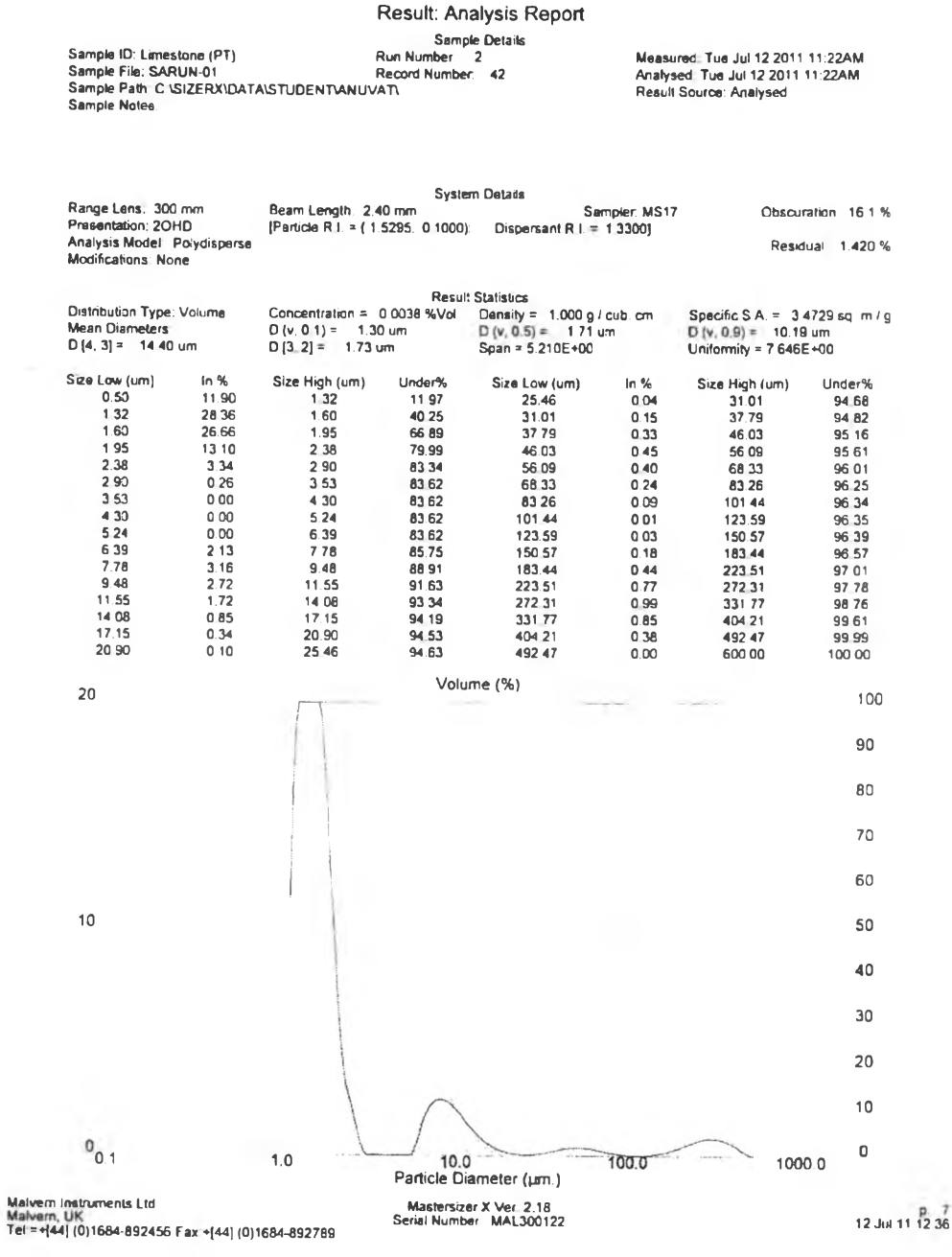
p. 6
12 Jul 11 12:35

Figure J31 PSA reference of Petch Thai Limestone, run number 1.



Result: Analysis Report

Sample Details

Sample ID: Limestone (PT)
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 2
Record Number: 42

Measured: Tue Jul 12 2011 11:22AM
Analysed: Tue Jul 12 2011 11:22AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 16.1 %
Residual: 1.420 %

Result Statistics

Distribution Type: Volume
Mean Diameters:
D[4, 3] = 14.40 um

Concentration = 0.0038 %Vol
D(v, 0.1) = 1.30 um
D[3, 2] = 1.73 um

Density = 1.000 g / cub. cm
D(v, 0.5) = 1.71 um
Span = 5.210E+00

Specific S.A. = 3.4729 sq. m / g
D(v, 0.9) = 10.19 um
Uniformity = 7.646E+00

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	11.90	1.32	11.97	25.46	0.04	31.01	94.68
1.32	28.36	1.60	40.25	31.01	0.15	37.79	94.82
1.60	26.66	1.95	66.89	37.79	0.33	46.03	95.16
1.95	13.10	2.38	79.99	46.03	0.45	56.09	95.61
2.38	3.34	2.90	83.34	56.09	0.40	68.33	96.01
2.90	0.26	3.53	83.62	68.33	0.24	83.26	96.25
3.53	0.00	4.30	83.62	83.26	0.09	101.44	96.34
4.30	0.00	5.24	83.62	101.44	0.01	123.59	96.35
5.24	0.00	6.39	83.62	123.59	0.03	150.57	96.39
6.39	2.13	7.78	85.75	150.57	0.18	183.44	96.57
7.78	3.16	9.48	88.91	183.44	0.44	223.51	97.01
9.48	2.72	11.55	91.63	223.51	0.77	272.31	97.78
11.55	1.72	14.08	93.34	272.31	0.99	331.77	98.76
14.08	0.85	17.15	94.19	331.77	0.85	404.21	99.61
17.15	0.34	20.90	94.53	404.21	0.38	492.47	99.99
20.90	0.10	25.46	94.63	492.47	0.00	600.00	100.00

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p. 7
12 Jul 11 12:36

Figure J32 PSA reference of Petch Thai Limestone, run number 2.

Result: Analysis Report

Sample Details

Sample ID: Limestone (PT)
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 3
Record Number: 43

Measured: Tue Jul 12 2011 11:24AM
Analysed: Tue Jul 12 2011 11:24AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000) Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 15.7 %
Residual: 1.453 %

Result Statistics

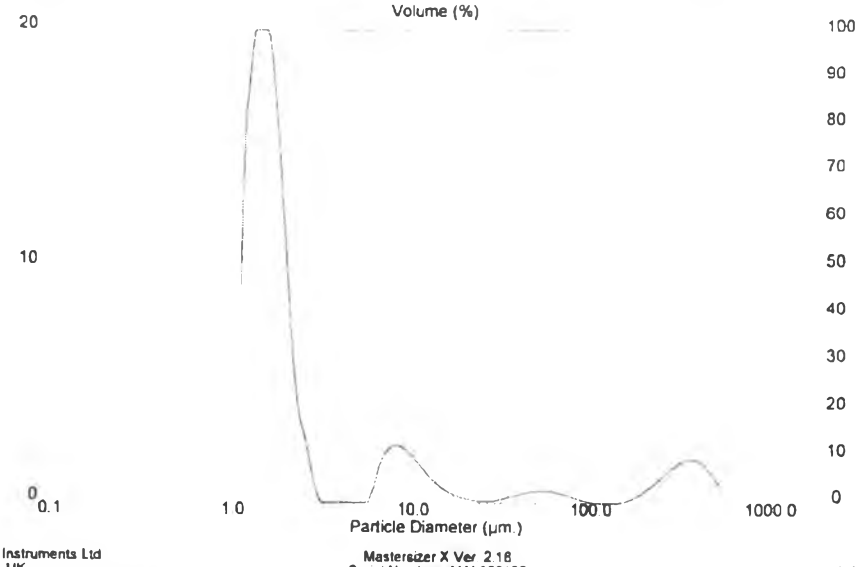
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 36.06 um

Concentration = 0.0041 %Vol
D (v, 0.1) = 1.32 um
D [3, 2] = 1.91 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 1.80 um
Span = 3.311E+01

Specific S.A. = 3.1400 sq. m / g
D (v, 0.9) = 60.76 um
Uniformity = 1.929E+01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	9.61	1.32	9.66	25.46	0.09	31.01	88.42
1.32	24.88	1.60	34.47	31.01	0.24	37.79	88.66
1.60	25.15	1.95	59.61	37.79	0.46	46.03	89.12
1.95	13.68	2.38	73.28	46.03	0.62	56.09	89.74
2.38	3.94	2.90	77.23	56.09	0.60	68.33	90.34
2.90	0.35	3.53	77.61	68.33	0.41	83.26	90.75
3.53	0.00	4.30	77.61	83.26	0.16	101.44	90.91
4.30	0.00	5.24	77.61	101.44	0.00	123.59	90.91
5.24	0.00	6.39	77.61	123.59	0.00	150.57	90.91
6.39	2.15	7.78	79.76	150.57	0.14	183.44	91.05
7.78	3.07	9.48	82.83	183.44	0.60	223.51	91.65
9.48	2.59	11.55	85.42	223.51	1.27	272.31	92.92
11.55	1.61	14.08	87.02	272.31	1.99	331.77	94.91
14.08	0.80	17.15	87.83	331.77	2.34	404.21	97.25
17.15	0.35	20.90	88.18	404.21	1.92	492.47	99.17
20.90	0.14	25.46	88.33	492.47	0.82	600.00	100.00



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p. 8
12 Jul 11 12:38

Figure J33 PSA reference of Petch Thai Limestone, run number 3.

Result: Analysis Report

Sample Details

Sample ID: Limestone (PT)
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 4
Record Number: 44

Measured: Tue Jul 12 2011 11:25AM
Analysed: Tue Jul 12 2011 11:25AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 15.7 %
Residual: 1.430 %

Result Statistics

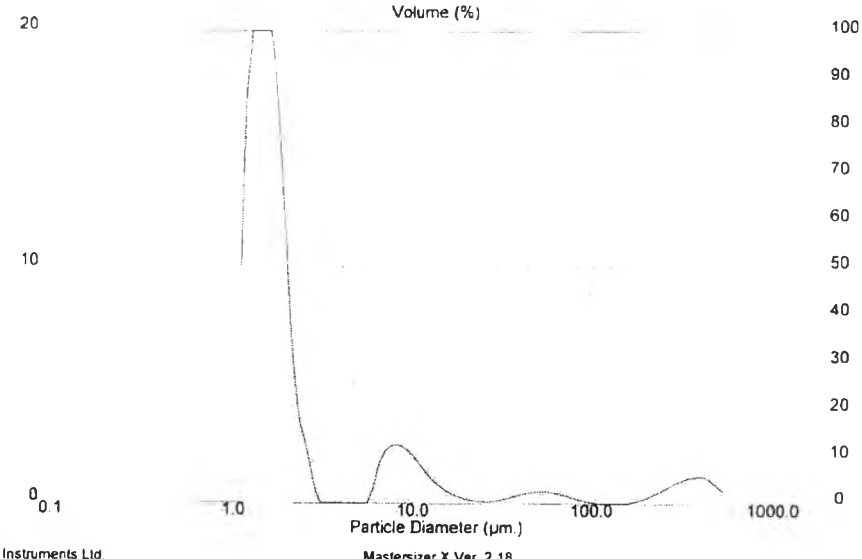
Distribution Type: Volume
Mean Diameters:
D[4, 3] = 24.87 um

Concentration = 0.0039 %Vol
D(v, 0.1) = 1.31 um
D[3, 2] = 1.83 um

Density = 1.000 g / cub. cm
D(v, 0.5) = 1.76 um
Span = 7.045E+00

Specific S.A. = 3.2847 sq. m / g
D(v, 0.9) = 13.69 um
Uniformity = 1.336E+01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	10.47	1.32	10.53	25.46	0.11	31.01	91.69
1.32	26.32	1.60	36.78	31.01	0.27	37.79	91.85
1.60	25.92	1.95	62.68	37.79	0.49	46.03	92.44
1.95	13.60	2.38	76.27	46.03	0.65	56.09	93.09
2.38	3.76	2.90	80.04	56.09	0.62	68.33	93.71
2.90	0.33	3.53	80.39	68.33	0.42	83.26	94.13
3.53	0.00	4.30	80.39	83.26	0.19	101.44	94.32
4.30	0.00	5.24	80.39	101.44	0.02	123.59	94.34
5.24	0.00	6.39	80.39	123.59	0.00	150.57	94.34
6.39	2.23	7.78	82.63	150.57	0.06	183.44	94.40
7.78	3.19	9.48	85.81	183.44	0.31	223.51	94.71
9.48	2.69	11.55	88.50	223.51	0.69	272.31	95.40
11.55	1.68	14.08	90.18	272.31	1.14	331.77	96.54
14.08	0.85	17.15	91.03	331.77	1.44	404.21	97.97
17.15	0.38	20.90	91.42	404.21	1.34	492.47	99.32
20.90	0.16	25.46	91.58	492.47	0.68	600.00	100.00



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p. 9
12 Jul 11 12:37

Figure J34 PSA reference of Petch Thai Limestone, run number 4.

Result: Analysis Report

Sample Details

Sample ID: Limestone (PT)
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 5
Record Number: 45

Measured: Tue Jul 12 2011 11:25AM
Analysed: Tue Jul 12 2011 11:25AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
(Particle R.I. = (1.5295, 0.1000), Dispersant R.I. = 1.3300)

Sampler: MS17

Obscuration: 15.7 %
Residual 1.443 %

Result Statistics

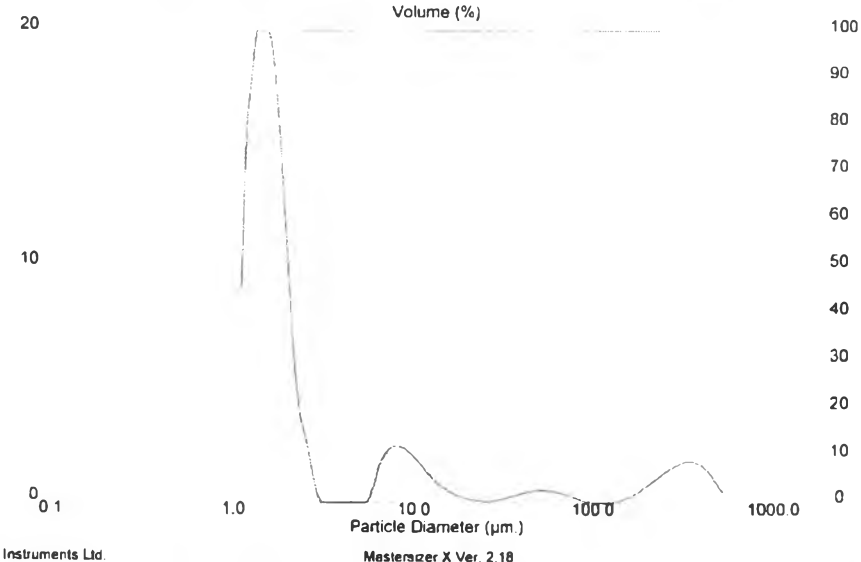
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 34.92 um

Concentration = 0.0041 %Vol
D (v, 0.1) = 1.33 um
D [3, 2] = 1.92 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 1.80 um
Span = 3.579E+01

Specific S.A. = 3.1230 sq. m / g
D (v, 0.9) = 65.73 um
Uniformity = 1.861E+01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	9.53	1.32	9.59	25.46	0.10	31.01	88.08
1.32	24.72	1.60	34.25	31.01	0.26	37.79	88.35
1.60	25.03	1.95	59.25	37.79	0.49	46.03	88.84
1.95	13.63	2.38	72.87	46.03	0.66	56.09	89.49
2.38	3.94	2.90	76.83	56.09	0.62	68.33	90.11
2.90	0.36	3.53	77.20	68.33	0.40	83.26	90.50
3.53	0.00	4.30	77.20	83.26	0.13	101.44	90.63
4.30	0.00	5.24	77.20	101.44	0.00	123.59	90.63
5.24	0.00	6.39	77.21	123.59	0.05	150.57	90.68
6.39	2.15	7.78	79.36	150.57	0.37	183.44	91.05
7.78	3.08	9.48	82.43	183.44	0.90	223.51	91.95
9.48	2.61	11.55	85.04	223.51	1.54	272.31	93.49
11.55	1.63	14.08	86.67	272.31	2.08	331.77	95.57
14.08	0.82	17.15	87.49	331.77	2.23	404.21	97.80
17.15	0.35	20.90	87.85	404.21	1.67	492.47	99.46
20.90	0.14	25.46	87.99	492.47	0.53	600.00	100.00



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p. 10
12 Jul 11 12:38

Figure J35 PSA reference of Petch Thai Limestone, run number 5.

Result: Analysis Report

Sample Details

Sample ID: Limestone (PT)
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 6
Record Number: 46

Measured: Tue Jul 12 2011 11:25AM
Analysed: Tue Jul 12 2011 11:25AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 15.8 %
Residual: 1.457 %

Result Statistics

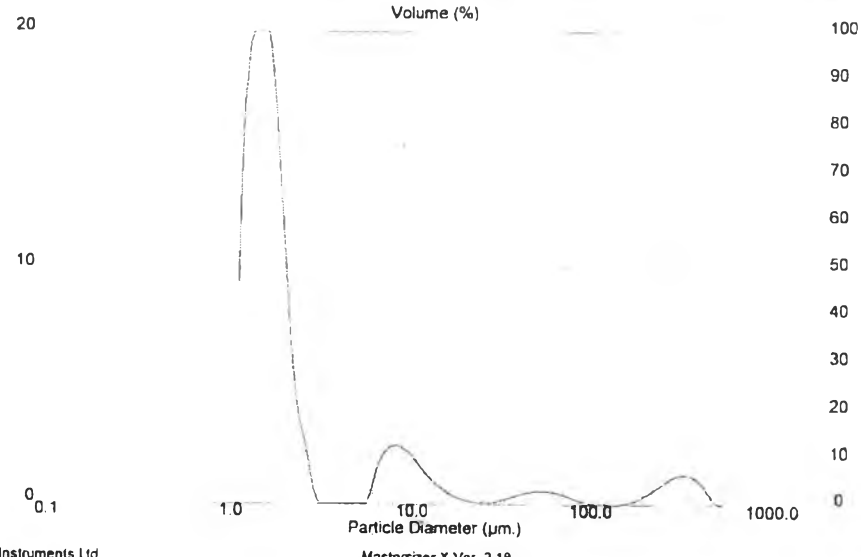
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 21.44 um

Concentration = 0.0040 %Vol
D (v, 0.1) = 1.32 um
D [3, 2] = 1.85 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 1.77 um
Span = 6.984E+00

Specific S.A. = 3.2475 sq. m / g
D (v, 0.9) = 13.70 um
Uniformity = 1.130E+01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	9.91	1.32	9.97	25.46	0.10	31.01	91.65
1.32	25.71	1.60	35.61	31.01	0.28	37.79	91.93
1.60	26.03	1.95	61.62	37.79	0.54	46.03	92.47
1.95	14.18	2.38	75.79	46.03	0.73	56.09	93.19
2.38	4.10	2.90	79.90	56.09	0.70	68.33	93.89
2.90	0.37	3.53	80.30	68.33	0.47	83.26	94.36
3.53	0.00	4.30	80.30	83.26	0.18	101.44	94.54
4.30	0.00	5.24	80.30	101.44	0.00	123.59	94.54
5.24	0.00	6.39	80.30	123.59	0.00	150.57	94.54
6.39	2.24	7.78	82.54	150.57	0.11	183.44	94.65
7.78	3.21	9.48	85.75	183.44	0.50	223.51	95.15
9.48	2.72	11.55	88.47	223.51	1.04	272.31	96.19
11.55	1.71	14.08	90.18	272.31	1.55	331.77	97.74
14.08	0.86	17.15	91.04	331.77	1.55	404.21	99.29
17.15	0.37	20.90	91.41	404.21	0.71	492.47	99.99
20.90	0.14	25.46	91.55	492.47	0.00	600.00	100.00



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P. 11
12 Jul 11 12:38

Figure J36 PSA reference of Petch Thai Limestone, run number 6.

Result: Analysis Report

Sample Details

Sample ID: Limestone (PT)
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 7
Record Number 47

Measured: Tue Jul 12 2011 11:26AM
Analysed: Tue Jul 12 2011 11:26AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000), Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 15.9 %
Residual: 1.431 %

Result Statistics

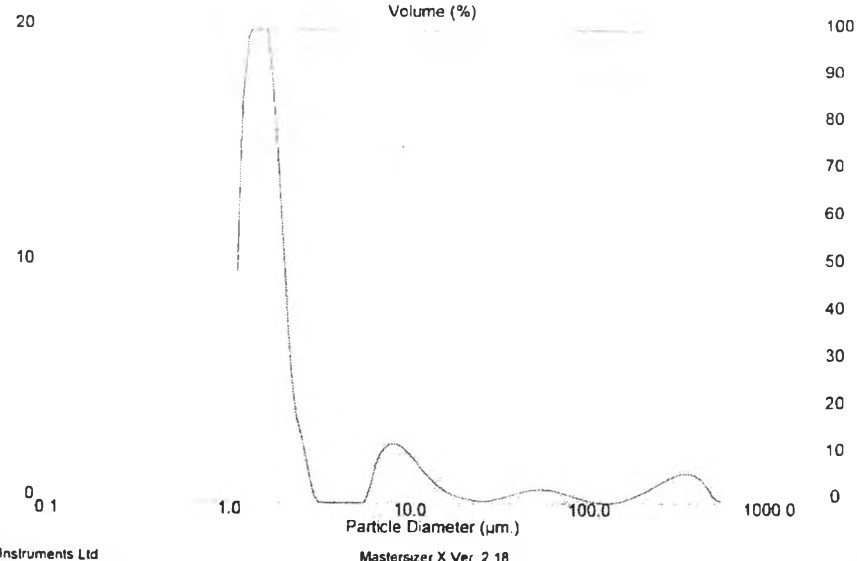
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 23.20 um

Concentration = 0.0040 %Vol
D (v, 0.1) = 1.32 um
D [3, 2] = 1.85 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 1.77 um
Span = 7.811E+00

Specific S.A. = 3.2420 sq. m / g
D (v, 0.9) = 15.14 um
Uniformity = 1.231E+01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	10.09	1.32	10.15	25.46	0.12	31.01	91.14
1.32	25.80	1.60	35.88	31.01	0.29	37.79	91.43
1.60	25.79	1.95	61.66	37.79	0.52	46.03	91.95
1.95	13.81	2.38	75.46	46.03	0.71	56.09	92.66
2.38	3.92	2.90	79.39	56.09	0.69	68.33	93.35
2.90	0.35	3.53	79.77	68.33	0.49	83.26	93.84
3.53	0.00	4.30	79.77	83.26	0.22	101.44	94.07
4.30	0.00	5.24	79.77	101.44	0.04	123.59	94.11
5.24	0.00	6.39	79.77	123.59	0.02	150.57	94.13
6.39	2.24	7.78	82.01	150.57	0.20	183.44	94.33
7.78	3.19	9.48	85.20	183.44	0.57	223.51	94.90
9.48	2.70	11.55	87.90	223.51	1.03	272.31	95.93
11.55	1.70	14.08	89.60	272.31	1.46	331.77	97.38
14.08	0.87	17.15	90.47	331.77	1.58	404.21	98.96
17.15	0.39	20.90	90.86	404.21	0.94	492.47	99.90
20.90	0.17	25.46	91.03	492.47	0.09	600.00	100.00



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p. 12
12 Jul 11 12:39

Figure J37 PSA reference of Petch Thai Limestone, run number 7.

Result: Analysis Report

Sample Details

Sample ID: Limestone (PT)
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 8
Record Number: 48

Measured: Tue Jul 12 2011 11:26AM
Analysed: Tue Jul 12 2011 11:26AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 16.0 %
Residual: 1.472 %

Result Statistics

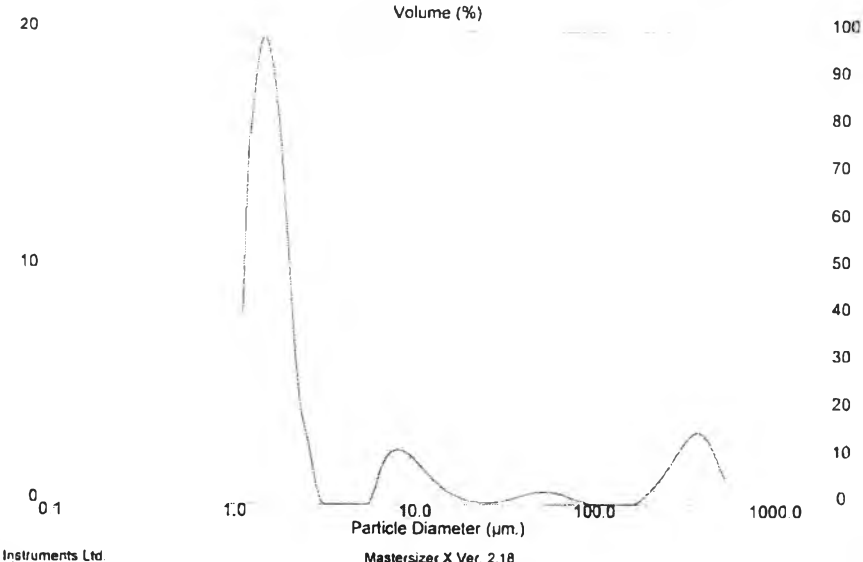
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 53.50 um

Concentration = 0.0044 %Vol
D (v, 0.1) = 1.34 um
D [3, 2] = 2.04 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 1.86 um
Span = 1.614E+02

Specific S.A. = 2.9368 sq. m / g
D (v, 0.9) = 300.92 um
Uniformity = 2.804E+01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	8.53	1.32	8.59	25.46	0.09	31.01	83.92
1.32	22.91	1.60	31.44	31.01	0.24	37.79	84.16
1.60	23.89	1.95	55.31	37.79	0.48	46.03	84.65
1.95	13.56	2.38	68.85	46.03	0.67	56.09	85.32
2.38	4.12	2.90	72.99	56.09	0.63	68.33	85.94
2.90	0.39	3.53	73.40	68.33	0.39	83.26	86.33
3.53	0.00	4.30	73.40	83.26	0.09	101.44	86.42
4.30	0.00	5.24	73.40	101.44	0.00	123.59	86.42
5.24	0.00	6.39	73.40	123.59	0.00	150.57	86.43
6.39	2.08	7.78	75.48	150.57	0.02	183.44	86.44
7.78	2.96	9.48	78.44	183.44	0.62	223.51	87.06
9.48	2.51	11.55	80.95	223.51	1.62	272.31	88.68
11.55	1.58	14.08	82.53	272.31	2.93	331.77	91.61
14.08	0.80	17.15	83.33	331.77	3.84	404.21	95.45
17.15	0.36	20.90	83.69	404.21	3.22	492.47	98.65
20.90	0.14	25.46	83.83	492.47	1.34	600.00	100.00



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p. 13
12 Jul 11 12:40

Figure J38 PSA reference of Petch Thai Limestone, run number 8.

Result: Analysis Report

Sample Details

Sample ID: Limestone (PT)
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes:

Run Number: 9
Record Number: 49

Measured: Tue Jul 12 2011 11:26AM
Analysed: Tue Jul 12 2011 11:26AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000), Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 16.2 %
Residual: 1.441 %

Result Statistics

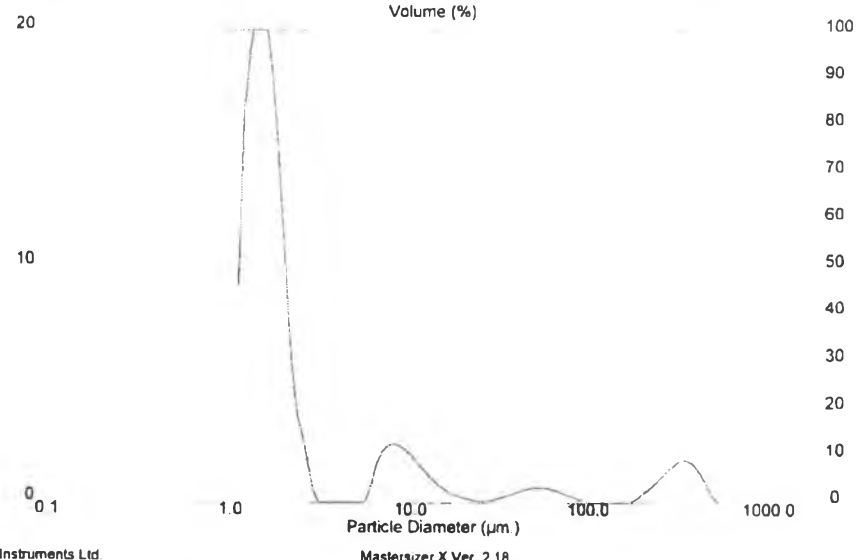
Distribution Type: Volume
Mean Diameters:
D (4, 3] = 27.88 um

Concentration = 0.0042 %Vol
D (v, 0.1) = 1.32 um
D [3, 2] = 1.89 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 1.79 um
Span = 1.938E+01

Specific S.A. = 3.1751 sq. m / g
D (v, 0.9) = 35.99 um
Uniformity = 1.479E+01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	9.67	1.32	9.73	25.46	0.10	31.01	89.81
1.32	25.11	1.60	34.77	31.01	0.29	37.79	90.10
1.60	25.45	1.95	60.20	37.79	0.58	46.03	90.67
1.95	13.88	2.38	74.07	46.03	0.79	56.09	91.47
2.38	4.03	2.90	78.11	56.09	0.75	68.33	92.22
2.90	0.37	3.53	78.50	68.33	0.50	83.26	92.71
3.53	0.00	4.30	78.50	83.26	0.19	101.44	92.90
4.30	0.00	5.24	78.50	101.44	0.00	123.59	92.91
5.24	0.00	6.39	78.50	123.59	0.00	150.57	92.91
6.39	2.20	7.78	80.71	150.57	0.01	183.44	92.91
7.78	3.15	9.48	83.86	183.44	0.44	223.51	93.36
9.48	2.69	11.55	86.55	223.51	1.16	272.31	94.52
11.55	1.71	14.08	88.26	272.31	2.00	331.77	96.51
14.08	0.89	17.15	89.15	331.77	2.24	404.21	98.75
17.15	0.40	20.90	89.55	404.21	1.18	492.47	99.92
20.90	0.15	25.46	89.70	492.47	0.07	600.00	100.00



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p. 14
12 Jul 11 12:40

Figure J39 PSA reference of Petch Thai Limestone, run number 9.

Result: Analysis Report

Sample Details

Sample ID: Limestone (PT)
Sample File: SARUN-01
Sample Path: C:\SIZERX\DATA\STUDENT\ANUVAT\
Sample Notes

Run Number: 10
Record Number: 50

Measured: Tue Jul 12 2011 11:27AM
Analysed: Tue Jul 12 2011 11:27AM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2OHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.5295, 0.1000); Dispersant R.I. = 1.3300]

Sampler: MS17

Obscuration: 16.3 %
Residual: 1.415 %

Result Statistics

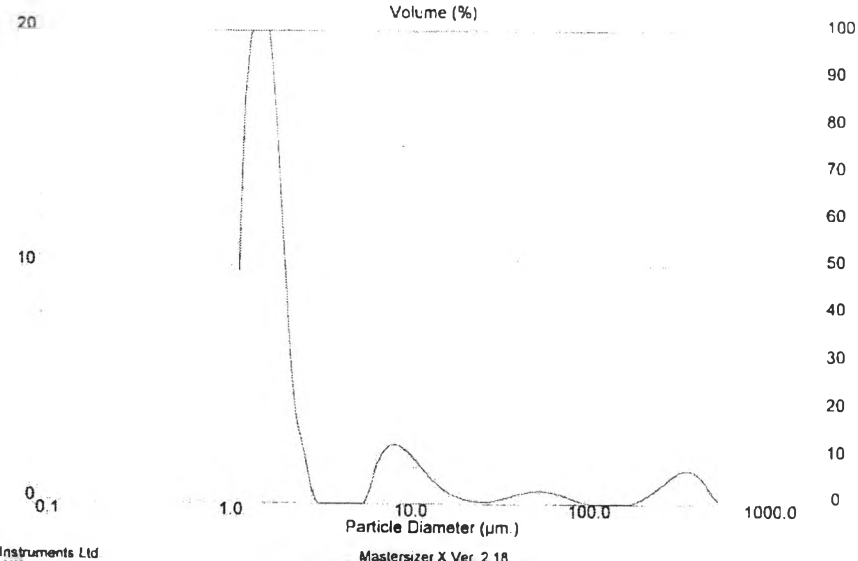
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 24.42 um

Concentration = 0.0041 %Vol
D (v, 0.1) = 1.32 um
D [3, 2] = 1.84 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 1.76 um
Span = 7.810E+00

Specific S.A. = 3.2532 sq. m / g
D (v, 0.9) = 15.09 um
Uniformity = 1.304E+01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	10.32	1.32	10.38	25.46	0.13	31.01	91.25
1.32	26.02	1.60	36.33	31.01	0.30	37.79	91.55
1.60	25.69	1.95	61.99	37.79	0.54	46.03	92.09
1.95	13.53	2.38	75.51	46.03	0.71	56.09	92.80
2.38	3.76	2.90	79.29	56.09	0.67	68.33	93.48
2.90	0.33	3.53	79.64	68.33	0.45	83.26	93.92
3.53	0.00	4.30	79.64	83.26	0.16	101.44	94.08
4.30	0.00	5.24	79.64	101.44	0.00	123.59	94.09
5.24	0.00	6.39	79.64	123.59	0.00	150.57	94.09
6.39	2.25	7.78	81.89	150.57	0.00	183.44	94.09
7.78	3.22	9.48	85.10	183.44	0.33	223.51	94.42
9.48	2.74	11.55	87.85	223.51	0.89	272.31	95.31
11.55	1.75	14.08	89.60	272.31	1.56	331.77	96.87
14.08	0.92	17.15	90.52	331.77	1.82	404.21	98.69
17.15	0.42	20.90	90.94	404.21	1.12	492.47	99.80
20.90	0.18	25.46	91.13	492.47	0.19	600.00	100.00



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p. 1
12 Jul 11 12:42

Figure J40 PSA reference of Petch Thai Limestone, run number 10.

J.4 Gas Pycnometer (GP)

Samples were characterized for density by GP (Quantachrome, Ultrapycnometer 1000). The samples were weight and placed in the chamber. The Helium was used as a medium gas to determine the volume of the sample. The density of samples can be calculated from weight and volume.

Table J126 Density of the product by GP

Sample No.	Density of Iron Nugget (g/cm^3)	Density of Slag (g/cm^3)
3-1	4.4771±0.0302	
3-2	4.7650±0.0013	
3-3	5.1658±0.1355	3.0606±0.0130
3-4	6.1654±0.0533	2.9741±0.0074
4-1	4.3664±0.0386	3.0838±0.0517
4-2	5.2558±0.0462	2.9115±0.0051
4-3	6.3428±0.0622	2.7944±0.0179
4-4	5.0725±0.0279	2.7628±0.0307
4-5	3.9513±0.0437	2.9126±0.0174
5-1	4.1025±0.2142	2.5723±0.0273
5-2	5.6097±0.1386	2.7472±0.0138
5-3	4.5710±0.0595	2.7641±0.0240
5-4	4.1004±0.0408	2.7944±0.0093
5-5	5.2808±0.1511	2.7026±0.0073
5-6	5.2227±1.4184	2.8407±0.0054
5-7	4.7237±0.0042	2.9636±0.0063
6-1	5.5596±0.0946	2.9771±0.0101
6-2	6.5608±0.1262	2.9198±0.0093
6-3	6.0483±0.0998	2.8204±0.0306

J.5 Polarized Optical Microscope (POM)

Samples were analyzed the surface appearances by POM (Leica, CH-9453). The magnification was fixed to 50x. The samples were place on the holder. The POM provide light source to the samples and reflect to the objective lens, thought to the detector.

J.5.1 Experiment 3

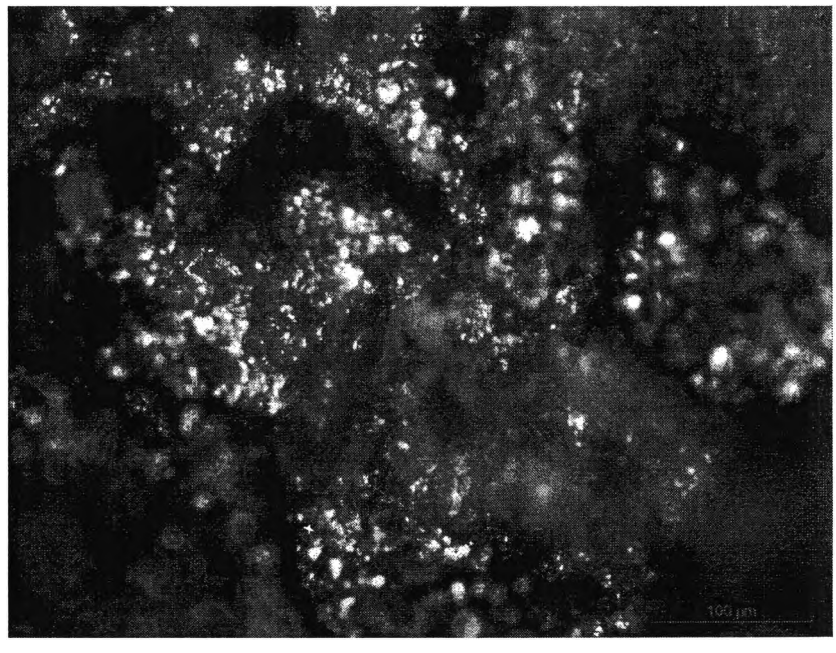


Figure J41 Appearance surface of product from Experiment 3 No.1.

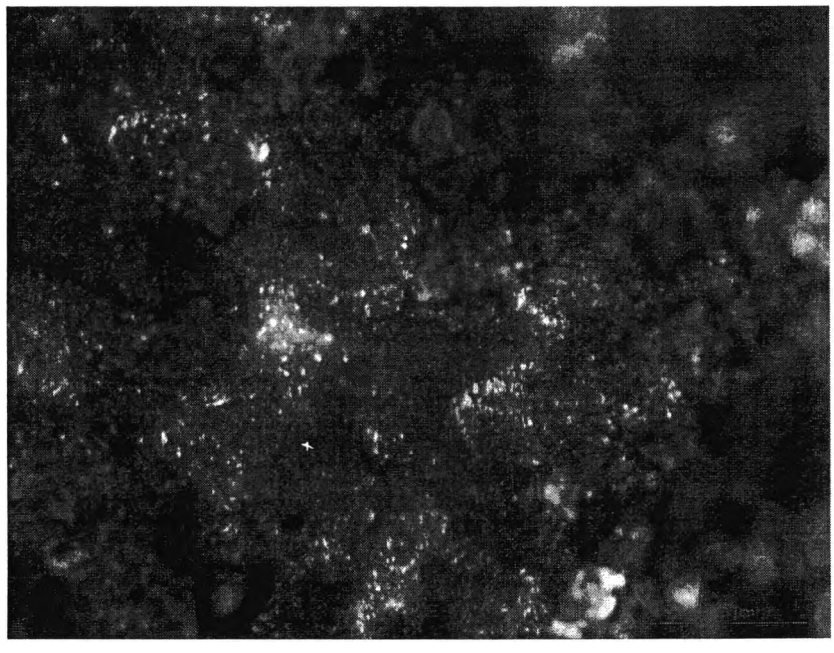


Figure J42 POM image of the product from Experiment 3 No.1.

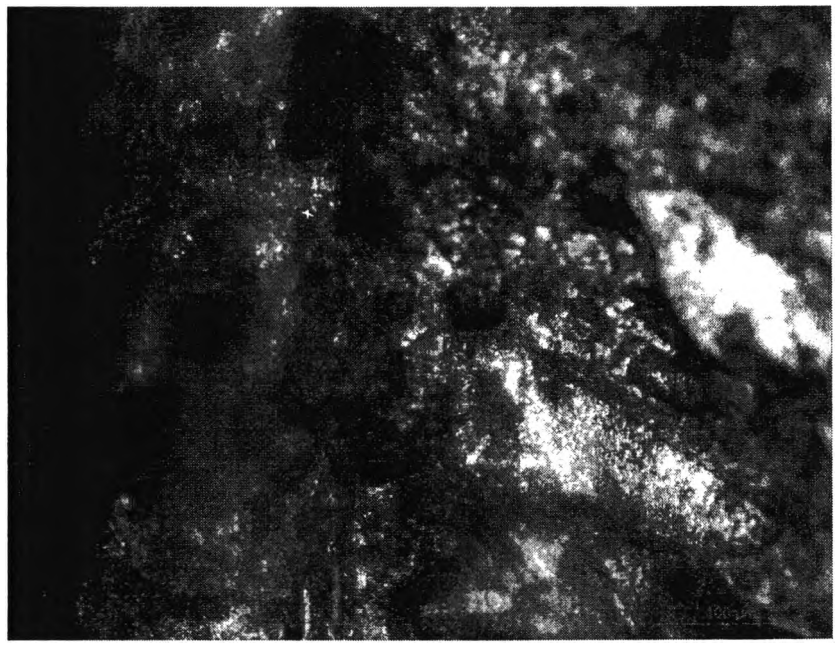


Figure J43 POM image of the product from Experiment 3 No.3.

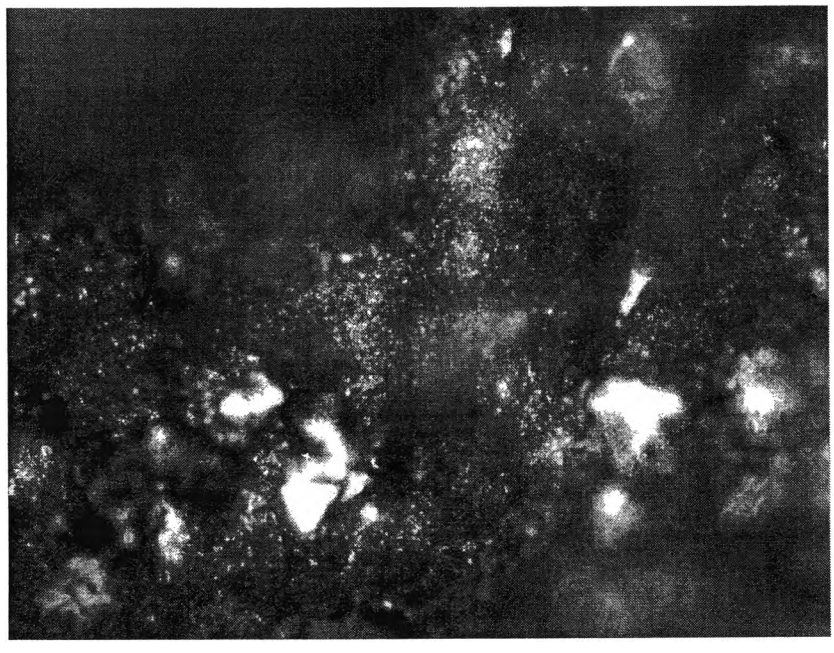


Figure J44 POM image of the product from Experiment 3 No.2.

J.5.2 Experiment 4

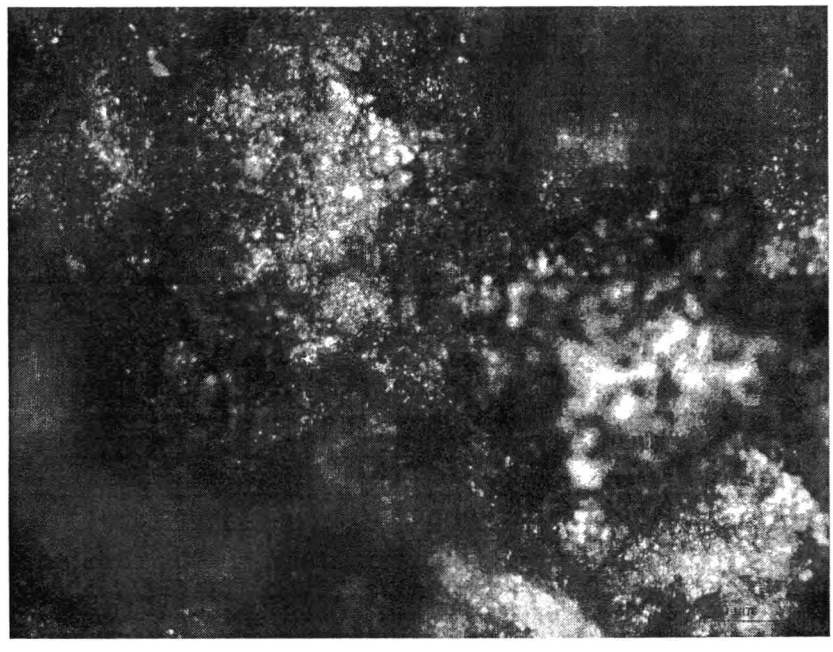


Figure J45 POM image of the product from Experiment 4 No.1.

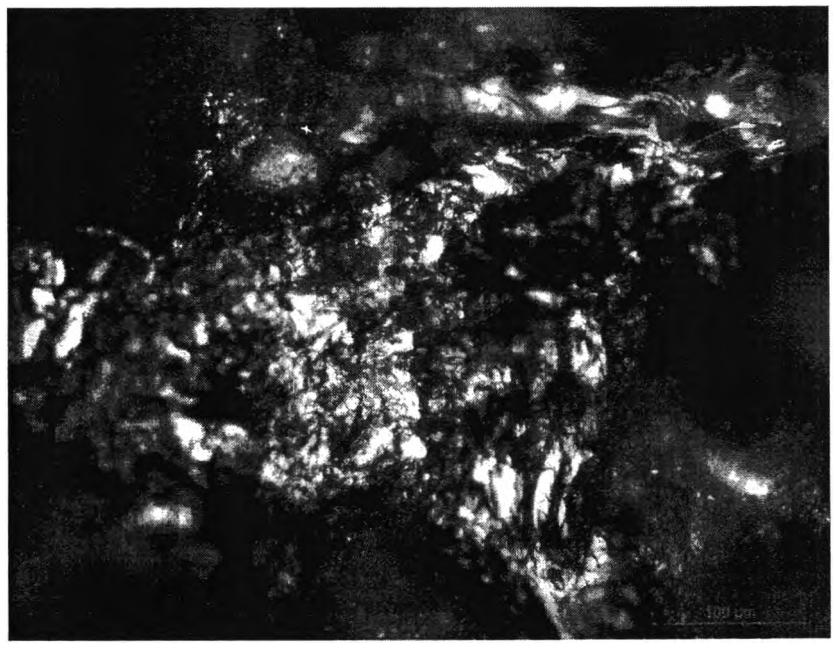


Figure J46 POM image of the product from Experiment 4 No.2.

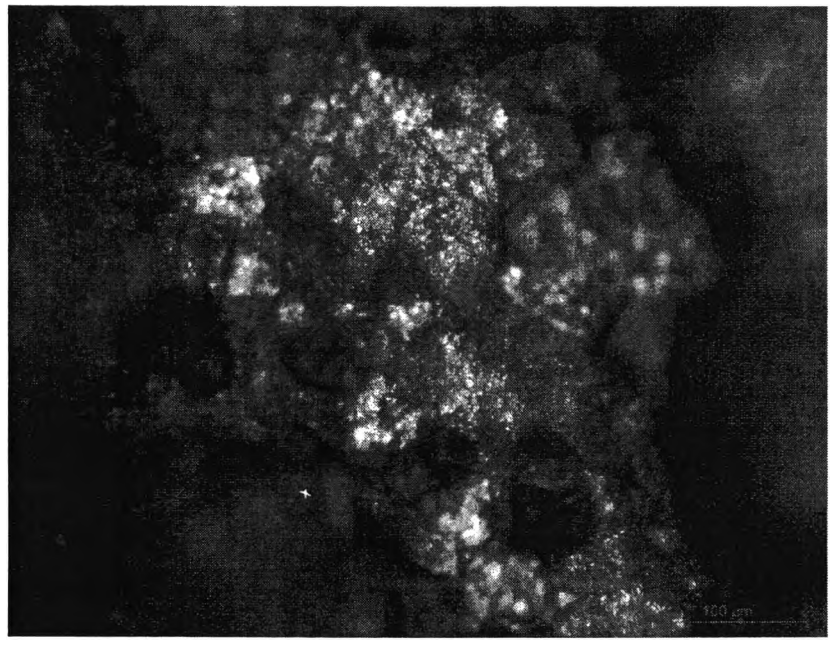


Figure J47 POM image of the product from Experiment 4 No.3.

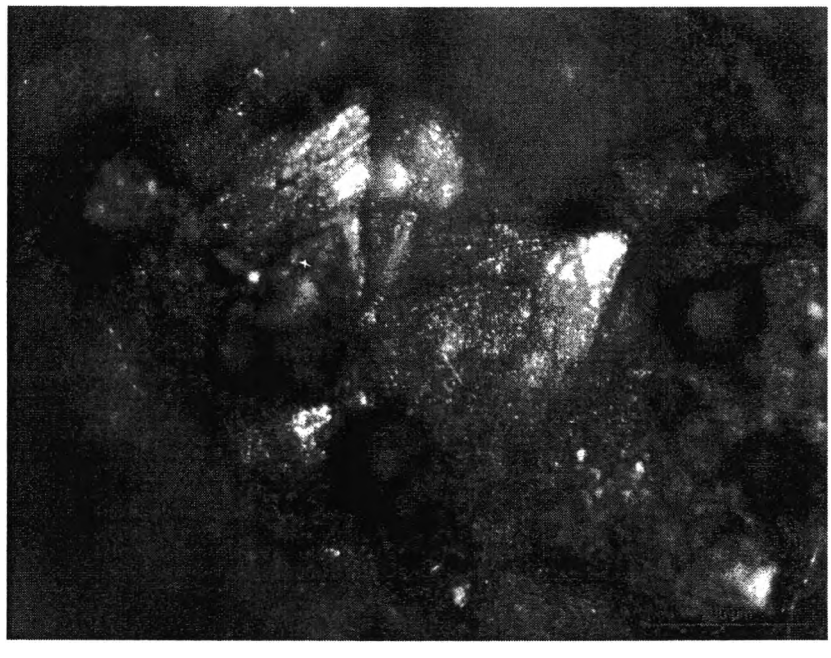


Figure J48 POM image of the product from Experiment 4 No.4.

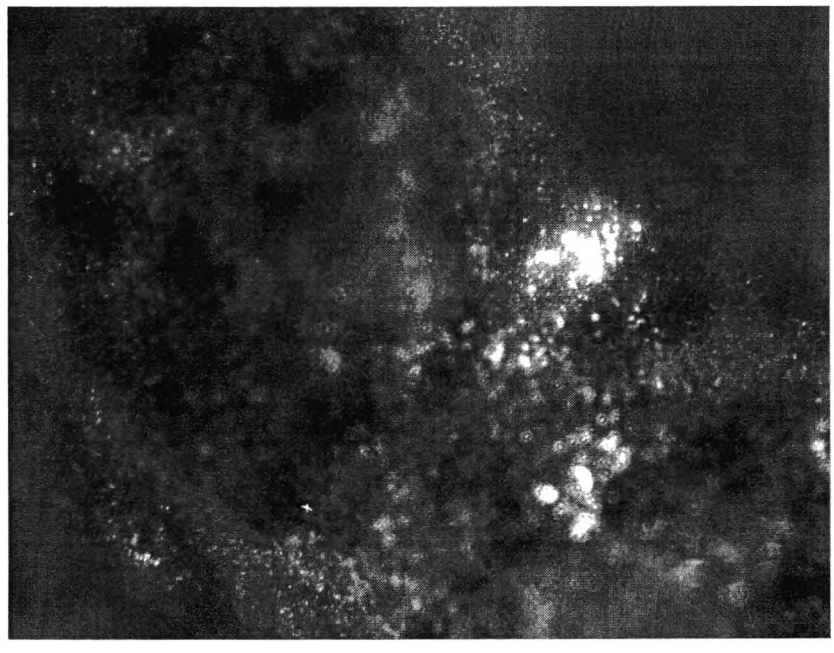


Figure J49 POM image of the product from Experiment 4 No.5.

J.5.3 Experiment 5

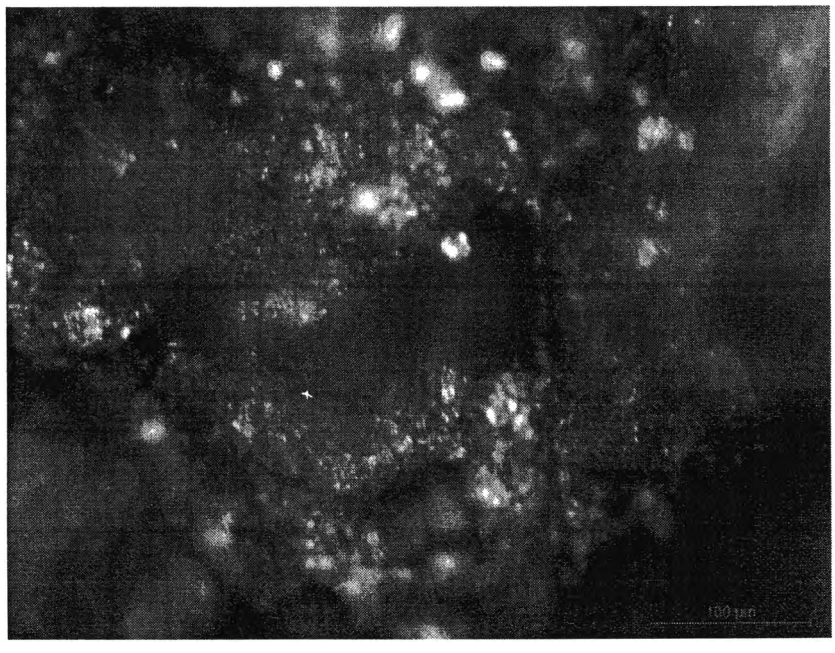


Figure J50 POM image of the product from Experiment 5 No.1.

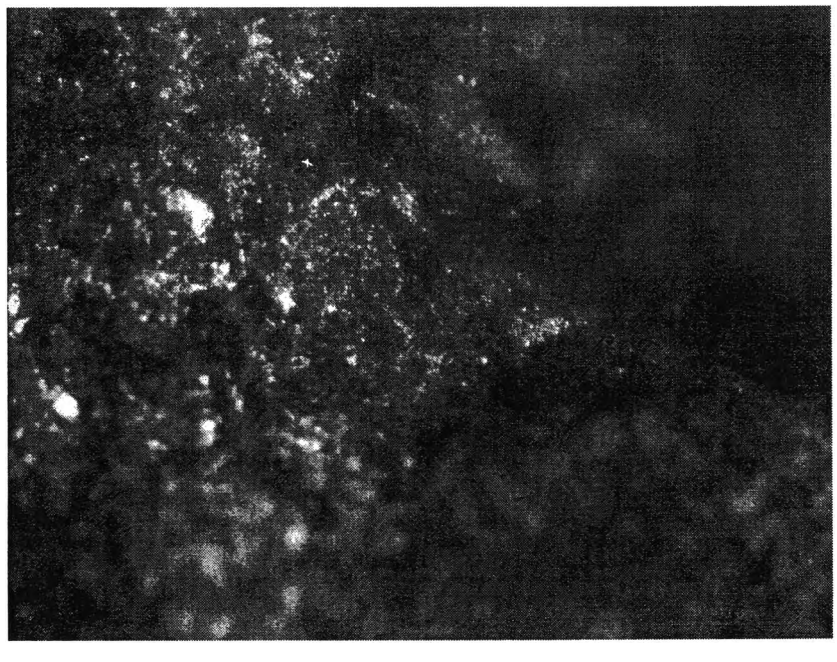


Figure J51 POM image of the product from Experiment 5 No.2.

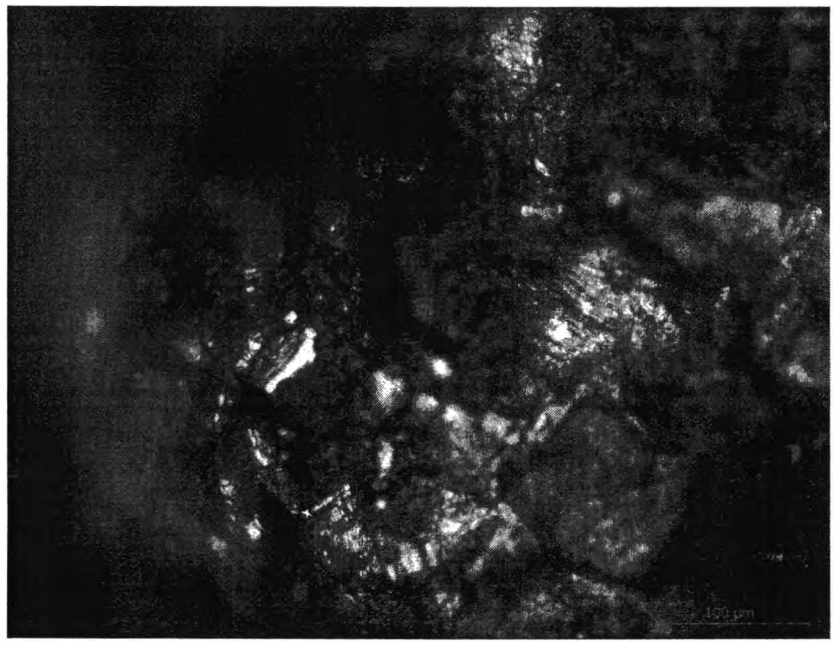


Figure J52 POM image of the product from Experiment 5 No.3.

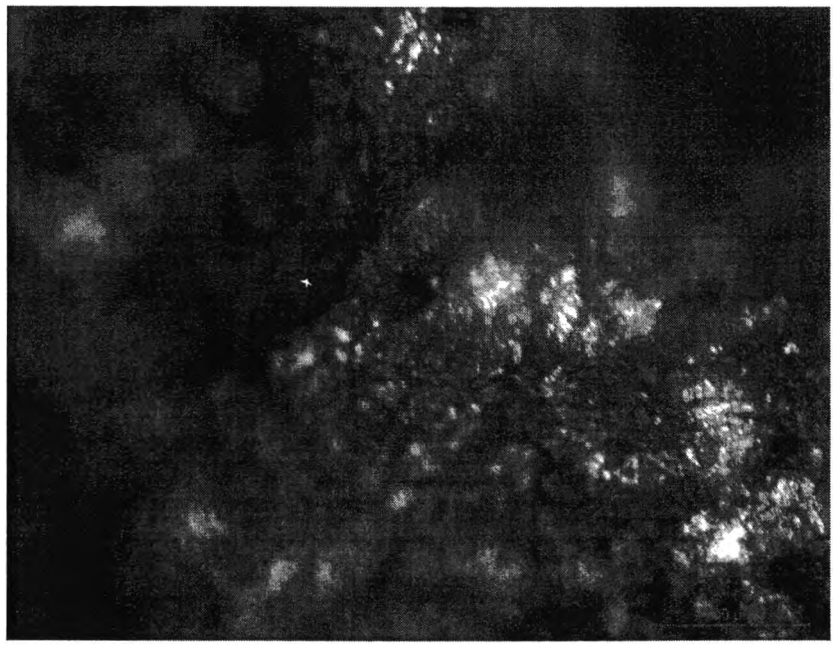


Figure J53 POM image of the product from Experiment 5 No.4.

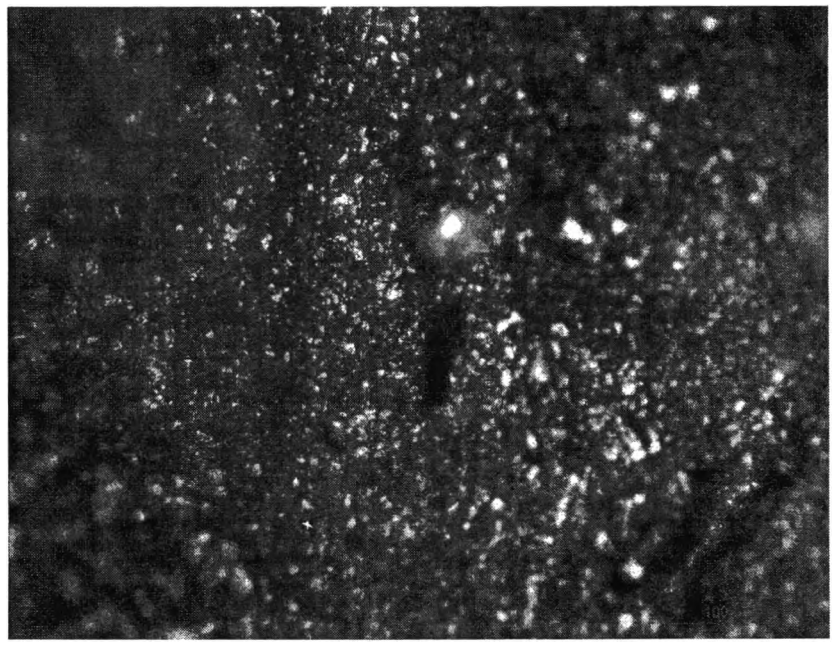


Figure J54 POM image of the product from Experiment 5 No.5.

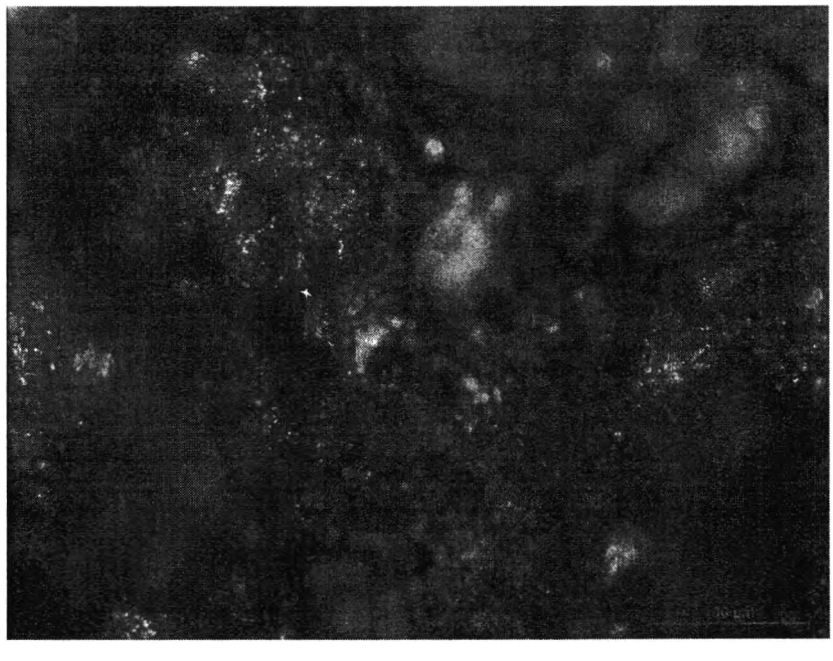


Figure J55 POM image of the product from Experiment 5 No.6.

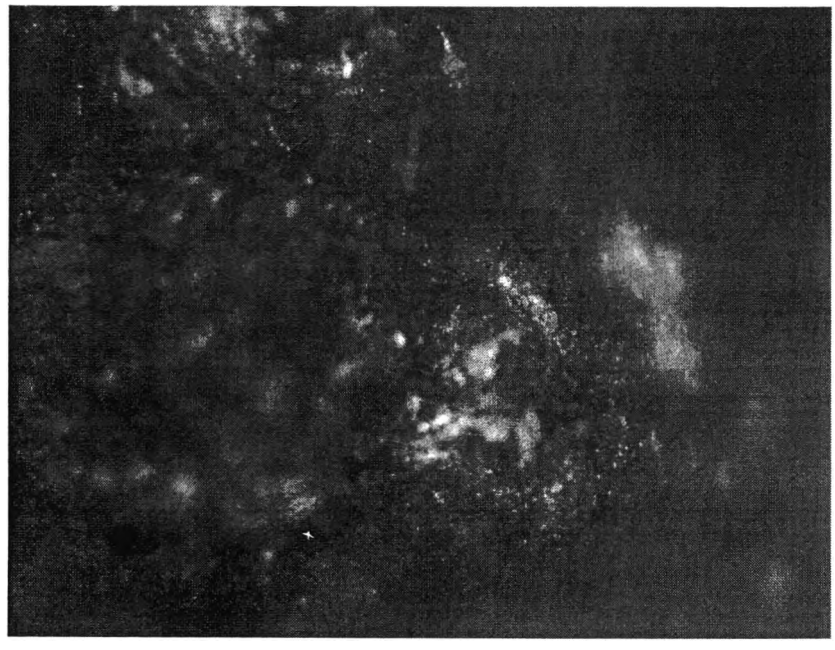


Figure J56 POM image of the product from Experiment 5 No.7.

J.5.4 Experiment 6

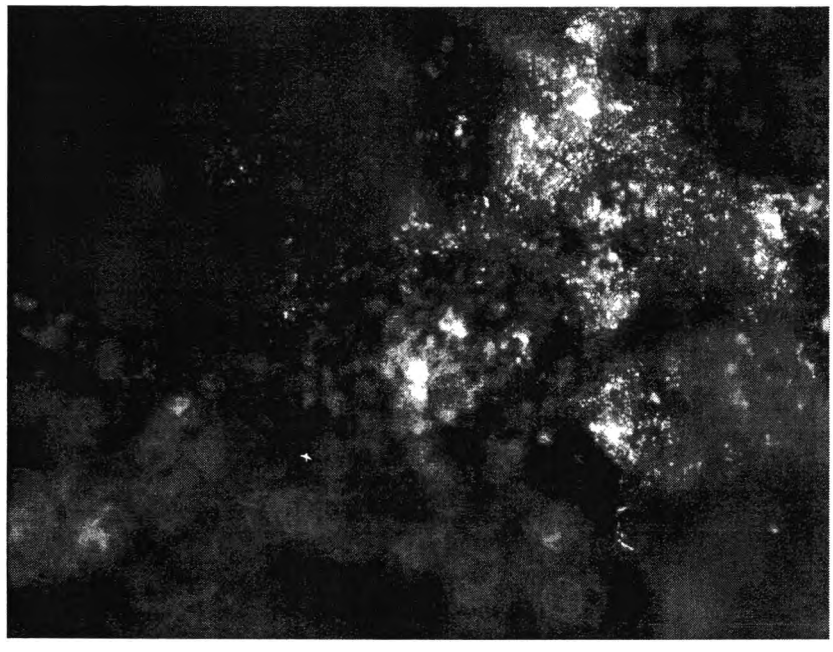


Figure J57 POM image of the product from Experiment 6 No.1.

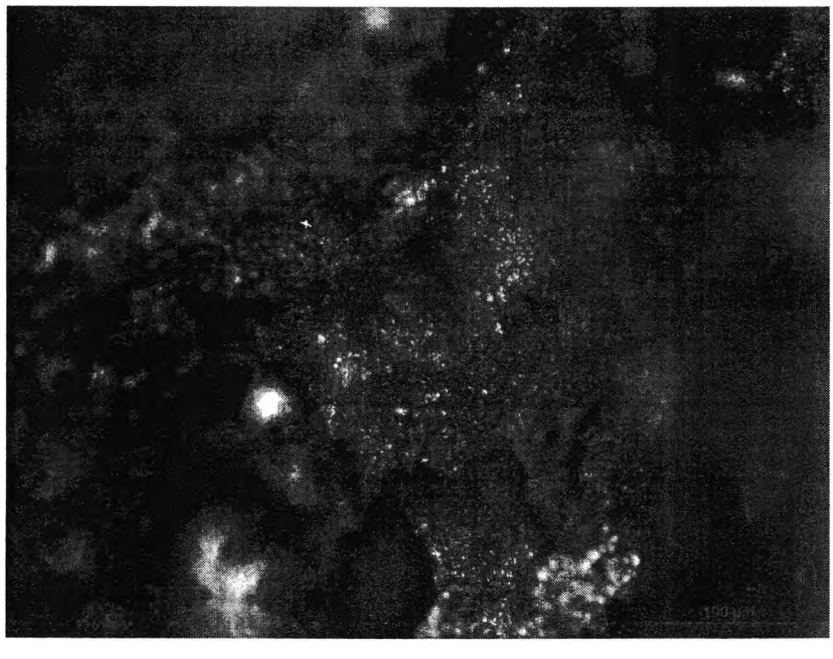


Figure J58 POM image of the product from Experiment 6 No.2.

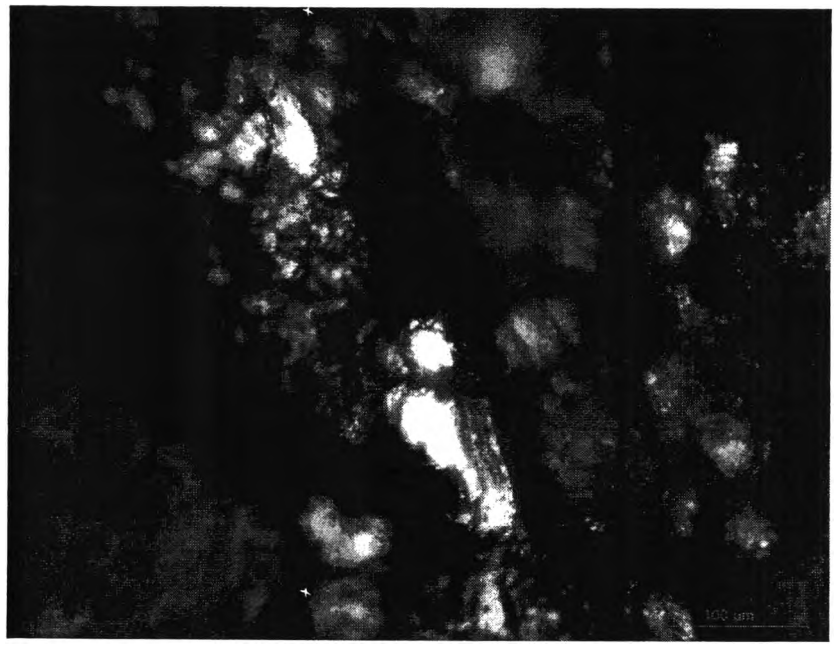


Figure J59 POM image of the product from Experiment 6 No.3.

J.6 Scanning Electron Microscope (SEM)

Sample were analyzed the morphology by SEM (Hitachi, model S-4800). The SEM accelerating voltage, current, and magnification are specified in the SEM figures. The samples were stacked onto stubs by using sticker carbon papers. The samples were clamped on the holder and placed into the high vacuum chamber for preventing the attenuation of X-ray by the air molecules.

J.6.1 Experiment 3

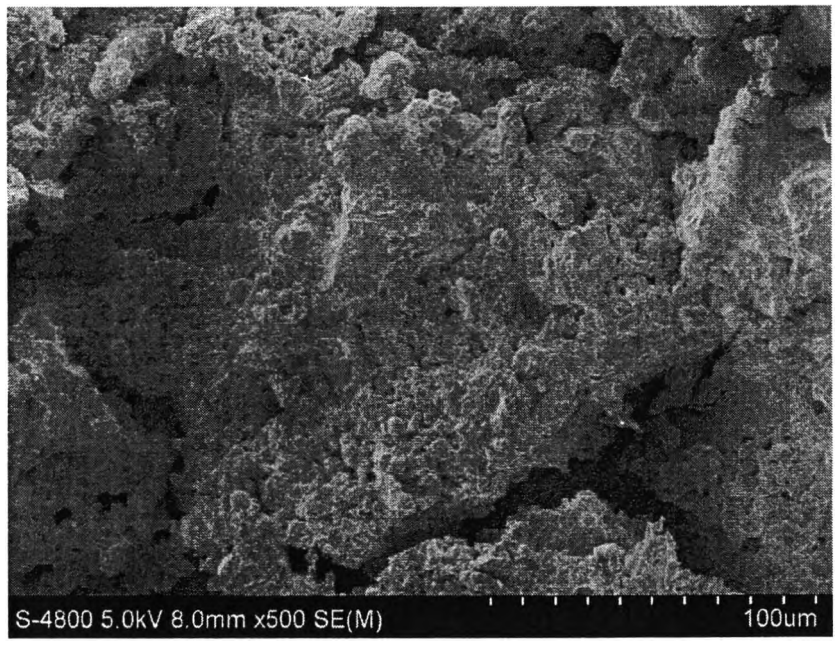


Figure J60 SEM image of the product from Experiment 3 No.1.

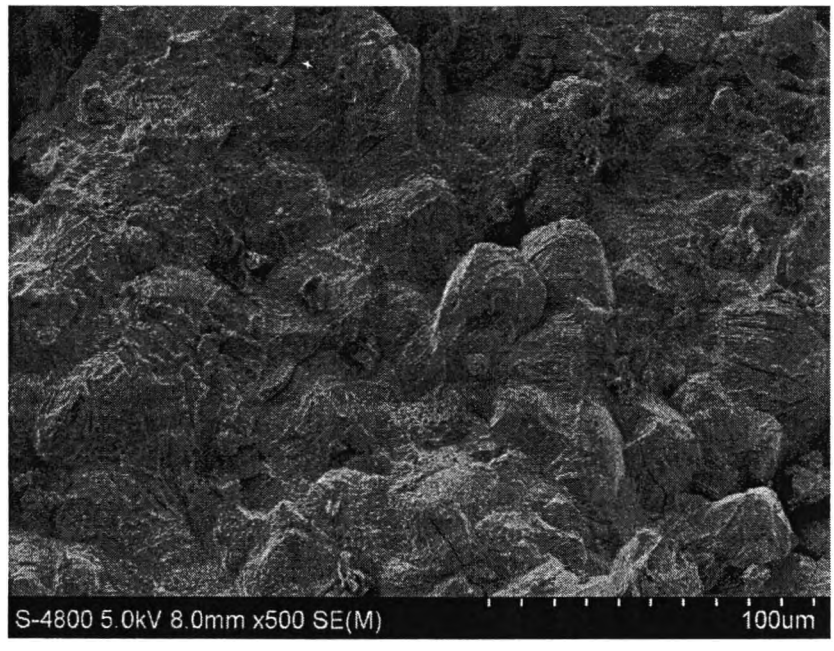


Figure J61 SEM image of the product from Experiment 3 No.2.

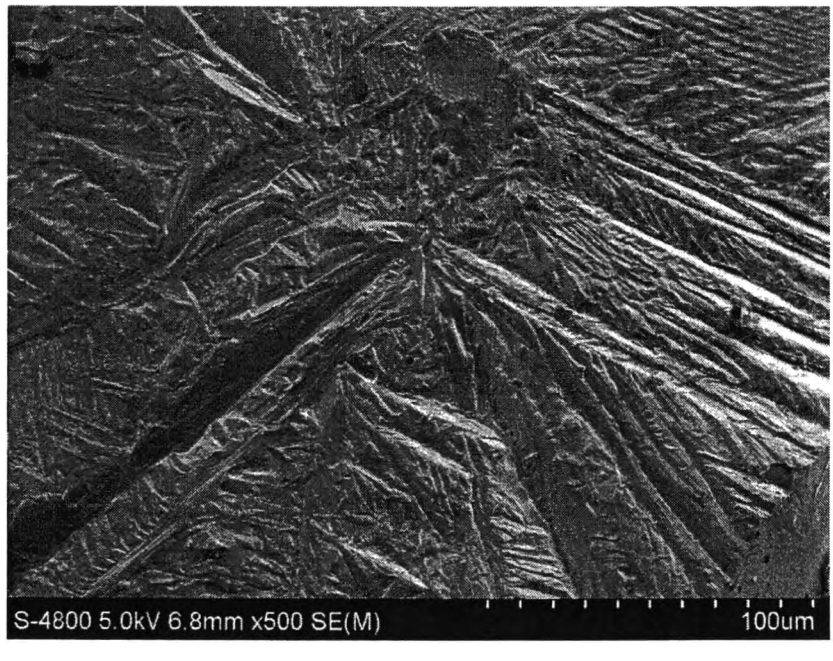


Figure J62 SEM image of the product from Experiment 3 No.3.

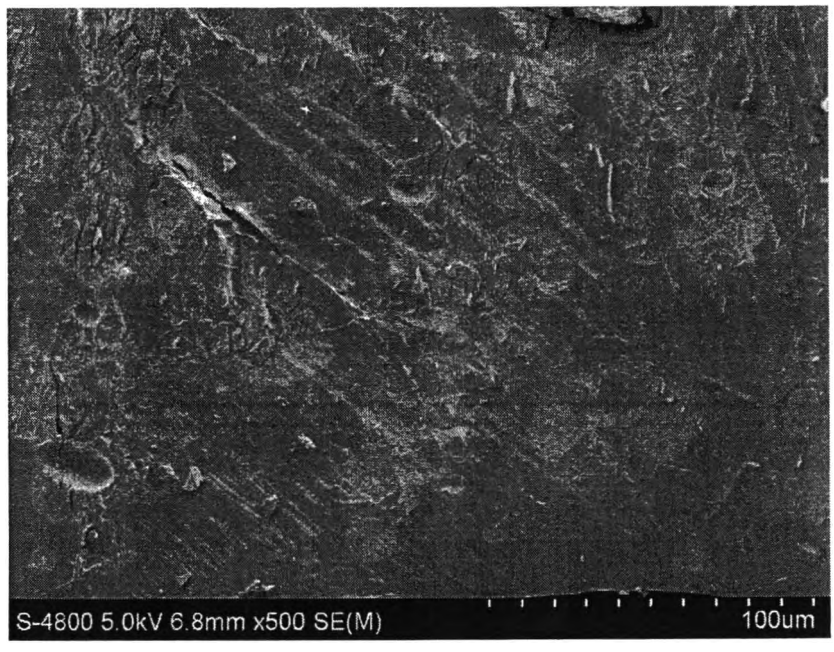


Figure J63 SEM image of the product from Experiment 3 No.4.

J.6.2 Experiment 4

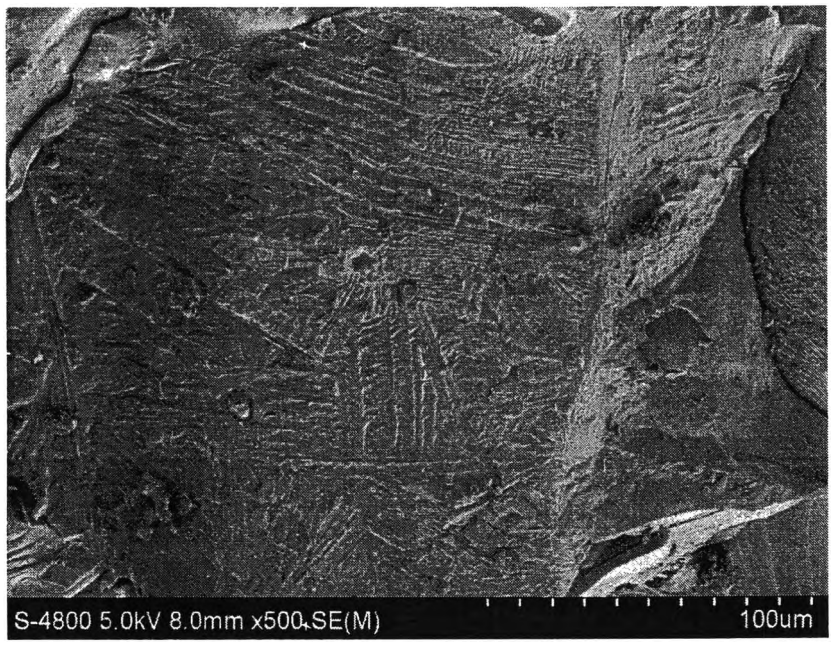


Figure J64 SEM image of the product from Experiment 4 No.1.

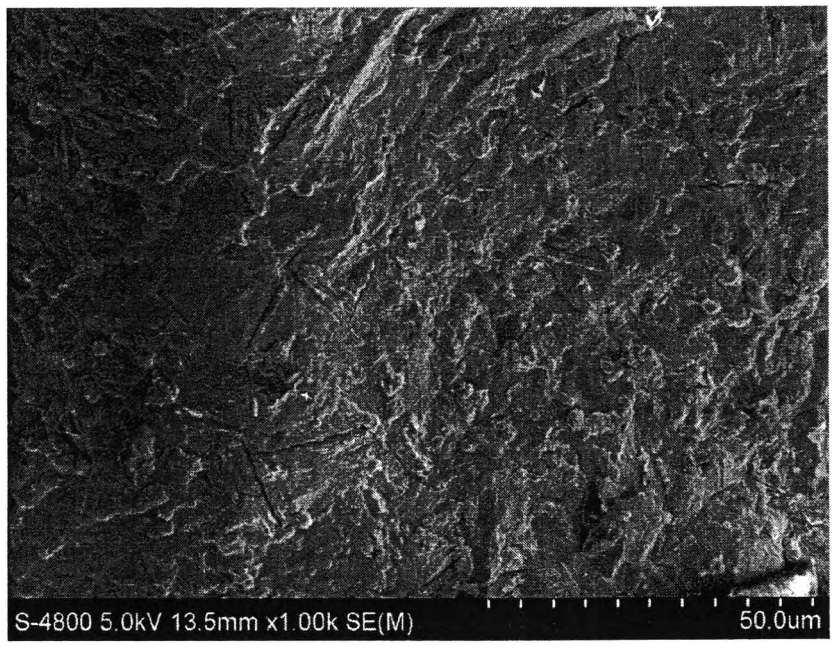


Figure J65 SEM image of the product from Experiment 4 No.2.

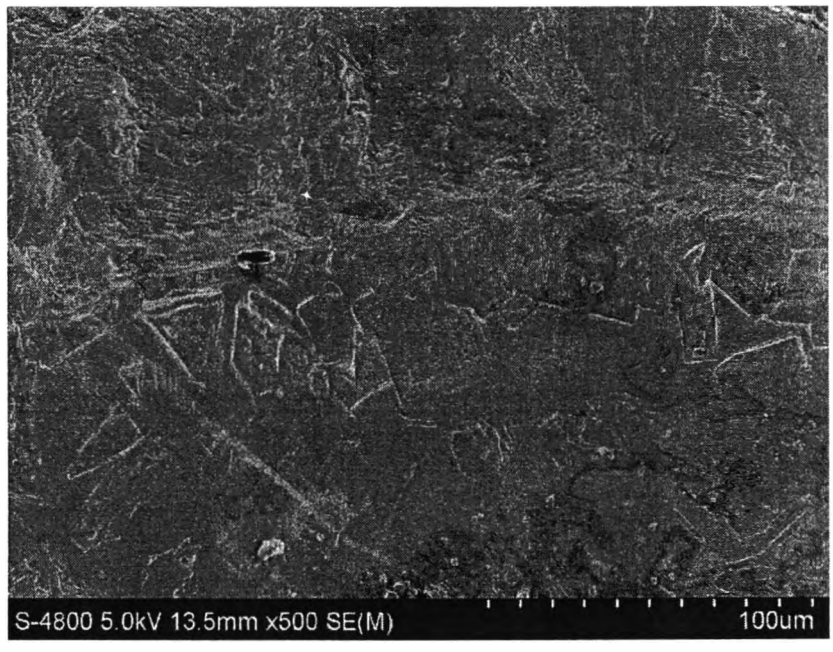


Figure J66 SEM image of the product from Experiment 4 No.3.

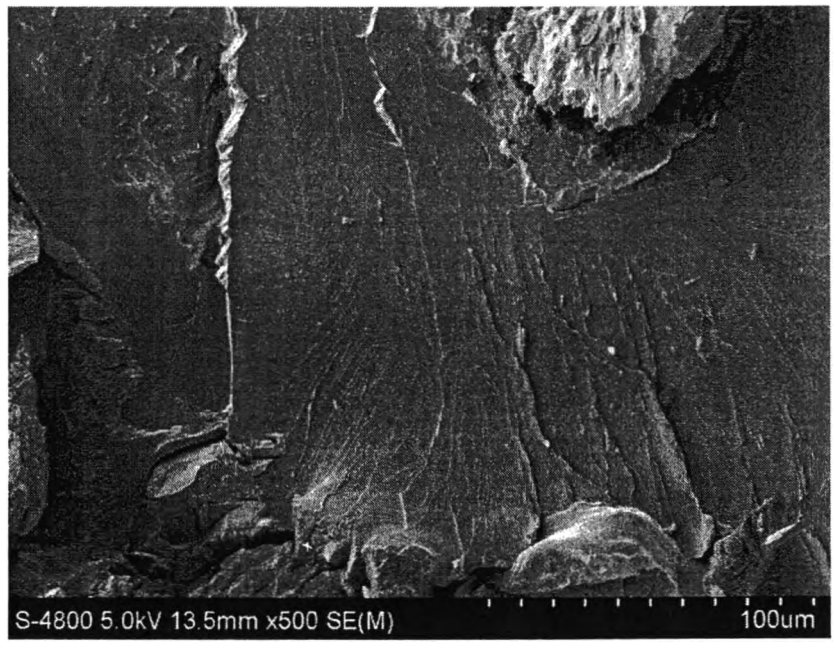


Figure J67 SEM image of the product from Experiment 4 No.4.

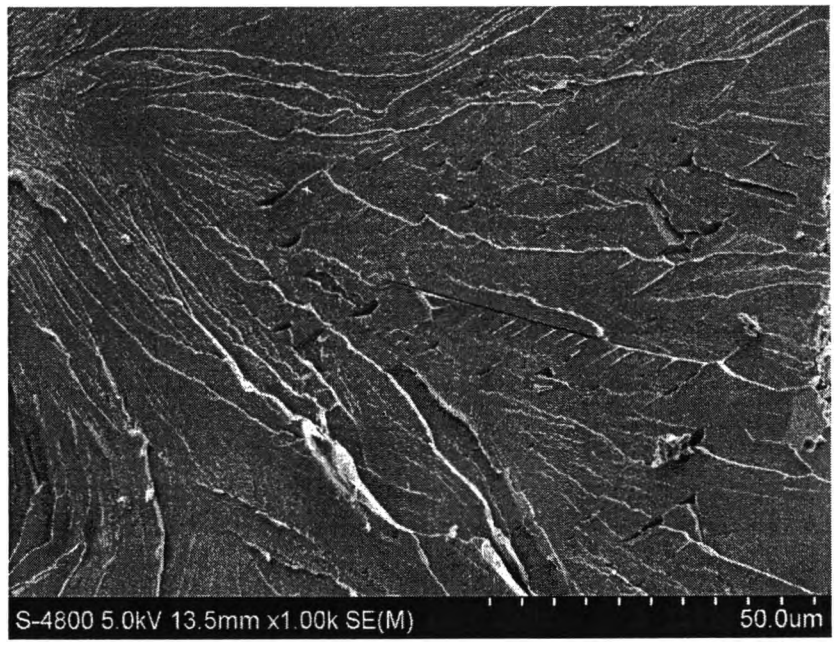


Figure J68 SEM image of the product from Experiment 4 No.5.

J.6.3 Experiment 5

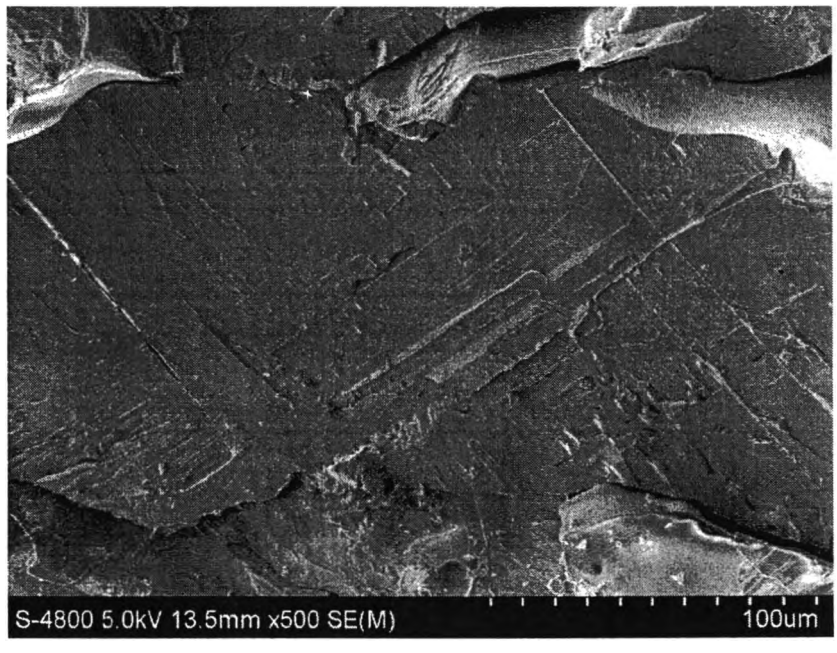


Figure J69 SEM image of the product from Experiment 5 No.1.

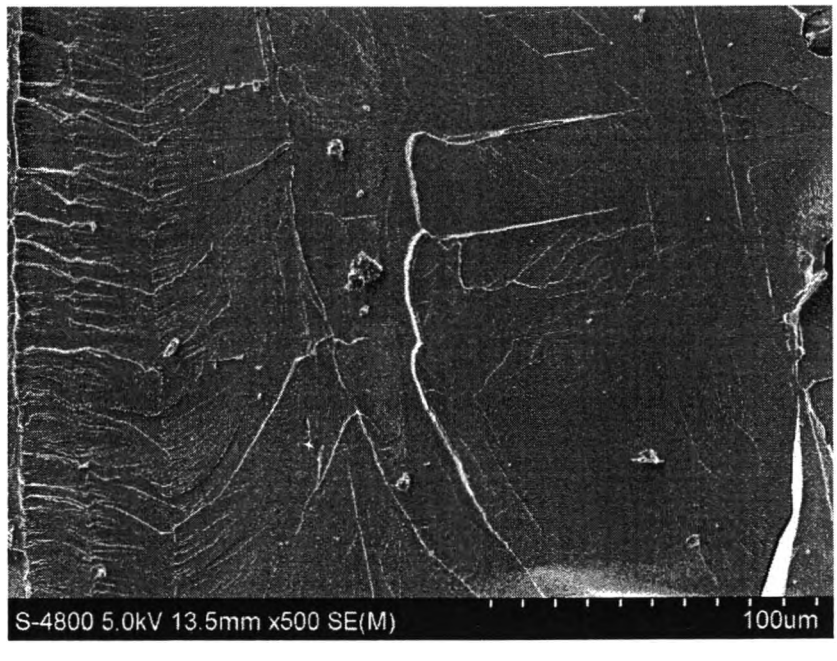


Figure J70 SEM image of the product from Experiment 5 No.2.

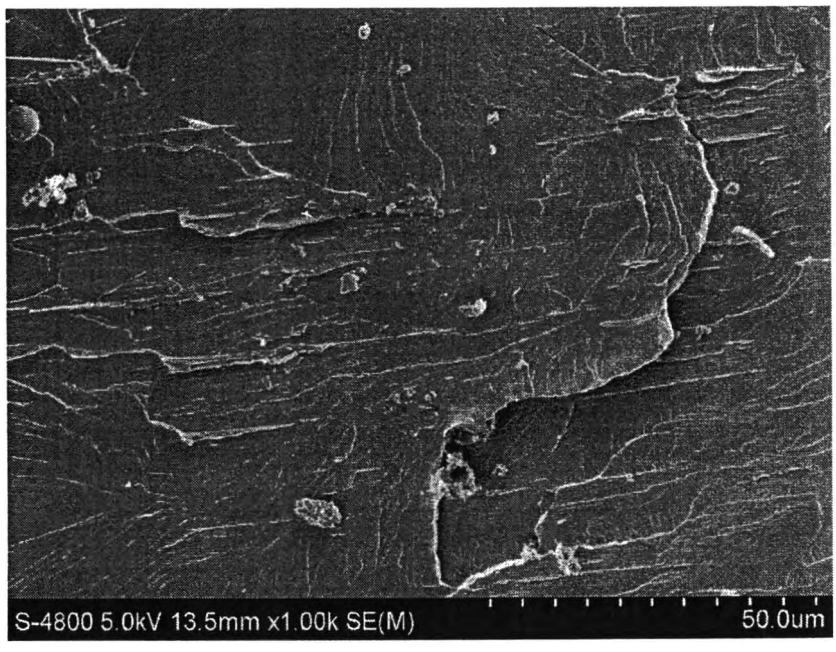


Figure J71 SEM image of the product from Experiment 5 No.3.

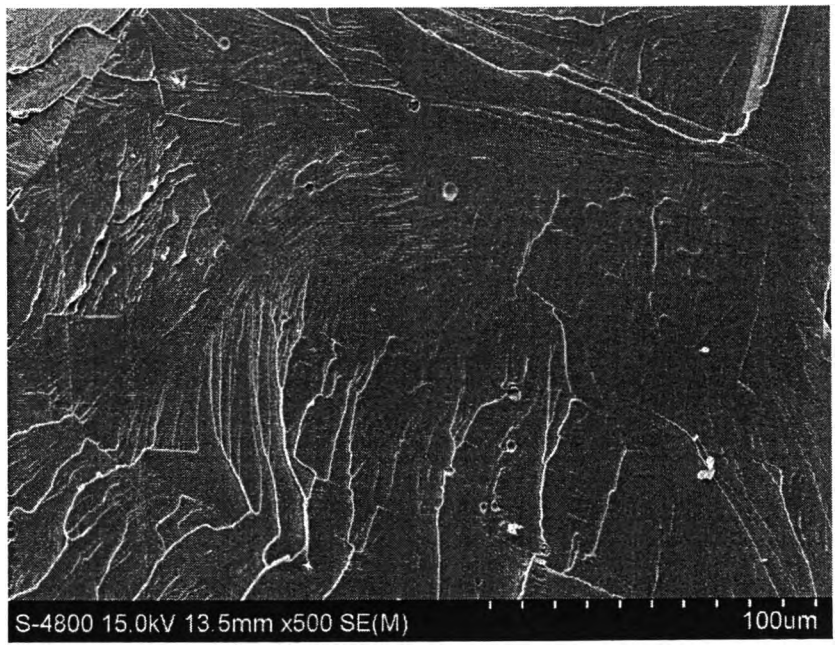


Figure J72 SEM image of the product from Experiment 5 No.4.

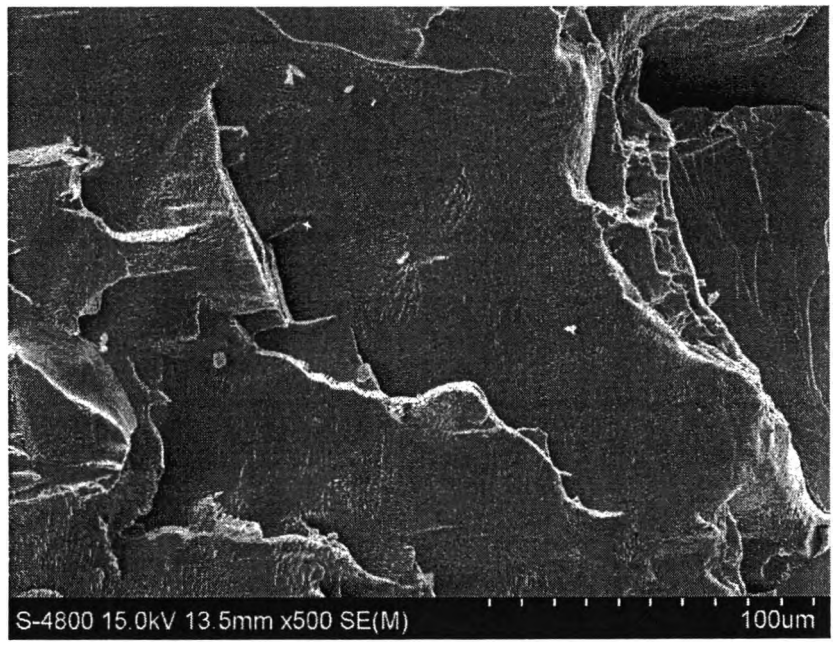


Figure J73 SEM image of the product from Experiment 5 No.5.

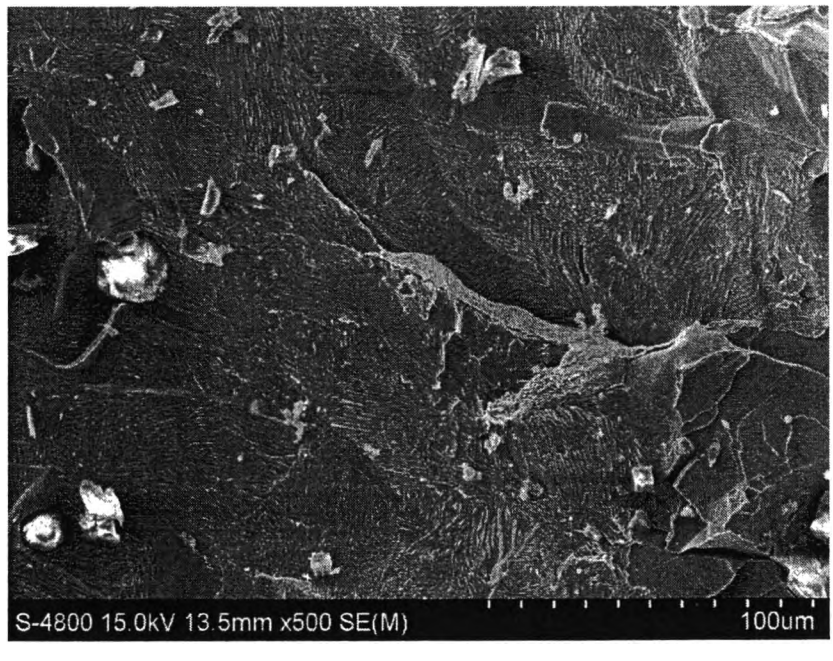


Figure J74 SEM image of the product from Experiment 5 No.6.

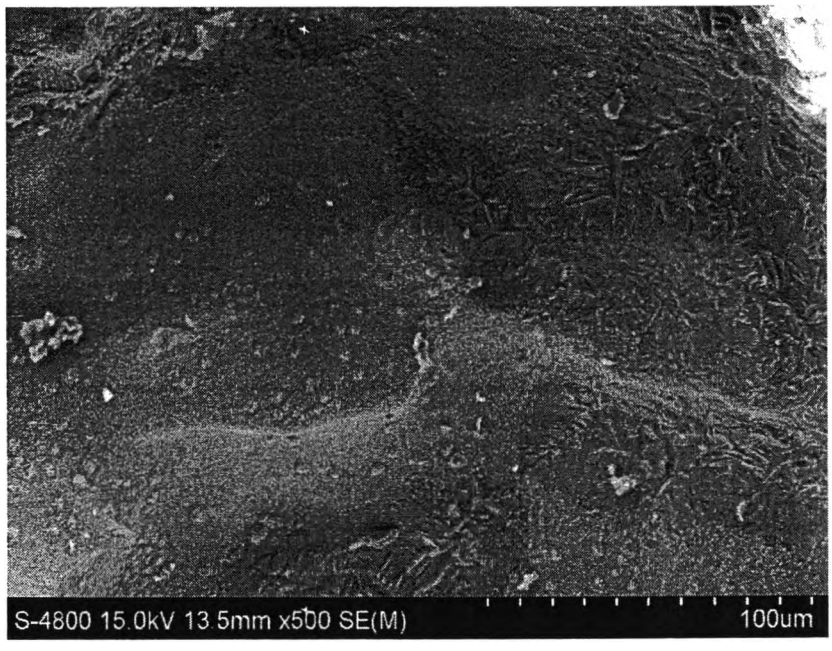


Figure J75 SEM image of the product from Experiment 5 No.7.

J.6.4 Experiment 6

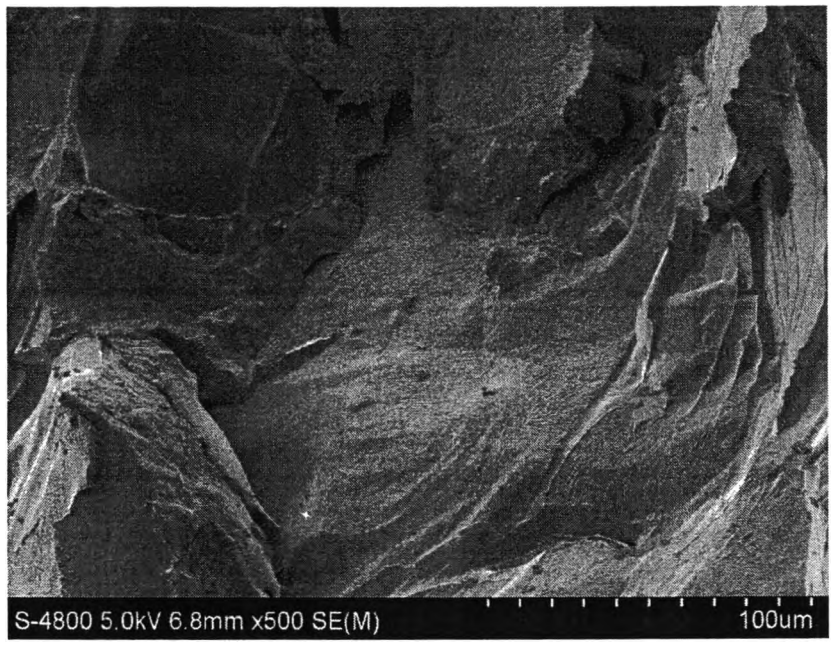


Figure J76 SEM image of the product from Experiment 6 No.1.

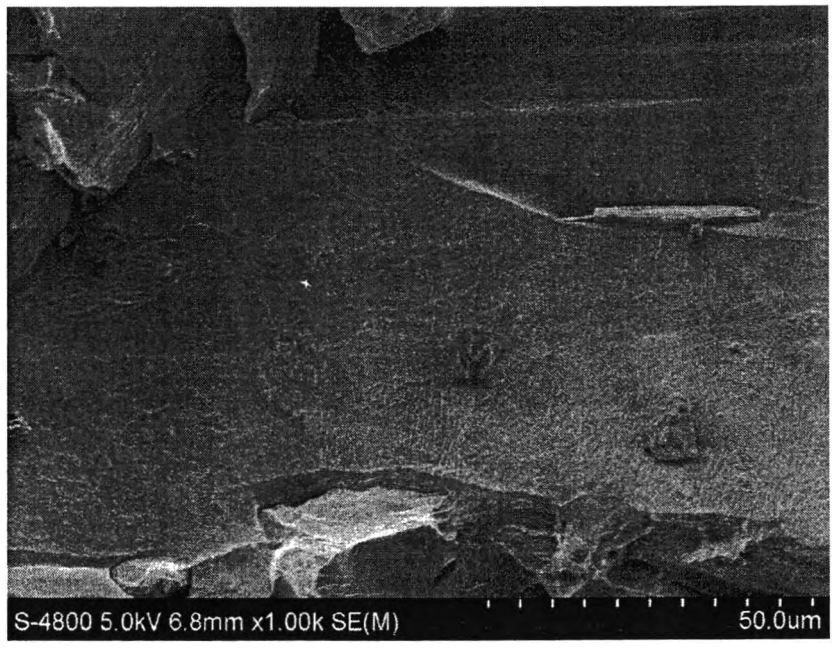


Figure J77 SEM image of the product from Experiment 6 No.2.

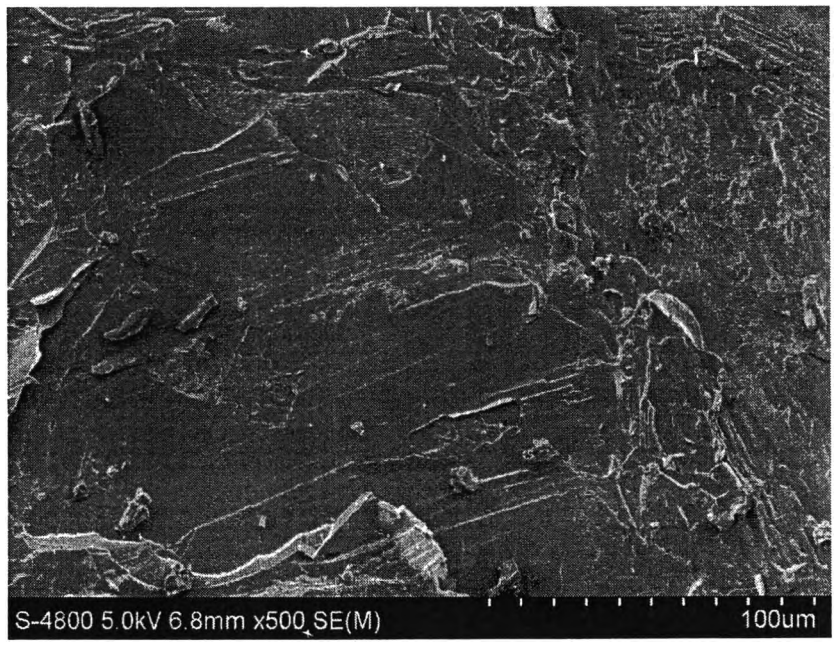


Figure J78 SEM image of the product from Experiment 6 No.3.

J.7 X-Ray Diffraction Spectrometer (XRD)

The sample was characterized for its structures by XRD (Rigaku D/max; model 2000) .The specimens were placed on the glass slide, clamped on the sample holder, and then exposed to X-ray. The anode tube of X-ray was Copper K-alpha.

J.7.1 XRD Diffraction Patterns of Iron Nugget

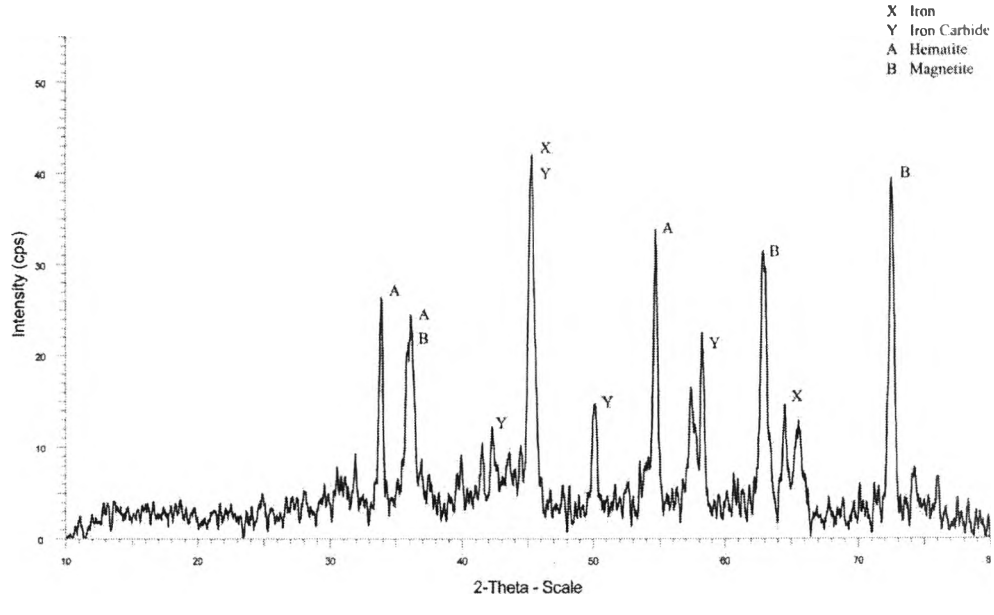


Figure J79 XRD spectrum of iron nugget, Experiment 4 No.1.

From the Figure J79, the peaks at the angles = 44.674 and 65.023 represent the iron. The peaks at the angles = 43.038, 43.917, 45.068, 49.212, and 58.357 represent the iron carbide. The peaks at the angles = 33.153, 35.612, and 54.091 represent the iron oxide (hematite). The peaks at the angles = 35.423, 62.516 and 73.950 represent the iron oxide (magnetite). (Aronniemi, 2004, Kugler, 2003)

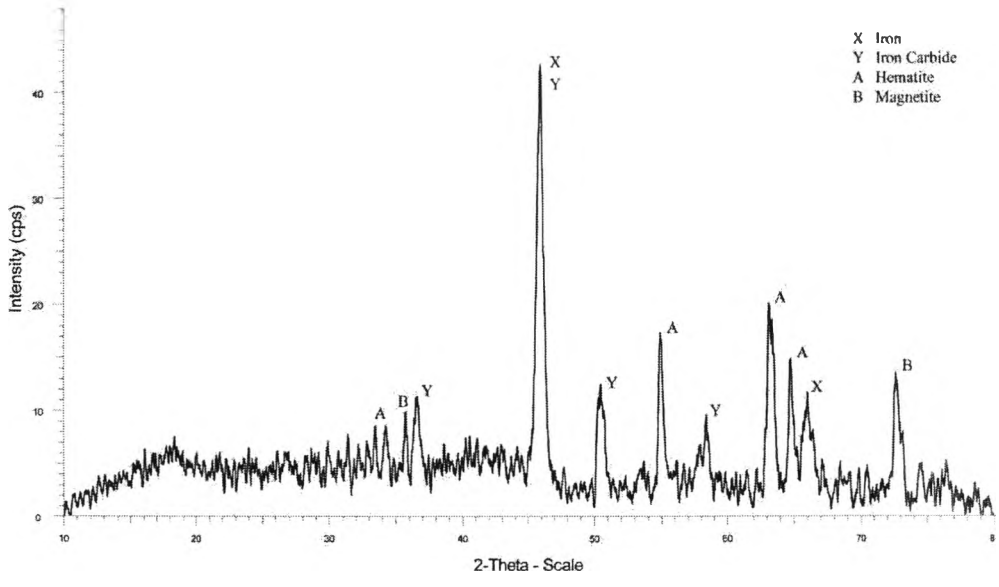


Figure J80 XRD spectrum of iron nugget, Experiment 4 No.2.

From the Figure J80, the peaks at the angles = 44.674 and 65.023 represent the iron. The peaks at the angles = 37.768, 49.212, and 58.357 represent the iron carbide. The peaks at the angles = 33.153, 35.612, 54.091, 62.451, and 63.991 represent the iron oxide (hematite). The peaks at the angles = 35.423 and 73.950 represent the iron oxide (magnetite). (Aronniemi, 2004, Kugler, 2003)

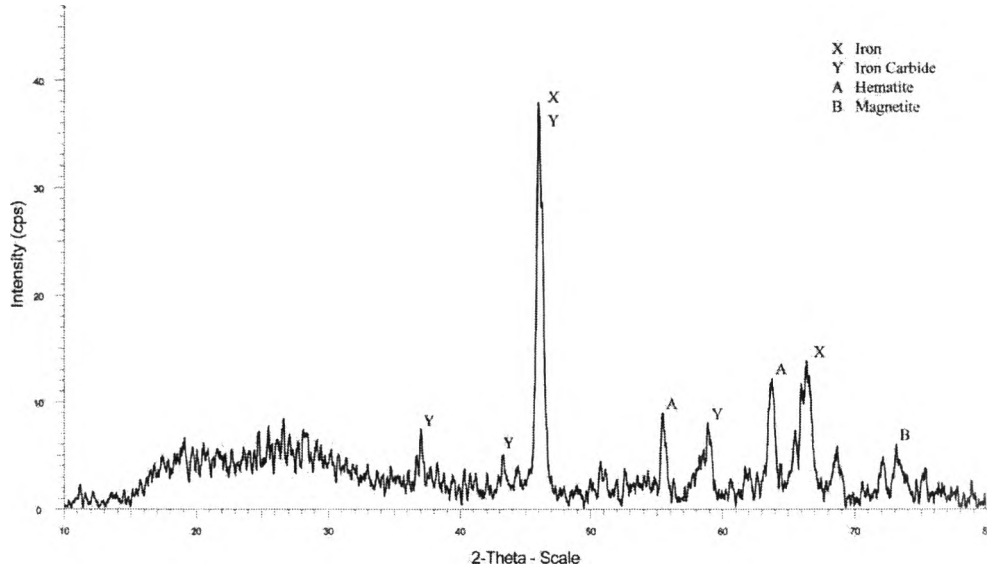


Figure J81 XRD spectrum of iron nugget, Experiment 4 No.5.

From the Figure J81, the peaks at the angles = 44.674 and 65.023 represent the iron. The peaks at the angles = 37.768, 43.917, 45.068, and 58.357 represent the iron carbide. The peaks at the angles = 54.091 and 63.991 represent the iron oxide (hematite). The peaks at the angles = 73.950 represent the iron oxide (magnetite). (Aronniemi, 2004, Kugler, 2003)

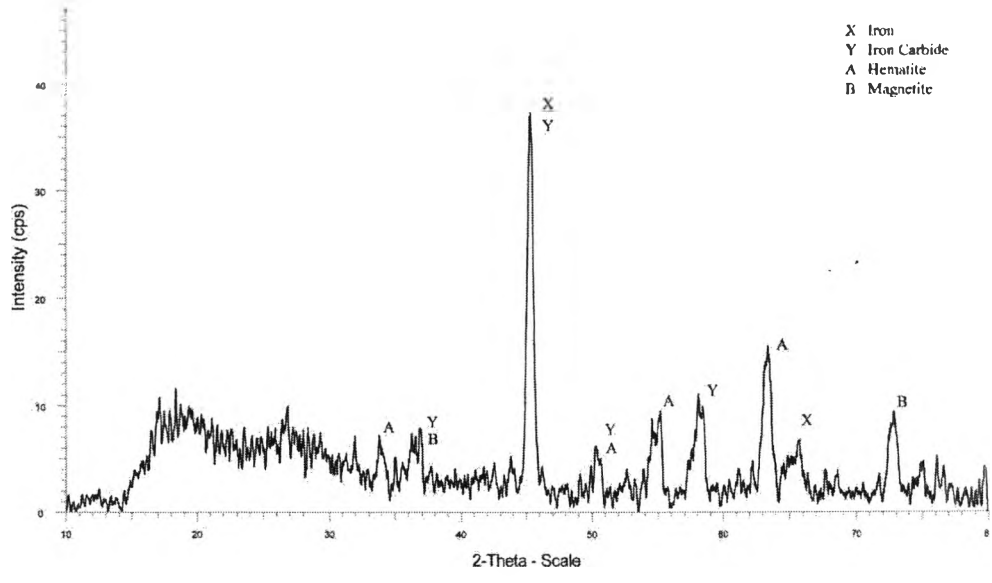
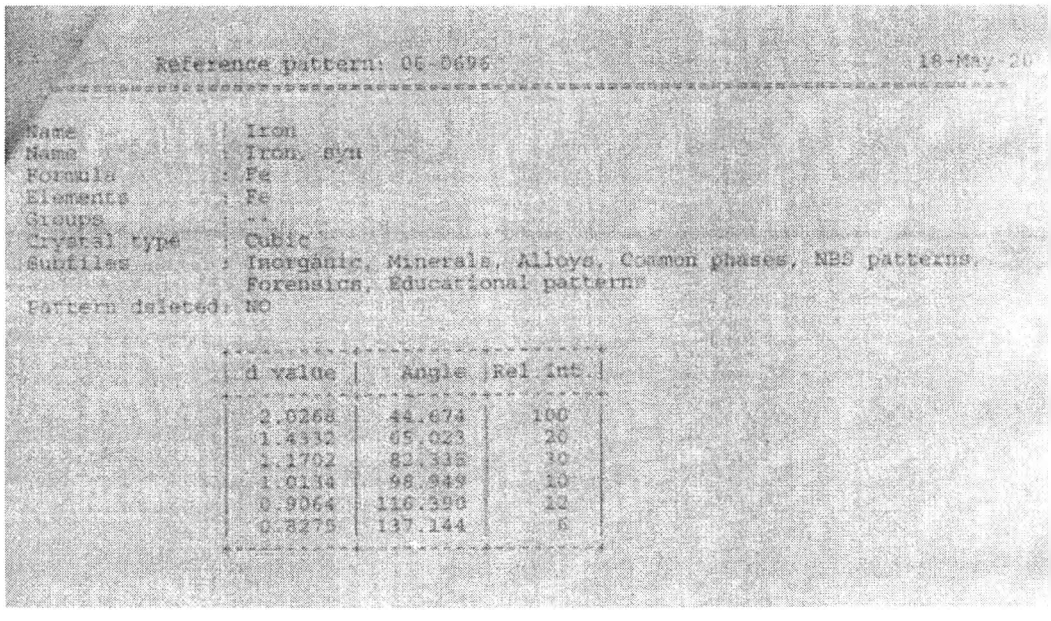


Figure J82 XRD spectrum of iron nugget, Experiment 5 No.3.

The peaks at the angles = 44.674 and 65.023 represent the iron. The peaks at the angles = 37.768, 45.068, 49.212, and 58.357 represent the iron carbide. The peaks at the angles = 33.153, 54.091, 62.451, and 63.991 represent the iron oxide (hematite). The peaks at the angles = 35.423 and 73.950 represent the iron oxide (magnetite). (Aronniemi, 2004, Kugler, 2003)

J.7.2 XRD Reference Patterns (Philips; model PW3719 and software X'Pert APD)

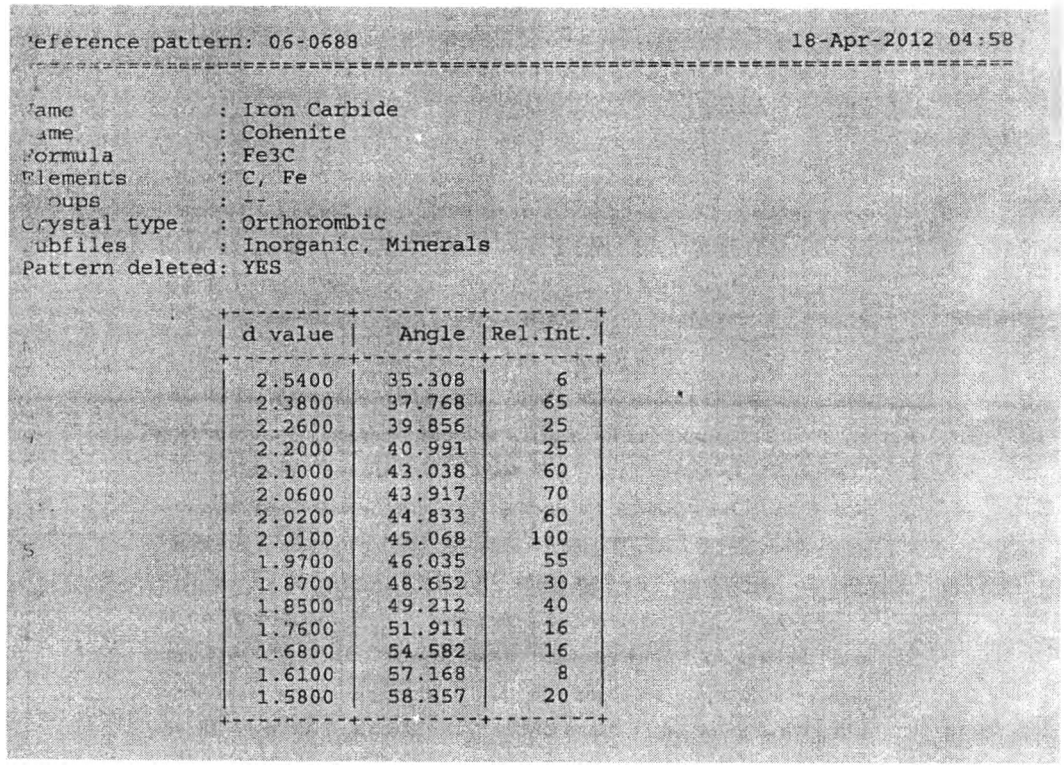


Reference pattern: 06-0696 18-May-20

Name	Iron
Name	Iron, syn
Formula	Fe
Elements	Fe
Groups	--
Crystal type	Cubic
Subfiles	Inorganic, Minerals, Alloys, Common phases, NBS patterns, Forensics, Educational patterns
Pattern deleted	NO

d value	Angle	Rel Int.
2.0268	44.674	100
1.4332	65.023	20
1.1702	82.338	30
1.0134	98.949	10
0.9064	116.390	12
0.8275	137.144	6

Figure J83 XRD reference pattern of iron.



eference pattern: 06-0688 18-Apr-2012 04:58

ame : Iron Carbide
ame : Cohenite
ormula : Fe3C
lements : C, Fe
oups : --
rystal type : Orthorombic
ubfiles : Inorganic, Minerals
Pattern deleted: YES

d value	Angle	Rel.Int.
2.5400	35.308	6
2.3800	37.768	65
2.2600	39.856	25
2.2000	40.991	25
2.1000	43.038	60
2.0600	43.917	70
2.0200	44.833	60
2.0100	45.068	100
1.9700	46.035	55
1.8700	48.652	30
1.8500	49.212	40
1.7600	51.911	16
1.6800	54.582	16
1.6100	57.168	8
1.5800	58.357	20

Figure J84 XRD reference pattern of iron carbide.

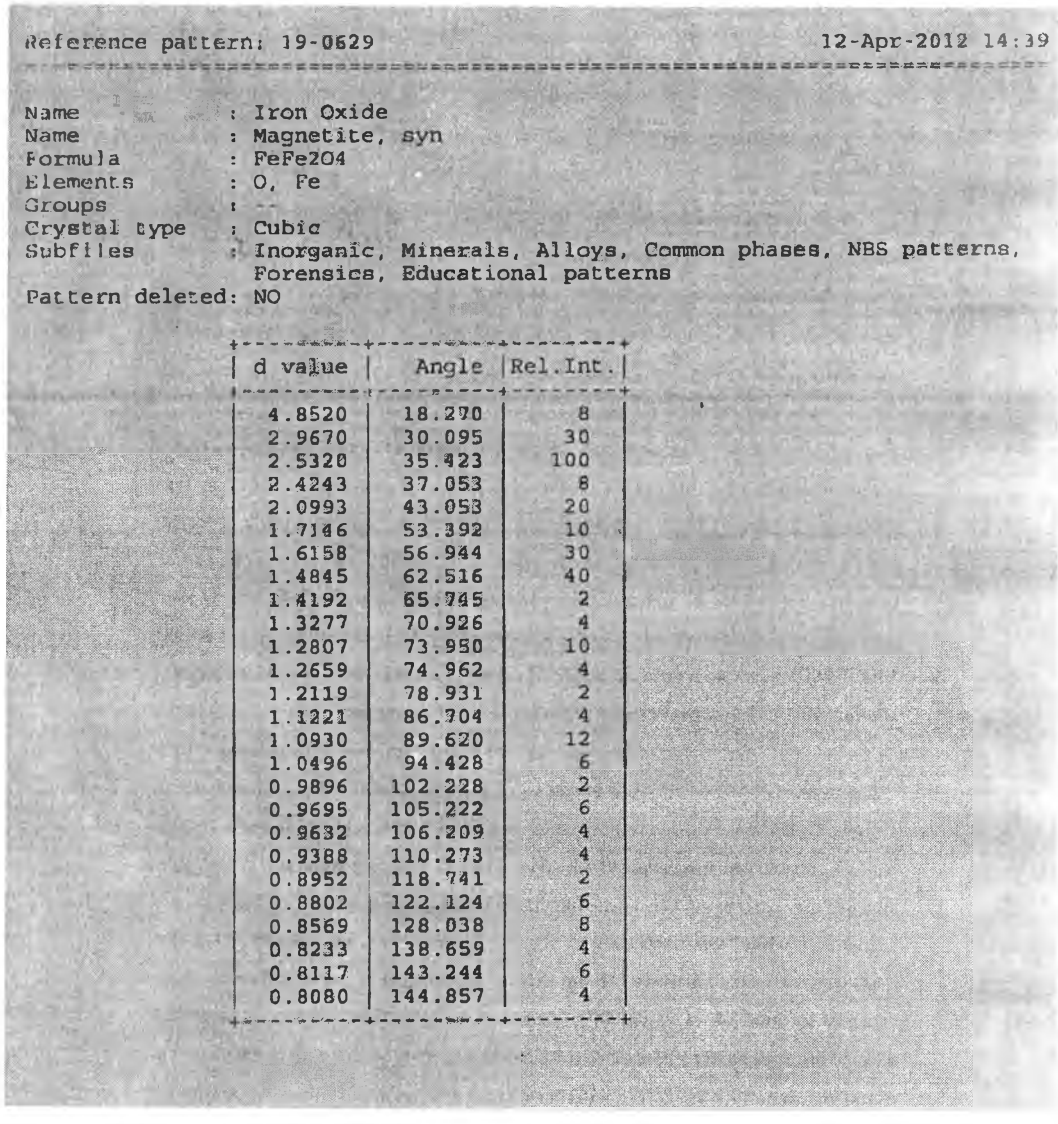
Reference pattern: 33-0664 12-Apr-20

Name : Iron Oxide
Name : Hematite, syn
Name : hematite
Formula : Fe2O3
Elements : O, Fe
Groups : --
Crystal type : Rhombohedral
Subfiles : Inorganic, Minerals, Alloys, Common phases, NBS patterns, Forensics, Educational patterns
Pattern deleted: NO

d value	Angle	Rel.Int.
3.6840	24.138	30
2.7000	33.153	100
2.5190	35.612	70
2.2920	39.277	3
2.2070	40.855	20
2.0779	43.519	3
1.8406	49.480	40
1.6941	54.091	45
1.6367	56.152	1
1.6033	57.429	5
1.5992	57.590	10
1.4859	62.451	30
1.4538	63.991	30
1.4138	66.028	1
1.3497	69.601	3
1.3115	71.937	10
1.3064	72.262	6
1.2592	75.430	8
1.2276	77.730	4
1.2141	78.760	2
1.1896	80.711	5
1.1632	82.940	5
1.1411	84.916	7
1.1035	88.542	7
1.0768	91.345	2
1.0557	93.715	7
1.0428	95.239	1
1.0393	95.663	3
0.9892	102.285	4
0.9715	104.914	1
0.9606	106.623	5
0.9581	107.025	4
0.9516	108.090	5
0.9318	111.518	2
0.9206	113.594	2
0.9081	116.045	5
0.8998	117.758	1
0.8954	118.697	3
0.8789	122.431	6
0.8648	125.929	1
0.8543	128.758	3

1

Figure J85 XRD reference pattern of hematite.



Reference pattern: 19-0629 12-Apr-2012 14:39

Name : Iron Oxide
Name : Magnetite, syn
Formula : FeFe2O4
Elements : O, Fe
Groups : --
Crystal type : Cubic
Subfiles : Inorganic, Minerals, Alloys, Common phases, NBS patterns, Forensics, Educational patterns
Pattern deleted: NO

d value	Angle	Rel.Int.
4.8520	18.270	8
2.9670	30.095	30
2.5320	35.423	100
2.4243	37.053	8
2.0993	43.053	20
1.7146	53.392	10
1.6158	56.944	30
1.4845	62.516	40
1.4192	65.745	2
1.3277	70.926	4
1.2807	73.950	10
1.2659	74.962	4
1.2119	78.931	2
1.1221	86.704	4
1.0930	89.620	12
1.0496	94.428	6
0.9896	102.228	2
0.9695	105.222	6
0.9632	106.209	4
0.9388	110.273	4
0.8952	118.741	2
0.8802	122.124	6
0.8569	128.038	8
0.8233	138.659	4
0.8117	143.244	6
0.8080	144.857	4

Figure J86 XRD reference pattern of magnetite.

Appendix K: Iron Ore Dressing

K.1 Instrument

Dry Magnetic Separator ERIEZ, model IMR (Induced Magnetic Roll) MAGNET 5Wx2Pol. The instrument image is shown in Figure K1.

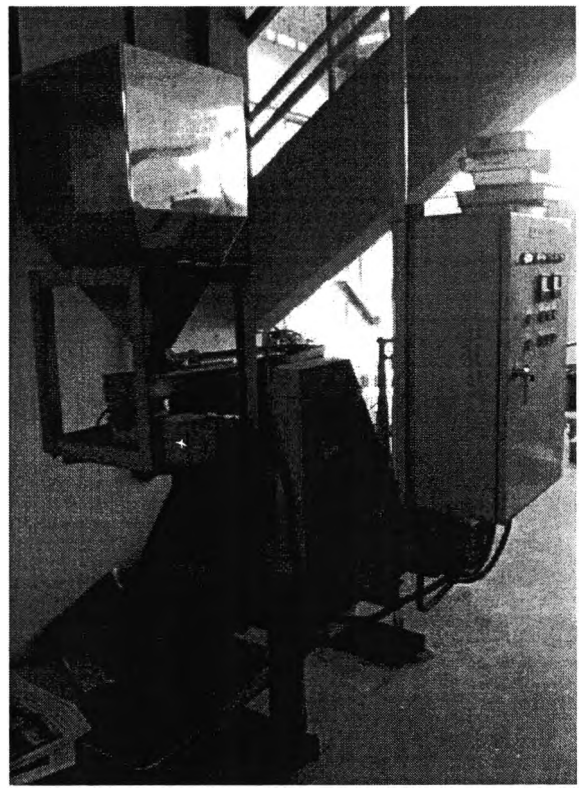


Figure K1 Dry Magnetic Separator ERIEZ, model IMR (Induced Magnetic Roll).

K.2 Experiment

The XK-03 was improved by Dry Magnetic Separator ERIEZ, model IMR MAGNET 5Wx2Pol. The magnetic current and voltage of the separation were set at 1.0A and 39V, respectively. The XK-03 was fed into the chamber of the magnetic separator and moved by a vibratory feeder on the top of the roll. The material passed through a gap between the pole of the magnet and the roll. Non-magnetic particles were separated from the roll and the magnetic particles were attracted to the roll. The weights and compositions of magnetic and non-magnetic particles were measured by a digital weight scale and XRF, respectively. The flowchart was shown in Figure K2.

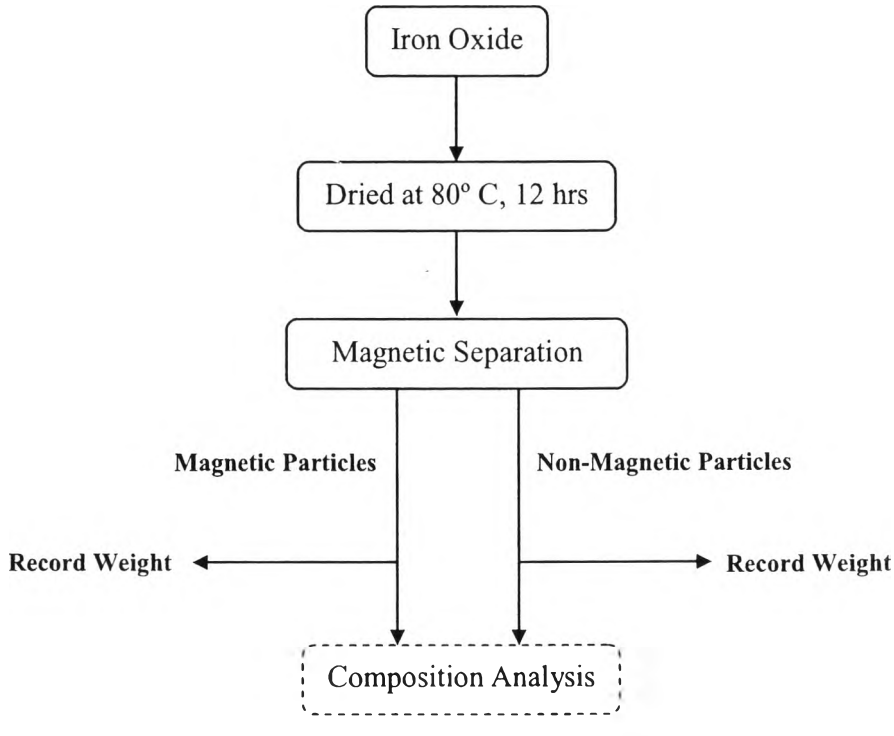


Figure K2 Iron Ore Dressing Flowchart.

K.3 Results and Discussion

The composition of magnetic (XK-03D) and non-magnetic (XK-03W) particles were observed using XRF. The raw XK-03 has 41.62 % Fe content (Appendix A) which can be classified as a low grade iron ore. The compositions of XK-03D and XK-03W are shown in Table K1, K2 respectively.

Table K1 XRF characterization of XK-03D

Element	% wt
Al	6.66
Ca	0.05518
Fe	35.8
K	1.279
Mg	0.2057
Mn	2.882
Na	0.2649
O	38.71
P	0.2773
S	0.01531
Si	13.64
Sr	0.01455
Ti	0.1896

Table K2 XRF characterization of XK-03W

Element	% wt
Al	4.749
Ca	0.04954
Fe	41.39
K	1.068
Mg	0.16
Mn	3.167
Na	0.1944
O	37.12
P	0.4057
S	0.01952
Si	11.51
Ti	0.1628

From the results, the magnetic separation method cannot improve the % Fe of low grade iron ore. The % Fe content of iron ore does not change after the separation.

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Proceedings:

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